

# ***Canada Water Act***

## Annual Report for April 2009 to March 2010





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# Foreword

The *Canada Water Act*, proclaimed on September 30, 1970, provides the framework for cooperation with provinces and territories in the conservation, development and use of Canada's water resources. Section 38 requires that a report on operations under the Act be laid before Parliament after the end of each fiscal year. This annual report covers progress on these activities from April 1, 2009, to March 31, 2010.

The report describes a wide range of federal activities conducted under the authority of the Act, including participation in federal–provincial/territorial agreements and undertakings, significant water research, and public information programs. A map depicting Canada's major drainage areas and drainage flows is provided in Figure 1.

## Provisions of the *Canada Water Act*

The following is a summary of the major provisions of the Act:

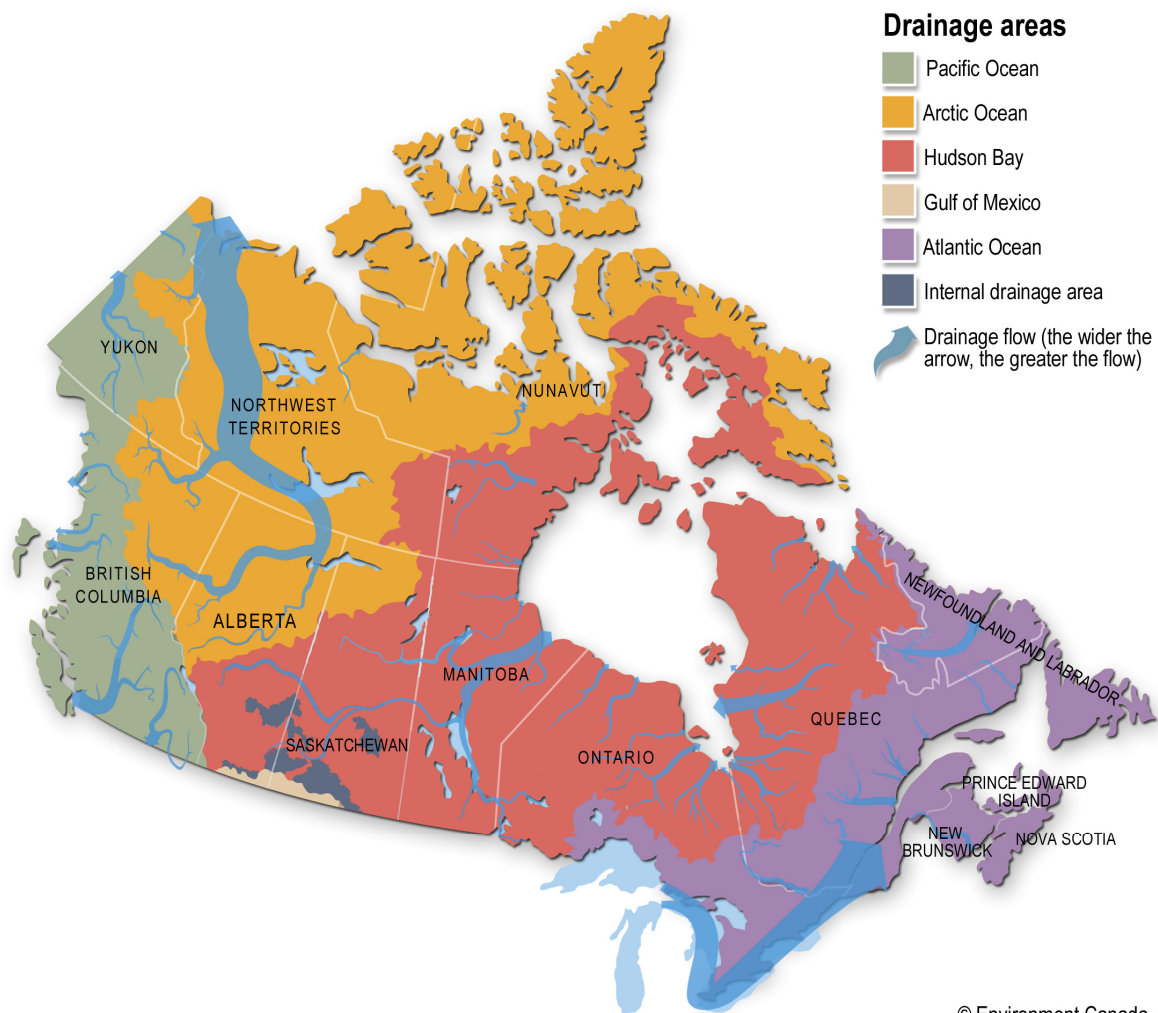
**Part I, section 4**, provides for the establishment of federal–provincial arrangements for water resource matters. **Sections 5, 6 and 8** provide the vehicle for cooperative agreements with the provinces to develop and implement plans for the management of water resources. **Section 7** enables the Minister, either directly or in cooperation with any provincial government, institution or person, to conduct research, collect data and establish inventories associated with water resources.

**Part II** provides for federal–provincial management agreements where water quality has become a matter of urgent national concern. It permits the joint establishment and use of federal or provincial incorporated agencies to plan and implement approved water-quality management programs. The application of alternative cooperative approaches and programs has resulted in **Part II** never having been used.

**Part III**, which provided for regulating the concentration of nutrients in cleaning agents and water conditioners, has been repealed. It was incorporated into the *Canadian Environmental Protection Act* in 1988 and later into sections 116–119 (Part VII, Division I) of the *Canadian Environmental Protection Act, 1999*, which came into force on March 31, 2000. (See the *Canadian Environmental Protection Act, 1999* annual reports to Parliament, available at [www.ec.gc.ca/CEPARRegistry/gene\\_info](http://www.ec.gc.ca/CEPARRegistry/gene_info).)

**Part IV** contains provisions for the general administration of the Act, including annual reporting to Parliament. In addition, **Part IV** provides for inspection and enforcement, allows the Minister to establish advisory committees, and permits the Minister, either directly or in cooperation with any government, institution or person, to undertake public information programs.

**Figure 1. Major drainage areas and drainage flows in Canada.**



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# Executive summary

This annual report on the *Canada Water Act* highlights activities under the Act from April 1, 2009, to March 31, 2010.

It has been 40 years since the *Canada Water Act* was passed by Parliament on September 30, 1970. To mark the occasion, this annual report includes a preface that reflects on what has been accomplished so far and looks forward to consider how the Act can serve us well in the coming decade.

The *Canada Water Act* provides an enabling framework for joint consultation between the federal and provincial/territorial governments in matters relating to water resources.

One of the forums for such joint consultation and cooperation is the Canadian Council of Ministers of the Environment (CCME), which engages in a number of water-related issues. In 2009–2010, the CCME endorsed both the *Canada-wide Strategy for the Management of Municipal Wastewater Effluent* and the document *Setting Strategic Directions for Water*, and continued its work on the Canadian Drinking Water Quality Guidelines.

Under the Act, data on water quantity and quality continue to be gathered and used for a wide array of purposes.

Hydrometric agreements have been administered as cooperative endeavours between most provincial governments and the federal government since 1975. These agreements provide for the collection, analysis, interpretation and dissemination of water quantity data. During 2009–2010, the Water Survey of Canada, the federal partner in the National Hydrometric Program, operated some 2200 hydrometric stations in Canada on behalf of provincial and territorial partners. There were no significant changes to the size of the hydrometric network in 2009–2010. Work continued on outreach, assistance during flood events, technology development, training and maintaining the Program's International Organization for Standardization (ISO) certification.

The Okanagan Basin Water Supply and Demand Project continued to evaluate present and future water needs and availability, which included assessing the effects of climate change impacts, population growth and water conservation measures.

A federal interdepartmental working group, led by Environment Canada, was established to begin developing a water availability indicator. This new indicator will describe water availability across Canada, and help inform the public, policy makers and other interested groups.

Environment Canada collaborates on water quality monitoring under individual agreements with British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, and Prince Edward Island. Cooperative water quality monitoring in Quebec is conducted through the St. Lawrence Plan. In 2009–2010, measurements at numerous water quality monitoring stations for groundwater, inland freshwater and transboundary waters were used to assess and report on status and trends, and evaluate the progress of protection and remediation programs. Benthic and aquatic habitat monitoring was also undertaken as part of the Canadian Aquatic Biomonitoring Network, which provides a nationally standardized protocol for the collection, identification and reporting of data.

Federal–provincial/territorial water quality data, as well as data from numerous other federal sites, contribute to the calculation of the Water Quality Index, which the federal government publishes as one of the Canadian Environmental Sustainability Indicators. The 2009 Canadian Environmental Sustainability Indicators report is based on data collected from 2005 to 2007 across a new core network of sampling stations. Among other highlights, freshwater quality measured at 153 river sites across Canada was rated as “good” or “excellent” at 39% of sites, “fair” at 43%, and “marginal” or “poor” at 18%.

This report summarizes the 2009–2010 activities of four inter-jurisdictional water boards: the Ottawa River Regulation Planning Board, the Prairie Provinces Water Board, the Mackenzie River Basin Board, and the Lake of the Woods Control Board. These boards tailored their activities to the needs in each region. These activities address issues such as the integrated management of reservoirs, flood protection, transboundary apportionment, water quality, relations between adjoining jurisdictions and development activities.

The Canadian Federal Great Lakes Program is a partnership of federal departments. It provides the framework for working toward Canada's commitments under the Canada–United States Great Lakes Water Quality Agreement, the key mechanism for protecting water quality and the health of the aquatic ecosystem in the Great Lakes. The Great Lakes Program also provides the federal focal point for cooperation with the Province of Ontario on these issues. Canada's activities are integrated with those of Ontario through the Canada–Ontario Agreement Respecting the Great Lakes Basin Ecosystem, which outlines how the two governments will cooperate and coordinate their efforts to restore, protect and conserve the Great Lakes Basin ecosystem. The Canada–Ontario Agreement plays a significant role in meeting Canada's obligations under the Canada–United States Agreement. Highlights of actions in 2009–2010 include a wide range of research, monitoring and restoration projects in Great Lakes Areas of Concern through the Great Lakes Action Plan as well as other projects through the Great Lakes and Regional Environmental Quality Monitoring and Surveillance program; projects to reduce the amount of nutrients, solids and bacteria entering watercourses; and research in support of Canada–U.S. Lakewide Management Plans.

The St. Lawrence Plan, initiated in 1988, is a Canada–Quebec Ecosystem Initiative to protect, conserve and restore the St. Lawrence River ecosystem. The 2005–2010 agreement signed between the federal government and the Province of Quebec ended March 31, 2010. This fourth phase of the St. Lawrence Plan continued the implementation of measures to conserve, protect and restore the ecosystem as well as recover its uses. In collaboration with government, community and industry partners, this extensive initiative undertakes numerous projects through various programs, such as the ZIP ([priority intervention zones]) program, the Community Interaction Program, and the Monitoring the State of the St. Lawrence River Program. In 2009–2010, activities included monitoring shore erosion and sediment and water quality; conducting research on the effects of nutrients and invasive species; and reporting on the health of the St. Lawrence ecosystem.

The Atlantic Ecosystem Initiative consists of two programs: the Atlantic Coastal Action Program, which is a unique community-based partnership program between Environment Canada and 16 multi-stakeholder community organizations in the four Atlantic provinces; and a program with regional coalitions whose work positively impacts larger ecosystems in the Gulf of Maine, the Southern Gulf of St. Lawrence and the Bay of Fundy. Both programs support initiatives that use local and regional expertise, and support people who are working in their own communities and regions to help build a better environment for Canadians. In 2009–2010, 34 projects, representing almost 60% of all projects under the Initiative, dealt with water issues; these included education, outreach and monitoring activities that contributed to the restoration, enhancement and improvement of water quality and watersheds.

In Environment Canada's regional offices, work is underway to coordinate the Department's intervention in priority ecosystems when neither formal agreements nor ecosystem initiatives exist.

This report also describes Environment Canada's work under the federal government's Action Plan for Clean Water, which provides \$96 million in cleanup funding to restore Lake Simcoe, Lake Winnipeg and Areas of Concern in the Great Lakes. In 2009–2010, projects funded in the Canadian Great Lakes Areas of Concern consisted of the implementation of remedial plans for contaminated sediment. The Lake Simcoe Clean-up Fund provided \$5.5 million in funding in 2009–2010 for 44 projects that focused on pollution reduction and the restoration of the lake's ecological integrity and coldwater fishery. Work under the four-year, \$18-million Lake Winnipeg Basin Initiative in 2009–2010 included the establishment of the Lake Winnipeg Basin Office to oversee and coordinate the components of the initiative, the initiation of a number of stewardship projects, and

various research and monitoring activities. The Action Plan for Clean Water also encompasses the Health of the Oceans Initiatives (HOTO). As part of its involvement in HOTO, Environment Canada received a total of \$0.75 million over five years towards activities in the Gulf of Maine. In 2009–2010, Environment Canada continued to support the activities of the Gulf of Maine Council on the Marine Environment.

In 2009–2010, Environment Canada scientists carried out numerous research projects on various current and emerging issues, such as testing methodologies, wastewater treatment technologies, oil sands related research, pharmaceuticals and personal care products, pathogens and parasites, nutrients, pesticides and agricultural runoff, nanoparticles, mercury, the health of aquatic ecosystems, water-related issues in northern Canada and hydro-meteorological modelling and prediction.

Environment Canada continued to provide water-related public information and water awareness activities through its Water website ([www.ec.gc.ca/eau-water](http://www.ec.gc.ca/eau-water)), which, as part of the Internet Content Renovation Initiative, integrates content that was previously part of other water-related websites in the department. In addition, the Biosphère Environment Museum ([www.biosphere.ec.gc.ca](http://www.biosphere.ec.gc.ca)) offered interactive exhibitions and guided activities designed to help visitors better understand major environmental issues, including those related to water.

# Preface — Forty years of Stewardship under the *Canada Water Act*

It has been 40 years since the *Canada Water Act* was passed by Parliament on September 30, 1970. What better time to reflect on what has been accomplished so far and look forward to consider how the Act can serve us well in the coming decade.

Both Canada and the world are different places than they were four decades ago, and many of the changes have influenced water management in Canada and elsewhere. There are many more and new players with a stake in our water resources; we are facing new and complex issues; and we have more and different tools and approaches to meet these challenges. Yet the main goals of the Act—to improve our knowledge base, facilitate cooperative federal–provincial arrangements for water management, and increase the degree of public participation—are as relevant today as when the *Canada Water Act* was passed. There are few major lakes and rivers in Canada that are not part of a watershed that straddles provincial, territorial or international borders, and it is still necessary to respond to the shared jurisdiction over water resources between the federal and provincial/territorial governments. The Act continues to be a primary authority for joint federal–provincial/territorial research and measures to support the sustainable use of Canada’s water resources.

There has been some important progress in how Canada manages its water resources during the past four decades, and many of these accomplishments can be attributed to the broad enabling framework that the *Canada Water Act* provides.

## ***Flood damage reduction strategies***

One early, tangible accomplishment was our adjustment to the hazard posed by floods. Water control structures (major dams, diversions and dykes) benefited from federal funding in the early years of the Act. Seen as necessary in their time to reduce the risk of flood damage in established communities, these undertakings were later viewed as a more appropriate responsibility for provincial and local governments. Between 1975 and 1998, the federal Flood Damage Reduction Program was designed to discourage unwise settlement on floodplains. The program consisted of flood-zone mapping and was implemented in cooperation with nine provinces and Indian and Northern Affairs Canada (on behalf of the Northwest Territories and reserves). Over 900 communities across the country were included in areas mapped and designated under the Flood Damage Reduction Program. Today, with the frequent occurrence of extreme weather events, all levels of government and the public increasingly require and rely on accurate flood forecasting capabilities. In this context, these original flood zone maps are still being used. A number of provinces and territories have since introduced independent programs intended to rationalize land use in floodplains, and the development of models to forecast these extreme events is ongoing.

## ***Water governance***

Another area where water resource management has evolved is water governance. Because water does not stop flowing at political borders, the safety and security of our water resources depend on Canada’s participation in bilateral and multilateral negotiations on environmental standards and controls. A key provision of the Act enables the federal government to conclude cooperative agreements and undertakings with provincial and territorial governments where there is “significant national interest.” To date, approximately 70 cost-sharing agreements have been authorized under the Act. During the 1970s, a number of these were comprehensive river basin planning agreements that produced a more complete picture of Canada’s water resources. Others are consultative arrangements that involve the formation of specific agencies, boards or committees. These committees maintain continuing consultation on water resource matters and advise on priorities for research, planning, conservation, development and utilization; advise on the formation of water policies and programs; and

facilitate the coordination and implementation of these policies and programs. Two federal–provincial boards (Ottawa River Regulation Planning Board and Prairie Provinces Water Board) and one federal–provincial–territorial board (Mackenzie River Basin Board) implement agreements related to water resource management and continue to be models of inter-jurisdictional cooperation. The Lake of the Woods Control Board, established before the *Canada Water Act* was passed, is often reported on in *Canada Water Act* annual reports to provide a more complete picture of federal–provincial water management in Canada. Reporting under the Act does not include the activities under various binational agreements and international governance mechanisms like the International Joint Commission boards of control used to manage boundary and transboundary waters between Canada and the United States.

Cooperative arrangements have established water quantity and quality monitoring networks throughout the country. The federal and provincial/territorial governments cooperate on the collection of water quantity information through formal hydrometric agreements that have been administered cooperatively since 1975. Today, there are agreements on water quantity surveys with all provinces and Indian and Northern Affairs Canada for the territories. Environment Canada, along with its partners, operates over 2200 hydrometric gauges across the country.

Beginning in the early 1980s, water quality monitoring agreements were negotiated between the federal government and governments in several provinces to achieve long-term commitments for the acquisition of comparable, scientifically sound data for the purposes of water resource management and to disseminate timely information on water quality to the public, government agencies, industry and the scientific community. Five federal–provincial water quality monitoring agreements are active today (British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, and Prince Edward Island), and other forms of agreements exist to establish partnerships for the monitoring of water quality in the other provinces.

The early 1980s marked another significant event in Canadian water governance. Faced with concerns over a broad range of cross-cutting issues—including climate change, acid rain, the contamination of entire drainage basins or large aquifers by toxic substances, regional water shortages, interbasin transfers and water export—the federal government sought ideas and public consensus on how to respond to these issues and needs. The result was the Inquiry on Federal Water Policy established in 1984 under the authority of Part IV (section 28) of the *Canada Water Act*. This work ultimately led, in 1987, to the Federal Water Policy—the first official statement by the federal government of its approach to water management and indirectly, its administration of the *Canada Water Act*. The overall objective of the Federal Water Policy is to encourage the use of freshwater in an efficient and equitable manner consistent with the social, economic, and environmental needs of present and future generations. The five strategies proposed to reach this goal contain many of the recognized characteristics of the process that we now call integrated watershed management.

Over the past 40 years, governments have come to realize that the most successful approach to water governance is one that can be described as “policy with” rather than “policy to,” meaning stakeholders are extensively engaged in priority setting and outcomes. The range of groups interested in water issues is broad and includes all levels of government, Aboriginal peoples, environmental groups, industry, community groups, research teams and citizens. The full partnership of these groups and individuals not only fosters an enabling environment that encourages action, but also creates the expectation of results.

Ecosystem Initiatives, such as the Great Lakes Action Plan, the St. Lawrence Plan and the Atlantic Ecosystem Initiative are good examples of the results that have been achieved through this type of collaborative governance mechanism. They have been described in the *Canada Water Act* annual reports since 1999–2000. More recently, the Lake Winnipeg Basin Initiative and the Lake Simcoe Clean-up Fund have been initiated under Canada’s Action Plan for Clean Water.

## ***Water research***

The foundation of good policy and decision making is good science—both physical science and social science—based on research, monitoring, and analytical and modelling techniques. It is not surprising then that significant water research has been conducted across the country under the authority of the *Canada Water Act*. This research has greatly increased our capacity to manage conventional water pollution; scientists and engineers can better predict the frequency of extreme droughts and floods; there is considerable expertise in watershed management for multiple uses; and, through water use surveys, we better understand the economic and social dimensions of water problems, such as pricing and allocation. The last 40 years have seen a heightening of concern over the impact of pollution on water quality, and research into water quality at Environment Canada has reflected these concerns. Early research efforts to mitigate water quality issues were concentrated on resolving the most visible concerns, such as eutrophication and single-point sources of effluents. Building on this early research, scientists gradually discovered more about the presence and long-term effects of problems such as persistent, bioaccumulative toxic pollutants and less obvious pollutants like endocrine-disrupting chemicals. Today, significant progress is being made on new substances of concern such as the products of nanotechnology. Since 1986, Environment Canada's Science and Technology Branch, in partnership with Canadian and international science communities, has conducted a considerable amount of key research on the health of aquatic ecosystems. It has also developed advanced technologies and methodologies, and built state-of-the-art laboratories like the Aquatic Life Research Facility in Burlington, Ontario.

Data on water flows and levels is used for various purposes, including navigation, forecasting droughts and floods, managing the water supply and electric power production, and studying environmental issues such as climate change.

Canadian researchers use baseline data collected over many years from national water and climate surveys in computer models to analyze and predict the volume of water available for various uses and conditions in watersheds and specific locations. As water availability becomes more of a concern, we continue to shift away from water supply management toward demand management, and we place added importance on providing for environmental flow needs. Water quantity information will remain vital in assessing our success in sustaining all the beneficial functions of freshwater environments.

## ***Public information***

Canadians' relationship with freshwater has changed since the *Canada Water Act* was passed. Where once water was seen as an inexhaustible resource that could be taken for granted, today the majority of Canadians rank freshwater as the country's most important natural resource, ahead of forests, agriculture and farmland, oil and fisheries.<sup>1</sup> Under Part IV of the Act, Environment Canada has used various tools over the years to disseminate water-related information—from media announcements related to the Flood Damage Reduction Program and publications aimed at the general public to information workshops, educational materials and comprehensive websites. Over the years, the public information program has become less focused on information on water management programs and more focused on educating citizens, including children, on the state of their water resources and empowering them to use the resource responsibly. In addition, new tools such as the Water Quality Index and Water Availability Indicator described in this report are used to summarize the status of surface freshwater quality and availability in Canada.

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<sup>1</sup> 2010 Canadian Water Attitudes Study, commissioned by the Royal Bank of Canada and Unilever Canada.

### ***The next decade***

The 40 years of the *Canada Water Act* have marked a period of evolution in Canada's approach to water resource management—from short-term to long-range planning; from a single-purpose approach to an integrated one; from localized projects to planning that encompasses the whole watershed and requires intergovernmental cooperation; from top-down policy making to decisions that are inclusive of many different stakeholders.

The strength of the *Canada Water Act* lies in its broad enabling framework. In dealing with a resource that defies jurisdictional boundaries, the Act has enabled the federal government to operate through voluntary agreements, joint activities and cost-sharing rather than through regulation. With heightening concern over the impact of climate change and development on Canada's water supply, water quality and aquatic biodiversity, there is greater public recognition of the need for sustainable water management and of the important role of this enabling legislation.

We still face serious water-related challenges requiring extensive research. Many of these current and emerging issues are international in scope and will require an interdisciplinary approach to water research, policy development and implementation. But change is not new, and over the years the *Canada Water Act* has proven flexible enough to respond to emerging issues and to adapt to the constant evolution of approaches related to environmental and resource management.



# COMPREHENSIVE WATER RESOURCE MANAGEMENT

## (Part I of the *Canada Water Act*)

### 1 Federal–provincial/ territorial programs

In Canada, the different levels of government have different jurisdictional roles related to the management of water resources, while there are also many areas of shared commitment.

Canadian provinces and one of the territories (Yukon) have the primary jurisdiction over most areas of water management and protection. Most of these governments delegate some authority to municipalities, in particular drinking water treatment and distribution, and wastewater treatment operations in urban areas. They may also delegate some water resource management functions to local authorities that are responsible for a particular area or river basin.

The federal government has responsibilities for managing water on federal lands (e.g., national parks), federal facilities (e.g., office buildings, labs, penitentiaries, military bases), First Nation reserves, as well as two of Canada's three territories (Nunavut and the Northwest Territories).

The *Canada Water Act* provides an enabling framework for joint consultation among the federal and provincial/territorial governments in matters relating to water resources. Joint projects involve the regulation, apportionment, monitoring or survey of water resources, and the pre-planning, planning or implementation of sustainable water resource programs.

Agreements for specific water programs require the participating governments to contribute funding, information and expertise in agreed ratios. For ongoing activities such as the water quantity survey agreements with each province, cost-sharing is in accordance with each party's need for the data. For study and planning agreements, the federal government and the provincial government each

assume half of the costs. The planning studies encompass interprovincial, international or other water basins where federal interests are important. Implementation of planning recommendations occurs on a federal, provincial, and federal–provincial basis. Cost-sharing for the construction of works often includes a contribution from local governments. A list of current agreements can be found in Appendix A of this annual report.

This section describes federal, provincial and territorial collaboration in the following areas:

- the Canadian Council of Ministers of the Environment
- data collection and use
- inter-jurisdictional water boards
- ecosystem initiatives

### 1.1 Federal–provincial cooperation

#### **Background**

The Canadian Council of Ministers of the Environment (CCME) is composed of the environment ministers from the federal, provincial and territorial governments. These 14 ministers normally meet at least once a year to discuss national environmental priorities and determine work to be carried out under the auspices of the CCME. The Council seeks to achieve positive environmental results, focusing on issues that are national in scope and that require collective attention by a number of governments. Through collaborative efforts, CCME working groups develop recommendations for ministers' consideration. Once approved, these products are available for use by CCME's member governments in their environmental management role.

#### **Progress to March 31, 2010**

During 2009–2010, CCME continued its work to develop and produce the Canadian Water Quality

Guidelines that provide nationally endorsed science-based goals for the quality of aquatic ecosystems. Additional water priorities through CCME included water and climate change; water valuation; groundwater resources and management; integration of water, environment and land-use planning; management approaches to water quantity issues; nutrient and trace contaminant loadings to ground and surface waters; and public perception of water.

In October 2009, ministers endorsed a document entitled *Setting Strategic Directions for Water*, a forward-looking framework intended to guide the CCME in its future actions and activities related to water. A three-year action plan to support the framework will be considered by ministers at the fall 2010 meeting.

The CCME also endorsed the *Canada-wide Strategy for the Management of Municipal Wastewater Effluent* in February 2009. The strategy, which will be implemented under the *Fisheries Act*, sets out a harmonized framework to manage discharges from more than 3500 wastewater facilities in Canada.

## 1.2 Data collection and use

### 1.2.1 The National Hydrometric Program

#### **Background**

Formal bilateral hydrometric agreements between most provincial/territorial governments and the federal government have been administered cooperatively since 1975. These agreements provide for the collection, analysis, interpretation and dissemination of water quantity data to meet a wide range of needs in the hydrology community.

Under the Partnership Renewal Process initiative, government partners have been reviewing, updating and revising the 1975 bilateral agreements. With new bilateral agreements signed between Canada and four provinces (Manitoba, Alberta, Quebec and Ontario) in 2008, the initiative is coming to a conclusion. Throughout 2009–2010, negotiations continued with the remaining provinces and territories, and a number of remaining bilateral agreements are expected to be signed in late 2010.

#### **Progress to March 31, 2010**

##### *Governance*

Both the National Administrators Table and the National Hydrometric Program Coordinators' Committee met regularly throughout 2009–2010 to discuss program issues. As part of their commitment to the principle of co-management under the National Hydrometric Program, a face-to-face meeting was held between the two groups in September 2009. The National Administrators Table reviewed progress under the Strategic Framework for the National Administrators Table, whose vision statement contemplates "leadership across Canada in timely service delivery of relevant, quality, responsive, integrated and standardized hydro-meteorological information and analysis that meets client and government needs." Other agenda items for the meeting included a presentation to the National Administrators Table on the results of Environment Canada's internal audit of hydrometric monitoring; a presentation to the National Administrators Table on climate change and its implications for hydrologic monitoring by the Yukon Department of the Environment; an update on the National Administrators Table's National Performance Measures Framework initiative; a discussion of human resources strategies for the National Hydrometric Program; a session on improving opportunities for coordination and communication strategies between the National Administrators Table and the National Hydrometric Program Coordinators' Committee; and a report to the National Administrators Table by the National Hydrometric Program Coordinators' Committee.

##### *The Network*

During 2009–2010 the Water Survey of Canada, the federal partner in the National Hydrometric Program, operated some 2200 hydrometric stations in Canada on behalf of the provincial and territorial partners. For the Province of Quebec, which is responsible for its own network, the ministère du Développement durable, de l'Environnement et des Parcs operated some 200 hydrometric stations under the National Hydrometric Program.

Although there were no significant changes to the size of the national hydrometric network in 2009–2010, there were adjustments to the network.

These adjustments included continued expansion in Newfoundland and Labrador, where three new provincial hydrometric stations were added in the Churchill Basin in Labrador in the context of the Lower Churchill hydroelectric development. One station was discontinued in Nova Scotia. There were no changes to the number of stations in Quebec, Ontario, Manitoba, Saskatchewan, Alberta and Yukon. In British Columbia, seven stations were added and one station was discontinued. In the Northwest Territories and Nunavut, the size of the shared network was reduced, and the operating periods at several stations were shortened owing to funding restraints. The number of hydrometric stations operated by Environment Canada for other clients on a full cost-recovery basis remained steady in 2009–2010.

### *Outreach*

The Water Survey of Canada participated in the annual Canadian Water Resources Association conference in Québec in June 2009 to showcase the National Hydrometric Program and to bring attention to its products and services. The overall feedback indicated that the information was well received, and participants gained a better understanding of the National Hydrometric Program and its products.

In particular, the clients of the federal–provincial/territorial hydrometric agreements shared their thoughts on the current value of the Water Survey of Canada's data products and services for their respective programs, and on what data products and services their programs will need in the future. Many of the clients use both real-time and historical data, with a majority indicating a need for reliable real-time water quantity information.

Considerable attention was directed to stabilizing the real-time Web service for hydrometric data in Canada. The new Common Look and Feel-compliant Web service under the WaterOffice portal was developed in 2009–2010 and will be operational as of May 2010.

### *Floods*

Record high snowfall conditions, combined with above-normal soil moisture conditions, produced near-record flood conditions for the Red River in

Manitoba and its tributaries in April through to late May 2009. The National Hydrometric Program's managers and technologists maintained close contact with and provided continuous water quantity information to the Manitoba River Forecast Centre during the flood period. Field crews from various regions in Canada were brought in to assist the Manitoba-based staff. These field crews were assigned to target flow measurements in the flooded areas. The real-time network, which reports hourly on the hydrometric conditions for the entire Province of Manitoba, demonstrated the significant utility of this mode of operation for managing flood situations.

A dry spring and summer in British Columbia resulted in low streamflow and drought conditions for most of the south and central interior of British Columbia. Low streamflow conditions were also experienced in southern Alberta and Saskatchewan.

In fall 2009, high flows were experienced on the south coast of British Columbia and Vancouver Island. There was extensive flooding on Vancouver Island. During this flooding episode, the National Hydrometric Program's managers and technologists, as well as the weather preparedness meteorologists, maintained close contact with and provided continuous water quantity information to British Columbia's River Forecast Centre.

### *Technology*

During 2009–2010, progress continued toward the implementation of the Hydrometric Work Station, a tool that will manage the National Hydrometric Program's entire data production process. The customization of the software to fully integrate the Water Survey of Canada's quality control processes was completed. The initial installation of the new Hydrometric Work Station will begin in early summer 2010.

The National Hydrometric Program continued to expand its installation, testing and implementation of new field technologies. In particular, the program continued to certify field staff in the correct use of acoustic equipment, and expanded the use of this equipment for field measurements in all regions of Canada. As a result, in 2009–2010 a majority of the field measurements were conducted using

acoustic technologies, thereby providing more reliable data.

### *ISO certification*

The federal National Hydrometric Program continued to maintain its International Organization for Standardization (ISO) certification during 2009–2010, and several internal and external audits were performed at various offices throughout Canada as required under the ISO process.

## 1.2.2 Water use and supply

### 1.2.2.1 Okanagan Basin Water Supply and Demand Project

#### **Background**

Initiated in 2006, the Okanagan Basin Water Supply and Demand Project estimates present and future water needs and availability, to inform water management and planning decisions in the Okanagan Basin of British Columbia. This assessment uses available data on a multitude of relevant factors including hydrology, climate and land use. The project also assesses the potential effects of climate change impacts, regional growth and water conservation measures on water use and availability under different scenarios.

British Columbia's Ministry of Environment leads the project in collaboration with the Okanagan Basin Water Board, the provincial Ministry of Agriculture and Lands, and the Ministry of Community and Rural Development. Environment Canada, Agriculture and Agri-Food Canada, and Fisheries and Oceans Canada also participate along with the Okanagan Nation Alliance, the University of British Columbia (Okanagan), Simon Fraser University, the BC Agriculture Council, the Water Supply Association of British Columbia, and the Planning Association of British Columbia.

#### **Progress to March 31, 2010**

The project identified data sources and gathered data, including Environment Canada climate data and hydrological data from stations located in the Okanagan Basin. In 2009–2010, Environment Canada provided technical support to obtain

basin-wide estimates of precipitation and evapotranspiration losses and determine how these important water balance factors could be affected under different climate change scenarios. Environment Canada also continued to participate in a basin-wide groundwater balance assessment as well as basin-wide assessments of instream flow needs, hydrology and water use and demand. A water balance computer model was used to assess the effects of different scenarios for potential climate change impacts, Mountain Pine Beetle infestation, regional growth and water conservation measures. Access to information provided by the Okanagan Basin Water Supply and Demand Study will be facilitated through an interactive website that is being developed and will be hosted by the Okanagan Basin Water Board.

### 1.2.2.2 Water Availability Indicator Initiative

The sustainability of freshwater supplies is a growing concern worldwide. Pressures—rapid urbanization, industrial expansion, agricultural intensification, and the impacts of climate change to name a few—stress water supply and affect the health of aquatic ecosystems. To ensure continued sustainability of freshwater for human use and ecosystem support, the water availability status in Canada must be tracked.

Following a recommendation of the National Round Table on the Environment and the Economy, a federal interdepartmental working group was established in 2006 to begin developing the Water Availability Indicator (WAI), which will describe the availability of water across Canada. The working group, led by Environment Canada, includes members from Statistics Canada, Natural Resources Canada, Fisheries and Oceans Canada, Agriculture and Agri-Food Canada, the Canadian Water Resources Association, and the International Institute for Sustainable Development. The working group held a series of workshops to select, review and refine the indicator.

The WAI will provide an important addition to the assessment of water resources in Canada. It will help to inform the Canadian public, policy makers, other decision makers and interested groups. The goal of the initiative is to create an indicator that

can be used to provide a nationally and regionally relevant picture of water availability.

In October 2009, Environment Canada endorsed the WAI initiative to report on water demand and availability in Canada. Work is underway to finalize the methodology, design and testing of the water demand and availability ratio.

Water availability refers to the volume of water in our rivers compared with the amount of water being used. This indicator is being derived by calculating the ratio of water demand to water availability at the sub-drainage area scale (representing 164 watersheds across Canada) on an annual basis. To calculate the ratio, a geographical information system is used to analyze water use data from several federal water use surveys and streamflow values from Water Survey of Canada HYDAT stations in a spatial and temporal frame relevant to water availability issues. Other available sources of data are used for validation purposes.

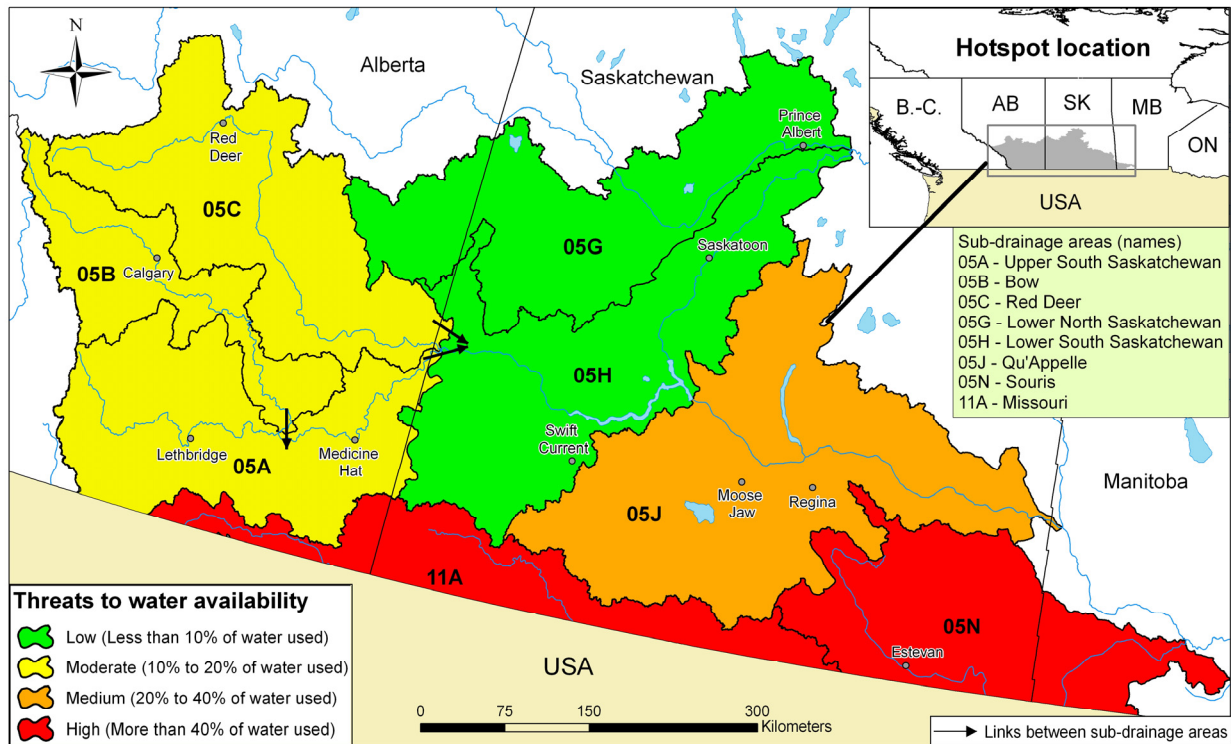
The indicator will be presented in maps and graphs at a national scale but is also intended to be regionally relevant and use currently available data. Sub-drainage areas that have existing or potential water scarcity problems like the southern Prairies

and the British Columbia interior (e.g., the Okanagan region) will be the initial focus of the project. The indicator will be estimated using data for the years 2005 and 2007. The first results of the initiative will be published in the 2010–2011 *Canada Water Act* annual report.

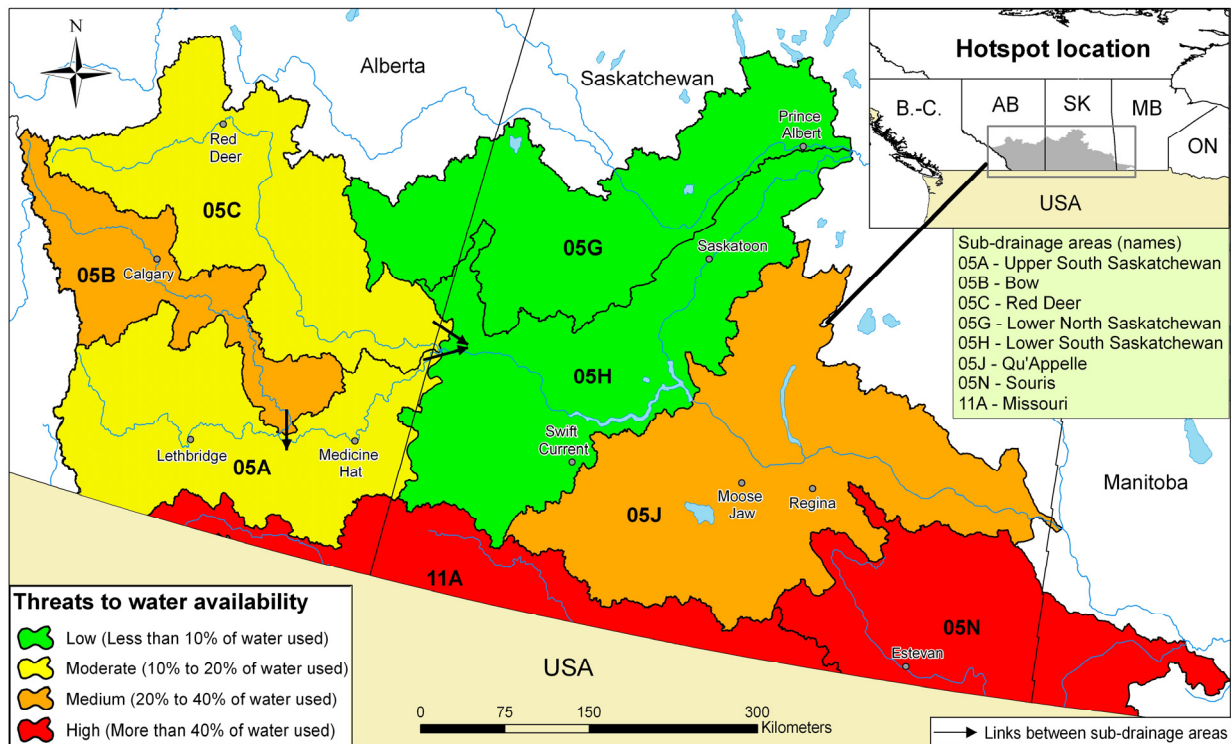
A case study of the water demand and availability ratio was done in the Mixed Grasslands sub-drainage areas located in the southern parts of Alberta and Saskatchewan. This region is known historically as a dry area with low precipitation. Although streamflow records indicate that 2005 was a relatively wet year, the water availability ratios in the Mixed Grasslands region were high (more than 40% of water used) for the Missouri and Souris sub-drainage areas and medium (20% to 40% of water used) for the Qu'Appelle sub-drainage area. For 2007, which experienced above-normal rainfall, the ratio for the Bow sub-drainage area increased from moderate (in 2005) to medium, while the ratios of the other sub-drainage areas remained unchanged from 2005. These ratios would likely be even higher for years with normal or below-normal rainfall. Figure 2 shows the water availability ratios in the Mixed Grasslands region for 2005 and 2007.

Figure 2. Preliminary water availability ratios in the Mixed Grasslands sub-drainage areas for 2005 and 2007.

**Threats to water availability in 2005 for the sub-drainage areas in the Mixed Grasslands hotspot**



**Threats to water availability in 2007 for the sub-drainage areas in the Mixed Grasslands hotspot**



## 1.2.3 Water quality

### **Background**

Beginning in the early 1980s, agreements were negotiated between the federal government and several provinces, including Quebec (1983), British Columbia (1985), Newfoundland (1986), Manitoba (1988), New Brunswick (1988) and Prince Edward Island (1989). The agreement with New Brunswick was revised in 1995 when the provincial government undertook to collect, analyze and manage the data for the water quality monitoring program.

The agreement with Prince Edward Island was incorporated into the Canada–Prince Edward Island Water Annex in 1996, which expired in 1999 and was replaced with the Canada–Prince Edward Island Memorandum of Agreement on Water, signed in May 2001. Water quality monitoring continued under this new agreement. The agreement with Quebec was terminated in 1995, because activities were similar to those in the St. Lawrence Plan (see Section 1.4.2). In the context of the 2005–2010 Canada–Quebec agreement, the St. Lawrence Plan includes a specific annex for the Monitoring the State of the St. Lawrence River Program.

To assess water quality, water samples are collected at various field sampling sites, at which time physical characteristics of the aquatic environment, such as temperature, pH and conductivity, can be measured. The water samples are then typically sent to one of Environment Canada's laboratories for environmental testing. The chemical analysis that is conducted on the samples varies depending on the province where the samples were collected, according to the specific objectives of the federal–provincial agreement. The general chemical parameters that are determined include nutrients, major ions, metals and a variety of organic and inorganic chemicals, along with laboratory measures of pH and conductivity to complement field data. Depending on specific regional requirements, more complex chemical analysis of water samples may also be performed to measure the levels of other compounds, such as pesticides, pharmaceuticals and petrochemicals. Results for the physical and chemical water quality monitoring are stored in, and made accessible through, a nationally distributed

network of water quality databases managed by Environment Canada.

The biological health of freshwater in Canada is monitored through the Canadian Aquatic Biomonitoring Network (CABIN) ([www.ec.gc.ca/rcba-cabin/](http://www.ec.gc.ca/rcba-cabin/)), which is an aquatic biological monitoring program for assessing the health of freshwater ecosystems in Canada. CABIN is based on a network-of-networks approach that promotes interagency collaboration and data sharing to achieve consistent and comparable reporting on freshwater quality and aquatic ecosystem conditions in Canada. The program is maintained by Environment Canada to support the collection, assessment, reporting and distribution of biological monitoring information. CABIN allows partners to take their observations and make a formalized scientific assessment using nationally comparable standards. A set of national CABIN protocols are used for field collection, laboratory work and analysis of biological monitoring data. A training program is available to partners to increase biomonitoring capacity nationally. National protocols and trained participants across the country result in a larger possible number of water quality assessments through data and resource sharing.

### **Progress to March 31, 2010**

Environment Canada's Fresh Water Quality Monitoring Program collected approximately 2300 samples at 343 sites to meet the obligations outlined as part of five federal–provincial water quality agreements as well as the requirements of various interprovincial and international transboundary watershed boards (see Section 1.3). These samples resulted in the addition of 120 000 measurements of various parameters to help determine the quality of Canada's water. Furthermore, data from 316 samples collected at 298 sites across Canada were incorporated into CABIN's database; 202 of these samples (190 sites) were collected by Environment Canada, while the remainder were collected by network partners. In addition to contributions from Environment Canada's network of biomonitoring sites, data were also provided by various other agencies including Parks Canada, Indian and Northern Affairs Canada, Fisheries and Oceans

Canada, provincial and territorial governments, industry and community groups.

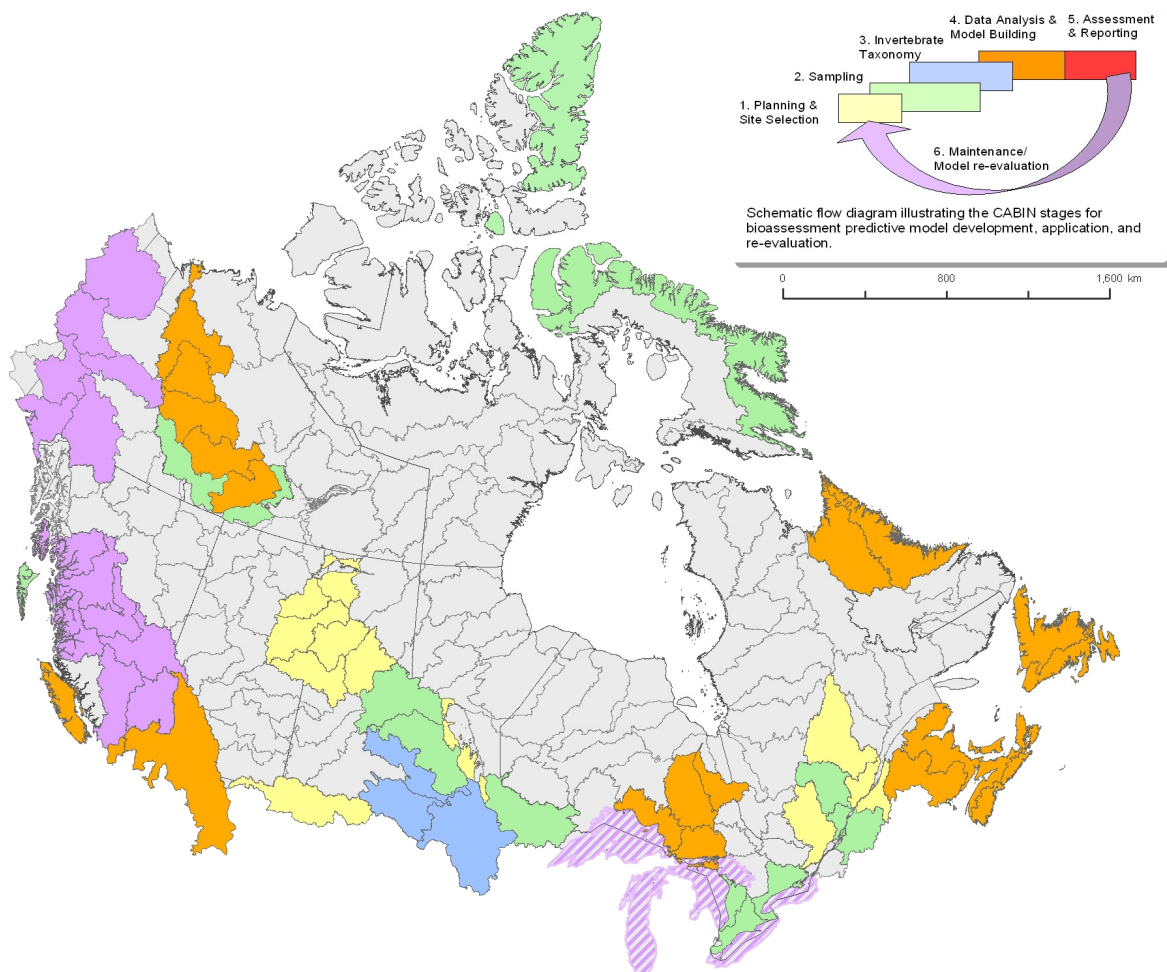
### CABIN

During 2009–2010, CABIN, in partnership with the Canadian Rivers Institute of the University of New Brunswick, continued to provide an online program that trains partners to implement the Network’s standardized protocol and to share resulting data within the national network. Over 100 students from across the country participated in the online training course. In-person field certification courses were held in a number of cities across Canada. Additionally, the International Polar Year initiative continued to provide an opportunity to expand training in Canada’s northern regions. As the number of CABIN-trained participants increases, the ability to generate new data and water quality assessments improves at the same time. New field

sampling and laboratory methods manuals were produced to promote consistency of data nationally. Data were collected across the country at sites where anthropogenic effects are minimal to build reference models that will be used to assess the biological health of freshwaters.

Reference models for water quality assessment are available for Yukon, British Columbia and the Great Lakes. Since CABIN was implemented nationally in 2006, reference-site data have been collected in several sub-basins across the country. These sub-basins are shown on the map in Figure 3, which also indicates the stage of the CABIN program for each sub-basin. In 2009–2010, data were collected at several hundred CABIN sites by Environment Canada and its partners with the aim of both building reference models and making water quality assessments.

**Figure 3. Stages of the CABIN program for water quality assessments using biomonitoring methods.**



### *British Columbia and Yukon*

Under the Canada–British Columbia Water Quality Monitoring Agreement, Environment Canada and the provincial Ministry of Environment jointly conducted water quality monitoring at 42 stream and river sites in British Columbia; the data and information from these sites are available on the freshwater quality monitoring section of the Environment Canada Water website ([www.ec.gc.ca/eaoudouce-freshwater](http://www.ec.gc.ca/eaoudouce-freshwater)). The majority of these sites are transboundary, on significant tributaries to transboundary waterways, or of other federal importance (e.g., Global Environmental Monitoring System stations, sites on Canadian heritage rivers, sites monitored for Olympic 2010 impacts and/or Canadian Environmental Sustainability Indicator reporting). Data from 39 of these sites were included in the 2009 Canadian Environmental Sustainability Indicators report (described in Section 1.2.4). Additionally, the B.C. Ministry of Environment and Environment Canada produced a more in-depth water quality assessment report for five sites located in the transboundary Kootenay River basin. Through CABIN, biological sampling is also conducted at water quality sites partnered under the Agreement.

Also available through Environment Canada's Water website are real-time water quality, flow and meteorological data gathered from the Fraser River Water Quality Buoy at Gravesend Reach in the Fraser River estuary. The Fraser River estuary site is also operated under the Canada–British Columbia Water Quality Monitoring Network.

Environment Canada operates eight long-term water quality monitoring sites in national parks in partnership with Parks Canada (six in British Columbia and two in Yukon). An additional eight stream and river sites are monitored in Yukon, primarily in collaboration with Environment Yukon. Two of the sites are operated in partnership with the Vuntut Gwitchin First Nation–Old Crow. All of the sites are located on transboundary rivers or on significant tributaries to transboundary waterways. Three of these sites are also part of the United Nations Global Environmental Monitoring System, and six sites were included in the 2009 Canadian Environmental Sustainability Indicators Report. A

final draft of the Canada–Yukon Water Quality and Aquatic Ecosystem Monitoring and Reporting Memorandum of Understanding has been completed to formalize the Canada–Yukon monitoring partnership and will be signed in 2010–2011.

Cooperative federal–provincial arrangements to test groundwater quality continued at several locations where groundwater monitoring wells have been installed through cost-sharing with the provincial government. A total of 12 monitoring wells are sampled on an annual basis, with 6 of these wells sampled on a monthly basis. This cooperative groundwater monitoring forms part of a larger Environment Canada groundwater monitoring network in the transboundary Abbotsford–Sumas aquifer, and also supports specific groundwater research projects investigating the potential occurrence and persistence of bacterial pathogens, pesticides and pharmaceutical compounds in groundwater. Additional cooperative groundwater monitoring is conducted on a semi-annual basis in the transboundary Osoyoos aquifer (southern Okanagan), where a combination of provincial and Environment Canada monitoring wells form the basis of the Environment Canada groundwater monitoring network for this transboundary area.

Given the resources available for water quality monitoring in the region, sites are strategically placed to address federal priorities (as noted above), as well as those of the monitoring partners. Coverage in southern British Columbia is generally adequate; however, coverage in central and northern British Columbia as well as in Yukon is limited.

### *Manitoba*

Water quality sampling continued at nine sites identified as part of the Canada–Manitoba Water Quality Monitoring Agreement. Monitoring at interprovincial sites that are identified in this agreement is discussed under the Prairie Provinces Water Board (see Section 1.3.2). The water quality station on the Red River at Emerson, which is located on the international boundary with the United States, supports the International Red River Basin Board. This water quality station was upgraded to accommodate the installation of state-

of-the-art auto-monitoring equipment. Upgrades included improving access to, and doubling the size of, the building, which will allow for the future upgrade of valves and pumps. The new structure continues to house the Water Survey of Canada's water-level monitoring equipment and data logger.

In 2009–2010, Manitoba and Environment Canada conducted joint sampling at five sites across the province to assess the effects of interagency variation in sampling and analytical procedures. Further and more extensive joint sampling will be undertaken in 2010. Since the announcement of the Lake Winnipeg Basin Initiative in 2007 (part of the federal government's Action Plan on Clean Water), discussions continue on the development of the Canada–Manitoba Memorandum of Understanding Respecting Lake Winnipeg, which is expected to be signed by the respective ministers in 2010. The existing Canada–Manitoba Water Quality Agreement will need to be reviewed to assess its compatibility and consistency with this new memorandum of understanding.

### *Quebec*

Water quality sampling underway at the monitoring station in La Mauricie National Park makes it possible to measure natural contaminant levels (e.g., heavy metals) and monitor interpretation parameters (e.g., conductivity, organic carbon, suspended solids and nutrients), which will be analyzed on a monthly basis. This water quality monitoring site is also used by different national projects: CABIN (benthos-monitoring project) and the Chemicals Management Plan.

Through an agreement with Parks Canada, operations continued at a water quality monitoring station on the Ottawa River downstream from the Carillon dam. Water monitoring at this station supports the implementation of the Monitoring the State of the St. Lawrence River Program. Negotiations to renew the agreement were held.

The Environment Canada–Canadian Space Agency joint remote water quality and cyanobacteria surveillance project commenced its second year in 2009–2010. The transfer of expertise between the research team and the monitoring team continued. As well, the Université de Sherbrooke participated in

field sampling (spectral information) at Lake Saint-Pierre, Lake Memphremagog and Missisquoi Bay. Results from remote sensing imagery point to the strong potential of these images to be used for water quality surveillance applications involving medium- and large-sized lakes.

Environment Canada and the ministère du Développement durable, de l'Environnement et des Parcs du Québec (MDDEP) agreed to collaborate on implementing a joint network to monitor water quality in Quebec. For this purpose, 42 stations operated by the MDDEP were selected to be part of this future federal–provincial agreement. The agreement will cover watercourses of national interest, such as the St. Lawrence and the Ottawa River, as well as eight Canada–United States transboundary watercourses. Through this agreement, 14 physical and chemical water quality parameters will be monitored, and sampling will be done on a monthly basis. Of these 42 stations, 23 will contribute data to the Water Quality Index for the Canadian Environmental Sustainability Indicators report.

### *Atlantic Provinces*

Bilateral annual meetings were held by representatives for the Canada–New Brunswick, Canada–Prince Edward Island, and Canada–Newfoundland and Labrador water quality agreements, to discuss and review the previous year's accomplishments and to plan and prioritize workloads for cost-shared and work-shared projects. Most monitoring sites were used to report on water quality on federal lands or to report on freshwater quality in the Canadian Environmental Sustainability Indicators report.

In New Brunswick, 5 federally designated, 10 federal–provincial designated and 36 provincially designated surface water quality stations were monitored under the federal–provincial agreement. In 2009–2010, 50 stations were used to report on freshwater quality in the Canadian Environmental Sustainability Indicators report. Three real-time water quality stations were operated on international rivers: two on the St. Croix River (at Milltown and Forest City) and one on a tributary of the Saint John River (at Tracey Mills on the Big Presqu'île Stream). Two federal automated water quality monitoring

stations were operated in partnership with Fisheries and Oceans Canada and National Defence on the Nerepis and Otnabog rivers in Canadian Forces Base Gagetown.

In Newfoundland and Labrador, 79 water quality sites continued to be sampled 4 to 6 times per year under the federal–provincial agreement. In 2009–2010, 37 stations were used to report on freshwater quality in the Canadian Environmental Sustainability Indicators report. In 2009–2010, 23 real-time water quality stations were actively monitored. Of these, 7 were part of the federal–provincial partnership, and 16 were funded through a partnership with private industry and the province.

In Prince Edward Island, 28 water quality monitoring sites were sampled, including 4 at groundwater stations, 10 at marine or estuarine stations, and 14 at freshwater streams. In 2009, data from 11 stream stations were used to report on freshwater quality in the Canadian Environmental Sustainability Indicators report. As well, three real-time water quality stations were active under a federal–provincial partnership.

In Nova Scotia, although no official water quality agreement exists between the federal and provincial government, a network of 24 water quality monitoring stations continued to be operated by Environment Canada throughout the province. In 2009–2010, 9 stations were used to report on freshwater quality in the Canadian Environmental Sustainability Indicators report. Two real-time water quality stations, one on the Little Sackville River and another on the upper reaches of the Annapolis River, continued to operate.

#### *Ontario, Saskatchewan and Alberta*

In Ontario, Saskatchewan and Alberta, there are no formal agreements in place with the federal government for monitoring the quality of inland waters, and most of the surface water monitoring for inland lakes and streams is performed by the provinces. These provinces contribute their water quality data to the Canadian Environmental Sustainability Indicators report. Environment Canada's water quality monitoring focuses on areas of federal jurisdiction, namely the Great Lakes and

Lake of the Woods in Ontario as well as rivers that cross interprovincial boundaries.

## 1.2.4 Canadian Environmental Sustainability Indicators

### **Background**

Since 2005, the Government of Canada has published the Canadian Environmental Sustainability Indicators (CESI) annual report ([www.ec.gc.ca/indicateurs-indicators/default.asp](http://www.ec.gc.ca/indicateurs-indicators/default.asp)), which provides indicators on the state of air and water quality, as well as on greenhouse gas emissions. Its water quality indicator uses the Water Quality Index, endorsed by the Canadian Council of Ministers of the Environment, to summarize the status of surface freshwater quality in Canada. Quality is assessed by examining the extent to which Water Quality Guidelines for the Protection of Aquatic Life (plants, invertebrates and fish) are being met at selected lake and river monitoring sites throughout Canada.

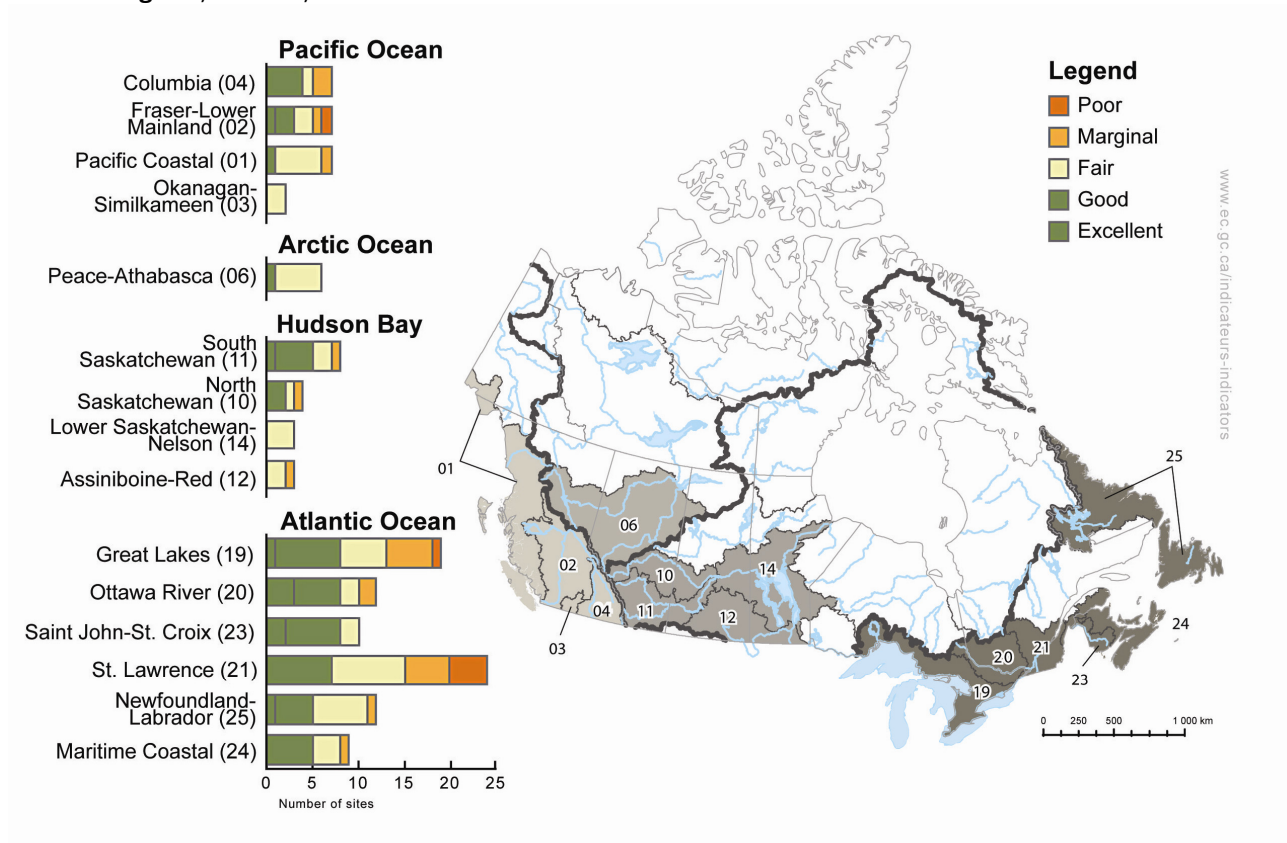
### **Progress to March 31, 2010**

The 2009 Canadian Environmental Sustainability Indicators report is based on data collected from 2005 to 2007.

For the 2009 report, the CESI water quality indicator was calculated using data from a newly established core network. This subset of river stations was created to focus the water quality indicator on major drainage regions under direct pressure from human activities. The creation of the core network also reduced a previous bias associated with having a large number of stations in the Windsor–Québec corridor. The 153 stations have been classified based on the extent and nature of human activities occurring within their drainage basins. This classification will allow further analysis and quantification of the potential pressure human activity is exerting on water across Canada.

Water quality measured at these 153 river sites across Canada was rated “excellent” for the protection of aquatic life at 10 sites (7%), “good” at 49 sites (32%), “fair” at 66 sites (43%), “marginal” at 22 sites (14%), and “poor” at 6 sites (4%) (Figure 4).

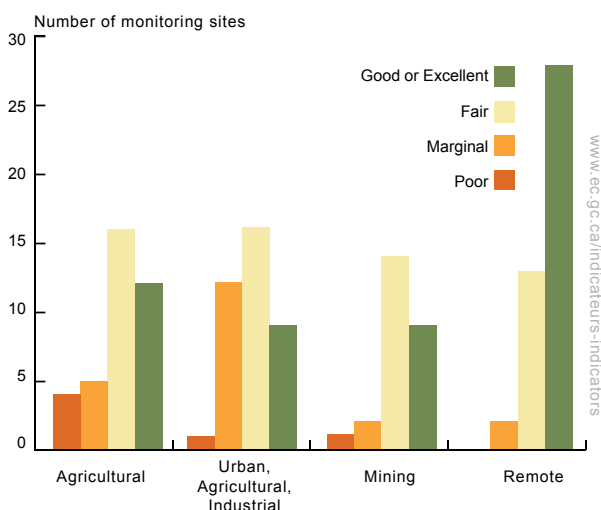
**Figure 4. Status of freshwater quality for protection of aquatic life at monitoring sites in selected drainage regions, Canada, 2005 to 2007.**



Note: Water quality was assessed using the Canadian Council of Ministers of the Environment's Water Quality Index. This chart is based on data from 153 core river monitoring sites selected to be representative of the 16 drainage regions where human activities are most intense. Comparison is more relevant among sites or across a number of years where the same parameters are used. Thus, caveats are required when comparing rankings among basins, as some methodological differences exist. (Source: data assembled by Environment Canada from federal, provincial, territorial and joint water quality monitoring programs.)

The lower ratings of “marginal” and “poor” are usually due to human activities including agriculture, industry and poor treatment of sewage and stormwater. Classification of the core network sites based on the extent and nature of human activities occurring within their drainage basins allowed us to quantify the potential pressure human activity is exerting on water quality across Canada (Figure 5).

**Figure 5. Water Quality Index ratings by monitoring site by land-use category, Canada, 2005 to 2007.**



Note: Sites with more than 20% agricultural land in their upstream drainage areas are categorized as agricultural. Sites are designated as mixed urban, agricultural and industrial if they meet two or more of the following conditions: 1) population density is greater than 25 persons/km<sup>2</sup>; 2) more than 10% is agricultural land; 3) there is at least one mine. Sites with a least one mine, and not meeting the previous population or agriculture conditions, were designated as mining. Remote sites are those with 95% undisturbed land. (Source: water quality data were assembled by Environment Canada from existing federal, provincial, territorial and joint water quality monitoring programs and the analysis was provided by Environment Canada. Population, mining and land cover statistics for each station drainage area were provided by Statistics Canada.)

## 1.3 Inter-jurisdictional water boards

### 1.3.1 Ottawa River Regulation Planning Board

#### Background

In 1983, Canada, Quebec and Ontario concluded the Agreement Respecting Ottawa River Basin Regulation. Under its terms, a board was constituted to plan and recommend regulation criteria for the 13 principal reservoirs of the basin, taking into account flood protection, hydroelectric power production and other interests. Supported by a regulating committee and secretariat, the Ottawa River Regulation Planning Board endeavours to ensure that the integrated management of the reservoirs provides protection against flooding along the Ottawa River and its tributaries, and along its channels in the Montréal region.

#### Progress to March 31, 2010

In 2009, spring freshet inflow volumes were above normal for all Ottawa River basins, particularly in the upper Ottawa River. This situation was not surprising, since winter precipitation was abundant. The spring runoff volume reaching the Ottawa River and its tributaries was well above normal, and although peak flows were above normal, they were not exceptional. The cooler temperatures around mid-April made it possible for the water to be discharged in two stages, creating two peaks in the majority of basins. Integrated management of the reservoirs did reduce peak flows by at least 31% on the main stem of the Ottawa River, and only minor flooding occurred in the middle and lower section of the river from Lake Coulonge to Lac des Deux Montagnes.

The wet weather extended into the summer of 2009, during which time above-average rainfall was recorded.

The Board supported a number of public information initiatives through the Ottawa River Regulation Secretariat. The Secretariat, which is housed at Environment Canada, maintains a website and a recorded message on toll-free telephone services in French and English, which

provide information about water levels and flows at various locations in the basin.

Since water levels were a concern during 2009, there were a large number of visits to the website (more than 47 279), and more than 2122 calls were made to the toll-free numbers. Secretariat personnel also participated in a number of radio and newspaper interviews.

The Board met on three occasions in locations in Ontario and Quebec. The agenda items and business considered by Board members were routine issues, such as current and planned projects along the Ottawa River; the operation of the Regulating Committee and its annual report, Secretariat operations; the hydrological model review; and correspondence and communications with organizations and the public. There were no issues that warranted reference to government departments or ministers.

### 1.3.2 Prairie Provinces Water Board

#### **Background**

In 1969, the governments of Canada, Alberta, Saskatchewan and Manitoba signed the Master Agreement on Apportionment to facilitate the equitable apportionment and protection of eastward-flowing interprovincial rivers and streams, and groundwater, in terms of both quantity and quality of water. The agreement also fosters the cooperation of the Parties in interprovincial water management.

Schedules A and B to the Master Agreement provide mechanisms to apportion water, foster cooperation and resolve potential disputes between Alberta and Saskatchewan, and Saskatchewan and Manitoba, respectively. Schedule C establishes the Prairie Provinces Water Board to administer the provisions of the Master Agreement. Schedule E specifies water quality objectives in 11 river reaches along the Alberta–Saskatchewan and Saskatchewan–Manitoba boundaries and further defines the water quality mandate of the Board.

#### **Progress to March 31, 2010**

Accomplishments in 2009–2010 included the following:

- Apportionment requirements were met in the 2009 calendar year on all eastward-flowing prairie streams that fall under the Agreement with the exception of a small deficit on Middle Creek.
- In addition to approving the hydrometric and meteorological monitoring stations list for 2010–2011, work continued on the modernization of the natural (apportionable) flow computation software programs.
- Work continued on the development of a groundwater schedule to the Agreement. No groundwater concerns were identified by jurisdictions in 2009–2010.
- The Board approved the 2010 water quality monitoring program and the 2008 Water Quality Excursion Report. Percent adherence to water quality objectives was very high for all rivers, such that water quality continues to be protected.
- A four-step process to review all water quality objectives for each of the 11 rivers continued, with a priority on nutrient objectives. Preliminary trend analysis was conducted for nutrients on all of the rivers under the agreement.
- The Board continued to exchange information on issues of common interest, including water quality issues related to Lake Winnipeg, Manitoba–Saskatchewan drainage issues, and the St. Mary and Milk River Management Initiative. A prairie hydrology study was completed to model wetland drainage and effects of land uses.
- The Board and each of its three standing committees—hydrology, water quality and groundwater—held at least one meeting and additional conference calls.
- Member agencies were informed about the Board's activities through the distribution of minutes, quarterly reports and an annual report.

### 1.3.3 Mackenzie River Basin Board

#### **Background**

The governments of Canada, British Columbia, Alberta, Saskatchewan, the Northwest Territories, and Yukon signed the Mackenzie River Basin

Transboundary Waters Master Agreement in July 1997. The Master Agreement endorses the principle of managing water resources for future generations such that the ecological integrity of the aquatic ecosystem is maintained. It provides for early and effective consultation on potential developments and activities in the basin that could affect the integrity of the aquatic ecosystem. It also contains provisions for seven sets of bilateral agreements between adjacent jurisdictions in the basin.

The 13-member Mackenzie River Basin Board administers the provisions of the Master Agreement, representing all Parties to the Agreement. Federal members include representatives from Environment Canada, Indian and Northern Affairs Canada, and Health Canada. Jurisdictions (the three provinces and two territories in the basin) are represented by 10 members, including an appointee from provincial and territorial government water management agencies, and an Aboriginal board member nominated by Aboriginal organizations.

Under the Master Agreement, Environment Canada is responsible for managing the expenditures of the board, which are cost-shared equally by the Parties. Shareable costs include the staffing and operation of the Secretariat office in Fort Smith, Northwest Territories (located near the centre of the Mackenzie River basin), to provide working-level support for the Board. The Executive Director of the Secretariat, hired by Environment Canada's Prairie and Northern Region, plans, directs and manages Board operations.

#### **Progress to March 31, 2010**

Accomplishments in 2009–2010 included the following:

- Board members met twice during the year and held a number of conference calls.
- The Board developed and issued a contract for the second State of the Aquatic Ecosystem Report (SOAER 2010) to follow up on SOAER 2003. SOAERs are required every five years by the Master Agreement to evaluate the status of the aquatic ecosystem of the basin. The 2010 report is scheduled for completion in fall 2010, and will focus on the impacts of oil sands, hydro power development and climate change,

as well as on the integration of traditional knowledge and western scientific information.

- The Board completed and submitted a business plan for 2010–2013 activities to Ministers in early 2010.
- The development of a basin hydrology model was completed, and a final project report was submitted in February 2010. The Board's Technical Committee began assessing the model as a mechanism for evaluating impacts of past and future water development projects on transboundary flows.
- The Board established a Traditional Knowledge and Partnerships Committee to improve and increase use of Aboriginal traditional knowledge by the Board and within jurisdiction activities, and to improve communication with Aboriginal organizations and residents. Indian and Northern Affairs Canada initiated a pilot project to summarize Aboriginal traditional knowledge for part of the Mackenzie Basin on behalf of the Board. This information will also contribute to SOAER 2010.
- The Board re-evaluated the location and activities of its Secretariat late in 2009, and decided to relocate the office from Fort Smith to Yellowknife by 2011.
- Member jurisdictions continued to exchange information through agency reports.

Progress on bilateral and multilateral water management agreements included the following:

- The Board completed a bilateral agreements guidance document to guide future bilateral negotiations by jurisdictions in early 2010. The report defines basin-wide objectives, principles, and the roles of participants, and provides a generic outline of the expected content of bilateral agreements as well as a schedule for completing negotiations and multi-lateral consultation by 2014.
- *British Columbia–Alberta*: Follow-up discussions on a joint background document completed in June 2008 were placed on hold, pending the Ministers' approval of the bilateral agreements guidance document. Bilateral discussions are scheduled to resume in spring 2010.

- *Alberta–Northwest Territories*: The two jurisdictions continue to collect and share background information in preparation for bilateral negotiations, scheduled to start in 2010 once the Northwest Territories has completed its water strategy.
- *Northwest Territories–Yukon*: The territories continue to meet biannually to share information and discuss transboundary water issues in accordance with their bilateral agreement. Planning related to the management of transboundary water resources continued, through the development of the Northwest Territories Water Stewardship Strategy and the Peel River Watershed Planning Commission.
- *Other bilateral agreements*: By mutual agreement, negotiations for other parts of the basin have been postponed, pending ministerial approval of the bilateral agreements guidance document, and progress on the British Columbia–Alberta and Alberta–Northwest Territories agreements.

### 1.3.4 Lake of the Woods Control Board

#### **Background**

The Lake of the Woods Control Board does not fall under the *Canada Water Act*, but it is included in this report to provide a more complete picture of federal–provincial water management in Canada.

The Lake of the Woods Control Board (LWCB) is a Canadian board consisting of four members, each with an alternate, who represent Canada (one member), Ontario (two members) and Manitoba (one member). Appointments are made by orders in council of the appropriate government and each appointee must be a professional engineer. The Board, established in 1919, is responsible for the regulation of levels in Lake of the Woods and Lac Seul and flows in the Winnipeg and English rivers downstream from these lakes to their junction. In addition, when the level of Lac Seul exceeds certain specified levels, the Board controls the diversion of water from Lake St. Joseph (Albany system) into Lac Seul.

The Board's authority is defined by concurrent Canada–Ontario–Manitoba legislation (*The Lake of*

*the Woods Control Board Act*; 1921, 1922, 1958) and is further mandated by a Canada–United States treaty (*Convention and Protocol for Regulating the Level of the Lake of the Woods*, 1925), necessary since Lake of the Woods is an international boundary body of water. This treaty also created a second board, the International Lake of the Woods Control Board (ILWCB). While Lake of the Woods is normally regulated solely by the LWCB, the outflow from the lake is subject to the approval of the ILWCB whenever the level of the lake rises above or falls below certain levels specified in the Treaty.

The responsibilities of the LWCB are fulfilled by directing what the outflows of Lake of the Woods and Lac Seul (and at times the Lake St. Joseph diversion) shall be. The Board maintains a full-time secretariat that monitors conditions in the basin, provides information and analysis, and recommends regulating strategy or specific outflows. It also implements strategy when so directed, conducts studies and maintains communications with basin users.

#### **Progress to March 31, 2010**

Snowfall and accumulation were above normal during the winter of 2008–2009 and were near record in some parts of the basin. These snow conditions, coupled with above-normal rainfall in the spring, led to high water levels and flows throughout the Winnipeg River drainage basin in spring and summer 2009. The Lake St. Joseph diversion fell under Board authority in late June and again for most of August and September, and diversion flows were restricted from late June until late September. Lake of the Woods levels were high but did not reach the level at which regulation is subject to the approval of the ILWCB.

The Board met three times during the year. The primary purpose of the meetings was to meet with representatives of interest groups to set a regulating strategy for the following period. The Board also held one public open house. The Board's Secretariat, which is housed at Environment Canada under a memorandum of understanding with the Board, maintains a website and a toll-free recorded message service that provide information on water levels and flows at sites across the basin. Secretariat personnel also provided input to the media on request.

## 1.4 Ecosystem Initiatives: watershed and water-related activities

Through the application of an ecosystem approach, the objective of Environment Canada's Ecosystem Initiatives is to attain the highest level of environmental quality within targeted ecosystems as a means of enhancing the health and safety of Canadians, preserving and enhancing natural resources, and optimizing economic competitiveness.

Ecosystem Initiatives achieve their objectives by relying on measurable environmental results, aligned and coordinated efforts, collaborative governance mechanisms, integrated science and monitoring, community and stakeholder involvement, sharing of information and experiences, and informed decision making.

Work is also being carried out in Environment Canada's regional offices to coordinate the Department's interventions in priority ecosystems when neither formal agreements nor Ecosystem Initiatives exist. For example, in the Pacific and Yukon Region, the Ecosystem Coordination Office facilitates an integrated approach in priority ecosystems in the region and works with external stakeholders to interface with regional and local governance. Two examples of the programs supported by the Ecosystem Coordination Office are the Burrard Inlet Environmental Action Program and the Fraser River Estuary Management Plan.

### 1.4.1 Great Lakes Program

#### **Background**

The Great Lakes Program is a partnership of federal departments (Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Health Canada, Natural Resources Canada, Public Works and Government Services Canada, Transport Canada, and Infrastructure Canada) and one federal agency (Parks Canada), whose goals are a healthy environment, healthy citizens and sustainable communities. This coordinated federal program significantly bolsters Canada's efforts to protect and restore the Great Lakes Basin ecosystem ([www.ec.gc.ca/grandslacs-greatlakes/](http://www.ec.gc.ca/grandslacs-greatlakes/)).

Federal partner departments' activities were integrated with those of Ontario through the Canada–Ontario Agreement Respecting the Great Lakes Basin Ecosystem. The Agreement outlines how the two levels of government will cooperate and coordinate their efforts to restore, protect and conserve the Great Lakes Basin ecosystem. It builds on the actions taken through previous agreements and focuses priorities for future actions. It also contributes to meeting Canada's obligations under the Canada–United States Great Lakes Water Quality Agreement.

Federal signatories to the Canada–Ontario Agreement include Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Health Canada, Infrastructure Canada, Natural Resources Canada, Parks Canada, and Transport Canada. Provincial signatories include Ontario's Ministry of Environment, Ministry of Natural Resources, and Ministry of Agriculture, Food and Rural Affairs.

#### **Progress to March 31, 2010**

Environmental restoration is now complete in the Wheatley Harbour Area of Concern (AOC), which represents a major achievement. The beneficial uses, related to fish and wildlife populations, water quality, sediment impacts and habitat, which were originally impaired, have been restored. The Stage 3 report documenting these achievements has been finalized and will be released in 2010.

#### **Remedial Action Plans**

Support continued for the coordination of remedial action plan activities, which included assessing and reporting on progress to date, on the success of past actions and on the status of remaining actions in all remaining Canadian AOCs. Some examples are listed below:

- All priority actions have been implemented in the St. Lawrence River (Cornwall) AOC. A draft Stage 3 report describes the results of monitoring to confirm the restoration of beneficial uses. A decision is expected in 2010–2011 on whether to delist the AOC or recognize it as an Area in Recovery.
- A Stage 2 report was completed for the Detroit River AOC, and a Stage 2 update report was

produced for the Niagara River AOC. These reports document the status of implementation actions to date, which have led to improved water quality and enhanced fish and wildlife habitat conditions. For example, over \$300 million in municipal wastewater treatment infrastructure improvements have been invested in these AOCs in recent years.

- Community involvement in decisions related to remedial actions improved in the Thunder Bay, Nipigon Bay, Jackfish Bay and Spanish Harbour AOCs through community funding partnerships and public advisory committees.
- Support for Remedial Action Plan coordination, planning, implementation reporting and monitoring continued, with public advisory committees examining restoration targets and progress in the Peninsula Harbour and St. Marys River AOCs.
- A status report on the Jackfish Bay AOC was prepared by Lakehead University with a review and contribution from Environment Canada. Environment Canada staff coordinated the first draft of a long-term monitoring plan to support the Canada–Ontario proposal to recognize Jackfish Bay as an Area in Recovery.

### Science and monitoring

Environment Canada undertakes science and monitoring projects to support decision making in the Great Lakes Areas of Concern in Canada and for lakewide management (see Section 2 for additional research projects related to the Great Lakes). Projects included the following:

- An assessment of the reproductive health of wild fish was conducted within the St. Marys River AOC. White Sucker (*Catostomus commersonii*) and Yellow Perch (*Perca flavescens*) were captured at five sites along the river, upstream outside of the AOC, and at additional collection sites. Fish were also provided to the province for contaminant analysis for the Guide to Eating Ontario Sport Fish.
- Through collaborative work with experts specializing in fish health, data from Canadian AOCs were used to assess the incidence of fish tumours as an indicator of beneficial use impairment. Data from the lower Great Lakes

were used to establish a reference tumour incidence in Brown Bullhead (*Ameiurus nebulosus*), and this reference incidence is being used to determine beneficial use impairment within AOCs.

- Through a large industry–academia–government collaborative project investigating the causes of and solutions to the reproductive effects occurring in fish downstream of pulp and paper mill effluents, wild fish were collected upstream and downstream of the pulp mill on the Spanish River at Espanola. Detailed reproductive assessments were conducted on a number of fish species, and results are being compared with those from laboratory studies. The goal is to identify short-term reproductive tests that can be used to determine the cause(s) of the reproductive effects observed in fish downstream of mill effluents.
- An assessment of amphibian health was conducted in the Detroit River AOC to determine hatching success, deformity rates and gonadal developmental deformities. Preliminary results indicate that deformities in newly transformed Leopard Frogs (*Rana pipiens*) were higher in the Detroit River site (7.5%) than at an upstream reference site (0%). Deformity rates above 5% are suggested to be above background levels. The incidence of abnormal gonads in male frogs from one of the five Detroit River sites approached 90% and was significantly higher than deformity rates at the upstream site (14%).
- Work on Herring Gulls (*Larus argentatus*), a piscivorous species, included a retrospective analysis of perfluorinated compounds and brominated flame retardants in gull eggs from selected International Joint Commission monitoring colonies; an assessment of egg hatchability; and an assessment of the gulls' physiological responses to stress. As well, a decade-long survey of colonial waterbirds was completed and suggested that Herring Gull populations are in decline in the Niagara, Detroit River and Toronto AOCs.
- Studies were undertaken to acquire knowledge that will be used to inform the development of contaminated sediment management plans. This work included the development of an

updated and revised statistical model for the bioassessment of nearshore sediments of the Great Lakes, and invertebrate bioaccumulation and toxicity testing of Spanish Harbour sediments to detect hot spots. The research program also undertook chemical, physical and biological assessments of sediments in the Nipigon Bay, Spanish Harbour and St. Marys River AOCs in support of contaminated sediment management plans. Scientists provided technical advice to the Remedial Action Plan Committees for the following AOCs: Peninsula Harbour, Nipigon Bay, Jackfish Bay, Thunder Bay, St. Marys River, St. Clair River, Wheatley Harbour and the St. Lawrence River at Cornwall. Wheatley Harbour has been delisted as an AOC, in part based on the results obtained with 2008–2009 data.

- Surveys using a deepwater video system investigated the offshore reefs of Lake Huron in support of the Lake Huron Lakewide Management Plan. Some of the 2009 sites were compared with historical underwater images of the offshore reefs. The 2009 survey documented dramatic changes brought about by the infestation of Zebra Mussels and algae. A collaborative project on Lake Erie is ongoing to identify potential fish habitat regions, using geospatial analysis derived from targeted substrate classification field investigations. The partners include Ontario and American state and federal agencies.
- New science monitoring projects undertaken in the Great Lakes Areas of Concern included assessing the levels of polycyclic aromatic hydrocarbons throughout Hamilton Harbour in support of the Randle Reef Sediment Remediation Project, and conducting water quality assessment in the St. Marys River in support of the Sugar Island Monitoring Workgroup. As well, results from various monitoring activities were reported to support decision making in AOCs.
- Department scientists took the first direct measurements of evaporation from lakes Superior and Huron as part of Environment Canada's support for the International Joint Commission's International Upper Great Lakes Study. These measurements are being used to improve our understanding of the evaporation

process over these immense lakes.

Comparisons between measurements and output from operational models show the latter tends to overestimate annual evaporation by approximately 25%. Improvements have been made to the Environment Canada forecast model that reduces this bias.

- Environment Canada and Fisheries and Oceans Canada scientists are involved in a study at the Experimental Lakes Area to determine whether low rainfall has a positive feedback on streamflow volumes. They are trying to determine whether, in Canadian Shield landscapes, a lower amount of runoff from the surrounding hillslopes leads to enhanced evaporation rates as a result of clearer lake water and higher surface temperatures. This has implications for forecasting streamflow to the Great Lakes during droughts.
- Research during 2009–2010 continued to focus on gaining an improved understanding of the role of groundwater within the Great Lakes ecosystem. Progress included characterizing extremes of air temperature and streamflow to determine climate impacts on fish communities, and mapping groundwater discharge to surface water for input into analyses of water use and supply relative to ecological requirements. In addition, methods and results initially developed for the Great Lakes region were used in a national-scale assessment of trends in groundwater recharge.
- Environment Canada worked with several partners at different levels of government in compiling and interpreting long-term data, and provided guidance to the provincial government on the implementation of Ontario's *Clean Water Act*. Environment Canada studies provided information on nutrients and physical processes, and were the first to show the importance of monitoring pathogens near the drinking water intakes in Lake Ontario. These studies also provided information on the reliability of the models being used as well as extensive data sets and guidance to the partners in the Great Lakes region, serving to improve confidence in the results. A cross-disciplinary research team composed of both water and atmospheric scientists developed lake-state prediction models that will be used

for assessing water quantity and quality in the lower Great Lakes.

### *Monitoring programs*

Environment Canada continued to conduct monitoring programs throughout the Great Lakes in support of Annex 2 of the new Canada–Ontario Agreement Respecting the Great Lakes Basin Ecosystem. These monitoring programs included the following:

- the Great Lakes Open Lakes Surveillance Program, which samples the offshore waters of the Great Lakes to provide status and trends information for water quality, to report on compliance with established guidelines, and to identify new and emerging issues;
- the Great Lakes Fish Contaminants Surveillance program, which measures and reports on trends in legacy and emerging contaminants in top predator and forage fish species (and receives funding from the Chemicals Management Plan);
- the Connecting Channels monitoring programs in the St. Clair, Niagara and St. Lawrence rivers, which measure and report on trends in inputs/outputs from the connecting channels to the lakes, and measures the success of remedial measures in these AOCs; and
- the Integrated Atmospheric Deposition Network, a binational program with the U.S. Environmental Protection Agency to report on spatial and temporal trends in concentrations and loadings of priority toxic chemicals in the Great Lakes (which receives funding from the Chemicals Management Plan).

### *Great Lakes Sustainability Fund*

In 2009–2010, Environment Canada’s Great Lakes Areas of Concern program and the associated Great Lakes Action Plan (\$40 million in funding over 2005–2010) continued to fund multi-stakeholder projects to restore beneficial uses in Great Lakes Areas of Concern through the Great Lakes Sustainability Fund.

The Great Lakes Sustainability Fund provided technical and financial advice to projects aimed at improving water quality, fish habitat and wildlife

habitat; assessing the status of beneficial use impairments; and characterizing contaminated sediment and developing contaminated sediment management plans in AOCs.

The Fund supported work in the Niagara River, St. Lawrence River (Cornwall), Hamilton Harbour, Toronto, St. Clair River and Detroit River AOCs to develop stewardship initiatives and to deliver programs to reduce nutrient inputs to watercourses from urban and rural nonpoint sources. Under these initiatives, outreach and education programs were directed to rural farming and non-farming landowners to encourage the adoption of rural best management practices.

The Fund supported studies leading to improved water quality through improved management of municipal wastewater. These projects focused on the reduction of solids, nutrients and bacteria from wet-weather flows (combined sewer overflows and stormwater) in the St. Marys River, Bay of Quinte, Niagara River and Toronto AOCs. These completed studies contributed to the City of Toronto Wet Weather Flow Management Master Plan; the City of Belleville Wet Weather Flow Plan (Bay of Quinte AOC), and the Combined Sewer Overflow projects in the cities of Welland and Niagara Falls (Niagara River AOC).

In the Bay of Quinte AOC, the Fund continued to support the development of an integrated pollution prevention and control plan for municipalities bordering the Bay of Quinte, including the development and implementation of stormwater management plans for new developments.

The Fund also provided technical and financial support for the Sault Ste Marie Stormwater Management Investigative Study—a design reference for stormwater management infrastructure. The application of design standards based on this report will benefit both infrastructure upgrades and private developments that drain to city systems, and ultimately serve to reduce adverse effects on the St. Marys River.

The restoration of fish and wildlife habitat is also a focus of the Fund. In 2009–2010, the Fund supported a number of projects to restore habitat in AOCs, including projects to restore wetlands in

Cootes Paradise and Grindstone Creek in the Hamilton Harbour AOC; wetlands in the Niagara River AOC; and shorelines in the Niagara River and St. Clair River AOCs.

The Fund also supported studies to assess the need and options for management of contaminated sediment over the next few years. The following work was undertaken in support of managing contaminated sediment in Great Lakes Areas of Concern:

- Peninsula Harbour: work to support the placement of a thin layer cap to manage contaminated sediment continued. A vessel traffic study was completed, and work began on the detailed engineering design and environmental assessment. In addition, a study to improve understanding of the existing benthic community was completed.
- Thunder Bay: fieldwork to support geotechnical and wind/wave and current investigations was completed. A draft report on the feasibility of sediment management options was prepared, and Phase II of the feasibility of the sediment management options was initiated.
- St. Marys River: a review of the 2008 biological assessment of sediment toxicity was completed, along with Phase I of the sediment fate and transport model. As well, additional biological sampling was undertaken.
- St. Clair River: a risk assessment of the mercury-contaminated sediment of the Canadian side of the St. Clair River was undertaken, and results were communicated to stakeholders (St. Clair Remedial Action Plan Committee, Binational Public Advisory Committee, Sarnia-Lambton Environmental Association), First Nations (Aamjiwnaang, Walpole Island) and the general public. This site is downstream of a site that was formerly the property of a chemical company and was remediated in 2004.
- Hamilton Harbour: work continued on the environmental assessment process in support of the planned approach to managing contaminated sediment at Randle Reef. This environmental assessment will be a comprehensive study report under the *Canadian Environmental Assessment Act*.

In addition, work continued to complete the engineering design of the containment structure, dredging of contaminated sediments, final capping and landscaping, and requirements for long-term monitoring and maintenance of the facility.

### *Great Lakes and Regional Environmental Quality Monitoring and Surveillance Program*

In 2003, the Great Lakes Binational Executive Committee endorsed the Great Lakes Cooperative Monitoring Initiative to improve the coordination of monitoring in the Great Lakes. A five-year rotational cycle was adopted to focus on one lake per year, with Lake Erie selected for 2009. Monitoring focused on the nearshore zones to better understand the impact of invasive species on nutrient transport from nearshore to offshore zones. A bioavailable phosphorous study was also conducted to investigate potential new sources of phosphorous and to investigate the trends and tributary loadings of bioavailable phosphorous to nearshore zones. A study in the western basin of Lake Erie was undertaken to study the impact of nutrient influx and timing of algal bloom appearance. Cooperative monitoring efforts also included a study on the contribution of nutrients to the lake in relation to differing farming techniques. These efforts pulled together federal, provincial and state agencies in a unique way that allowed for building on existing programs.

### *Canada – United States cooperation*

The Great Lakes Binational Toxics Strategy is an innovative public-private collaborative arrangement between Environment Canada, the U.S. Environmental Protection Agency (US EPA) and many stakeholders. Under the Strategy, work continued toward reducing emissions and releases of mercury, polychlorinated biphenyls (PCBs), dioxins and furans, hexachlorobenzene and benzo(a)pyrene to the Great Lakes environment. In 2009–2010, Canada moved toward its PCB Challenge goals, primarily through the implementation of Canada's new *PCB Regulations* (SOR/2008-273, September 5, 2008). Canada also continued to monitor levels of dioxins in the environment, maintained its release inventory, collaborated with the United States to reduce

uncontrolled combustion sources such as burn barrels, and launched a modelling study to better understand the transboundary impacts associated with releases of dioxins and furans from North American and global sources. Canada has also made available its report on the testing of newer EPA-certified woodstoves, which confirmed that these have lower benzo(a)pyrene emission factors than predicted. In collaboration with the United States, Canada released the Strategy's 2008 Status Report summarizing binational efforts to address the above-mentioned legacy substances and progress made to broaden the Strategy's scope to encompass substances of emerging concern.

Canada also made progress on the development of a Canadian framework to identify and prioritize substances of emerging concern in the Great Lakes.

In collaboration with the Ontario Ministry of the Environment and Health Canada, Environment Canada continued its outreach activities on the safe disposal of unused and expired pharmaceutical products to the citizens of Thunder Bay, and promoted them to other Lake Superior north shore communities.

A national wastewater monitoring program initiated in 2009–2010 in support of Canada's Chemicals Management Plan also contributes to meeting objectives under the Strategy. The program aims to improve our understanding and prediction of the occurrence and fate of emerging contaminants in typical Canadian municipal wastewater and solids treatment processes, and to determine whether control measures are needed to prevent these substances from entering the municipal wastewater system. This monitoring program included five wastewater treatment plants that discharge into the Great Lakes or a tributary of the Great Lakes. Polybrominated diphenyl ethers, bisphenol A, perfluorinated compounds, selected metals, selected phenols and acidic pharmaceuticals were monitored in raw influent, primary effluent, final effluent, primary sludge, waste biological sludge and treated biosolids. This work will lead to a greater understanding of the extent to which these substances are entering the Great Lakes from municipal wastewater treatment facilities. As the understanding of the sources and extent of the

problem deepens, different approaches, such as increased awareness through education, can be developed to address this issue.

Environment Canada, in collaboration with the U.S. Environmental Protection Agency, regularly reports on the ecological health of the Great Lakes ecosystem. In 2009, three reports were finalized and distributed: *The State of the Great Lakes 2009 Highlights*, *The State of the Great Lakes 2009 Technical Report*, and the *Nearshore Areas of the Great Lakes 2009* report. These reports are issued in accordance with the reporting requirements of the Great Lakes Water Quality Agreement and are available on the Binational.net website ([www.binational.net/solec/sogl2009\\_e.html](http://www.binational.net/solec/sogl2009_e.html)). In addition to these reports, a review of the entire Great Lakes indicator suite and planning for the October 2011 State of the Great Lakes Conference were initiated.

Environment Canada, with the U.S. Environmental Protection Agency, co-chairs binational lakewide management plans under the Canada–United States Great Lakes Water Quality Agreement. The management plans identify binational ecological objectives and management strategies, including science priorities for data collection to fill knowledge gaps in ecosystem status and trends. In 2009–2010, a number of lakewide management plan reports and activities were undertaken:

- The Lake Superior Aquatic Invasive Species Complete Prevention Plan was drafted and updated following stakeholder review. The purpose of the plan is to prevent new aquatic invasive species from entering and becoming established in Lake Superior. The Lake Superior Aquatic Invasive Species Complete Prevention Plan supports the mandate of the Government of Canada's invasive species strategy (by preventing introduction of invasive alien species to Lake Superior). In 2010–2011, a series of workshops will be held throughout the basin to promote the plan before it is finalized and an implementation plan is drafted.
- Priorities for the binational Cooperative Science and Monitoring Initiative in 2011 were identified.

- The Canadian agencies and organizations involved in the Lake Huron Binational Partnership supported efforts to raise awareness, engage communities and take action to protect and restore Lake Huron under the Lake Huron Watershed Canadian Framework for Community Action that was developed. As well, Environment Canada participated in the Southern Georgian Bay Coastal Initiative, led by the mayors of Wasaga Beach and the Town of the Blue Mountains. The initiative seeks to develop mechanisms for the protection and restoration of the southern Georgian Bay coast.
- In recent years, Lake Erie water quality has declined. Algal blooms that threatened the Lake Erie ecosystem in the past have returned. In the 1970s and 1980s, collaborative efforts to reduce phosphorus in Lake Erie by treating point-source discharges were successful, and lake conditions improved. However, in the mid-1990s, problems resurfaced, but the reasons for the resurgence of the algal blooms are much more complex than in past decades. To better understand the current nutrient situation, the technical report *Status of Nutrients in the Lake Erie Basin* was prepared. The Lake Erie Lakewide Management Plan Committee recognizes an urgent and immediate need for coordinated nutrient management actions and, as a result, the drafting of the Lake Erie Binational Nutrient Management Strategy began in 2008. Once completed, it will define the goals, objectives, targets, indicators, priority watersheds, monitoring and research needed to limit further eutrophication and improve current conditions in Lake Erie.
- *The Beautiful Lake: A Binational Biodiversity Conservation Strategy for Lake Ontario*, April 2009 was completed, identifying recommendations for priority actions to protect 24 significant coastal shorelines and watersheds around Lake Ontario. The Strategy formulates six recommendations: conserving critical lands and waters; reducing the impact of aquatic invasive species; restoring connections and natural hydrology; restoring native fish communities and native species; restoring the quality of nearshore waters; and planning for and adapting to climate change. The Lakewide Management Plan Committee

is reviewing the recommendations and will identify which ones can be formally integrated into a lakewide management plan biodiversity conservation implementation strategy.

## 1.4.2 St. Lawrence Plan

### **Background**

Launched in 1988, the St. Lawrence Plan ([www.planstlaurent.qc.ca](http://www.planstlaurent.qc.ca)) is a Canada–Quebec Ecosystem Initiative to protect, conserve and restore the St. Lawrence River ecosystem. The five-year program, which has been renewed three times since its initial signing in 1988, has achieved concrete results through concerted efforts by federal and provincial departments, supported by the private sector, universities, research centres, ZIPs (*zones d'intervention prioritaire* [priority intervention zones]) committees, non-governmental organizations and riverside communities. The program focuses on the St. Lawrence River and the mouth of its main tributaries, from Lake Saint-François at the Quebec–Ontario border to the eastern tip of the Gulf of St. Lawrence.

The 2005–2010 agreement, signed in November 2005, ended on March 31, 2010. This fourth phase of the St. Lawrence Plan continued the collaborative implementation of several measures designed not only to conserve, protect and restore the ecosystem but also to recover its uses. It also marked the development of a new governance mechanism to achieve integrated management of the St. Lawrence. Although this phase has officially ended, the partners have agreed to continue their activities and to extend funding into 2010–2011 for some of these activities, including the ZIP program, the Community Interaction Program and the Monitoring the State of the St. Lawrence Program, to jointly ensure the transition to a new agreement. Environment Canada began negotiations with the Government of Quebec to develop and sign a new agreement on the St. Lawrence.

### **Progress to March 31, 2010**

#### *Integrated management of the St. Lawrence River*

Before concluding their activities for Phase IV of the St. Lawrence Plan, multi-stakeholder working

groups on the integrated management of the St. Lawrence prepared reports on strategic planning and implementation of this management model. The report *Integrated Management of the St. Lawrence – Governance Mechanisms* is available on the St. Lawrence Plan website ([www.planstlaurent.qc.ca/](http://www.planstlaurent.qc.ca/)).

#### *Community involvement and awareness*

The 14 ZIP committees and Stratégies Saint-Laurent, the head organization of the ZIP committees, continued to assist local communities in their endeavours to protect, conserve and enhance the St. Lawrence ecosystem. Several projects were carried out in 2009–2010, including the launch of a web portal providing information that will help increase coastal communities' adaptability when faced with erosion, coastal submergence or landslides; the monitoring of erosion, invasive plant species and recreational uses of the fluvial section by several community groups; the creation of a guide to conserving and enhancing valuable shoreline sites on the Lower North Shore; and the restoration of several streams on farmland near Lake Saint-Pierre.

The Community Interaction Program continued to provide support to the non-governmental organizations that undertake projects to benefit the St. Lawrence. In 2009–2010, 15 projects were implemented through this program, including a bank stabilization and protection project at Îles de la Paix, which created fish habitat and protected a bird sanctuary, as well as shelters for vulnerable species. Twelve other projects were approved and will be carried out in 2010–2011. They are the result of the efforts invested by riverside communities to attract more interest and broaden the scope of their efforts by emphasizing the St. Lawrence Plan's priorities.

The St. Lawrence Global Observatory was officially launched in November 2009. The objective of this web portal ([www.slgo.ca](http://www.slgo.ca)), which governmental and academic organizations can join, is to promote the use of computer-based tools in making decisions about the St. Lawrence River, and to enhance existing databases. As of March 31, 2010, the St. Lawrence Global Observatory had six full-time employees to handle portal rollout and manage partnership agreements on site content.

#### *Monitoring the State of the St. Lawrence River Program*

The network of government and non-governmental partners and collaborators remained active and productive in terms of reporting on the state of the St. Lawrence through a number of activities, including chairing the State of the St. Lawrence Monitoring Advisory Committee, participating regularly in the Management Committee of the Canada–Quebec Agreement on the St. Lawrence River, and maintaining close ties with other advisory committees active in the fields of ecological integrity, community involvement and awareness, shore access and navigation.

A significant amount of scientific information related to the health of the St. Lawrence was produced and disseminated in 2009–2010. The Monitoring the State of the St. Lawrence River Program published the *Overview of the State of the St. Lawrence River*, in which the large river's bill of health is described as moderate to good for several indicators. Sediment contamination in Lake Saint-Pierre has decreased. The reintroduction of the Striped Bass (*Morone saxatilis*) has been successful, and the Beluga (*Delphinapterus leucas*) population remains stable, although it shows no major signs of recovery. Shellfish water quality tends to be improving. Few changes have been observed in bird populations or in wetlands and swimming areas. Overall, however, the St. Lawrence remains vulnerable. Shoreline erosion, water turbidity and water contamination by toxic substances in certain tributaries crossing farmland are of special concern, as is biotic integrity as based on the composition of freshwater fish communities. Concentrations of new substances such as polybrominated diphenyl ethers are also cause for concern, since they are on the rise in all compartments of the ecosystem.

The indicators for the Monitoring the State of the St. Lawrence River Program were improved by increasing the number of substances analyzed and the area being monitored. These indicators were included in reports and data sheets, the highlights of which are described below.

More than 400 surface sediment samples were collected from 2003 to 2008 in the various fluvial lakes (Lake Saint-François, Lake Saint-Louis and Lake

Saint-Pierre), in the fluvial section between Montréal and Sorel, and in Lac des Deux Montagnes at the mouth of the Ottawa River. The results, published in 2009, show that mercury and PCB concentrations have decreased by 70% to 90% over the past 30 years, while concentrations of other metals (copper, zinc, lead, arsenic and cadmium) have decreased by approximately 30% to 50%. The work also reveals the persistence of certain chemical compounds such as polycyclic aromatic hydrocarbons, dioxins and furans, and organotins in areas such as Îles de la Paix and Îles de Contrecoeur. In addition, the results provide a first look at new substances such as polybrominated diphenyl ethers, which are increasing in Lake Saint-Pierre, mainly because of urban discharges upstream. Finally, natural or pre-industrial concentrations were determined for the entire river and now serve as a baseline level for contaminated sediment management.

An analysis of changes in the surface area of the St. Lawrence River wetlands over the years was also completed. This study shows the pronounced differences between the period from the 1970s to 2000–2002 and the period from 1945 to 1970. The significant surface area losses that occurred before 1970 were reduced considerably over the following three decades. Marshland and swamp area, excluding shallow water, even increased slightly between 1990–1991 and 2000–2002. However, net wetland losses are still observed in the Montréal–Longueuil and Lake Saint-Pierre areas. Moreover, in several sections of the river, the wetlands tend to be relatively dry and there is an increased presence of invasive exotic plant species. Conversely, major gains are recorded in the area stretching from the eastern tip of Lake Saint-Pierre to the Gulf of the St. Lawrence.

A fact sheet was prepared in 2009 to show that several mechanisms act simultaneously in the bank erosion process. Water level fluctuation, freeze–thaw cycles and wave action from passing boats are the main factors that increase bank erosion. Half of the suspended solids that pass through the river in the vicinity of Lévis near Québec are the result of bank erosion.

An initial description of the benthic communities of shoreline wetlands at Lake Saint-Pierre was

produced. The most abundant organisms in the fluvial lake in sites affected by river plumes are crustaceans, molluscs and insects. The main environmental factors influencing benthic communities are vegetation type, water quality (total phosphorus, dissolved carbon) and the upstream water sources (Great Lakes, Ottawa River, mixture).

Water quality continued to be monitored in the Ottawa River, a main tributary of the St. Lawrence. Although the river shows clear signs of contamination by toxic substances, the level of contamination is comparable to that in other watercourses in southern Quebec. Metal concentrations measured at the Carillon station on the Ottawa River are on the same order of magnitude as those detected in relatively uncontaminated areas. Furthermore, metal concentrations measured on and in suspended particles are on the same order of magnitude as those in the earth's crust. By contrast, the concentrations of polycyclic aromatic hydrocarbons are midway between those of contaminated water bodies and those of relatively pristine ones.

The results of the Monitoring the State of the St. Lawrence River Program were shared with the scientific community on various occasions, including the 36th Aquatic Toxicity Workshop from September 27 to 30, 2009, in the Charlevoix region; the 62nd Annual Conference of the Canadian Water Resources Association from June 9 to 12, 2009, in Québec on the theme Water Quantity and Quality; and the colloquium Ecotoxicology Assessment of Agricultural Contamination: from the Yamaska to Lake Saint-Pierre, held in spring 2009. Discussions on a number of topics were held at conferences of Environment Canada's Quebec Region, with knowledgeable audiences such as ZIP committees, and at the Environment Canada Science Forum in Montréal on February 13, 2010. Easy-to-understand communication materials on the state of the St. Lawrence (kiosks and banners) were used regularly at public events held by ZIP committees and Stratégies Saint-Laurent. Approximately 3500 people were reached by these materials at about 20 different events.

Initiatives aimed at increasing community participation in the Monitoring the State of the St. Lawrence River Program continued. In addition to offering scientific and technical support to communities, Environment Canada helped and trained several groups in activities to monitor the state of the river in terms of bank erosion, invasive plant species and recreational uses:

- Environment Canada continued to monitor bank erosion at about 100 stations between Lake Saint-Louis and Saint-Pierre-les-Becquets. Three ZIP committees participated in this project, thereby contributing to erosion monitoring at 53 additional stations.
- Six riverside community organizations continued to monitor 8 invasive plant species at more than 100 stations between Lake Saint-François and Saint-Pierre-les-Becquets.
- The Lake Saint-Pierre ZIP committee monitored recreational uses (sportfishing, swimming, boating and nature observation) during the summer for a fourth consecutive year. Furthermore, this pilot monitoring activity was assessed by Great Lakes United to prepare for its potential rollout for the entire St. Lawrence.

### *Ecological integrity*

Work to gain knowledge on migratory bird populations that use the St. Lawrence as a breeding, migrating or overwintering area continued. The purpose of this work was to acquire information that would assist in prioritizing conservation efforts.

Environmental prediction work continued for the portion of the St. Lawrence River between Cornwall and Québec. Hydrodynamic modelling of the section affected by tidal cycles and freshwater inflow between Trois-Rivières and Québec began, habitat models were refined, St. Lawrence River water temperature modelling continued and physical models were made more efficient so as to be operational at the Canadian Meteorological Centre. Environmental prediction tools were used to conduct environmental impact studies, particularly in the area of sustainable navigation.

The impacts of urban discharges on the St. Lawrence ecosystem are now better identified and assessed. The study of the fate of pharmaceuticals

in Montréal municipal effluent discharged into the St. Lawrence River and the elimination of these pharmaceuticals through wastewater disinfection processes continued. Some of these compounds were found to be toxic to mussels and fish at very low concentrations.

Research into the effects of nutrients on the composition of algae in Lake Saint-Pierre led to the discovery of a proliferation of benthic cyanobacteria in this critical sector of the St. Lawrence.

Research continued on invasive species in the St. Lawrence, notably the Chinese Mitten Crab (*Eriocheir sinensis*) and the Round Goby (*Neogobius melanostomus*).

### *Navigation*

Stakeholder consultation regarding navigation on the St. Lawrence was fruitful in a number of areas, especially with respect to integrated management of sediment dredging. The Navigation Coordination Committee launched the Dredging Activity Planning Registry ([www.planstlaurent.qc.ca/dredging](http://www.planstlaurent.qc.ca/dredging)), which aims to promote regional solutions to problems with contaminated dredging sediments, while encouraging public participation in work planning. The Committee also developed practical guides, including guides on the development of environmental surveillance and monitoring programs, and on the physical and chemical characterization of sediments. Management safeguards were also put in place to protect aquatic life from the physical effects of suspended solids during dredging.

### *Agriculture*

A monitoring project on sulfonyleurea herbicides in the Baie Saint-François watershed was carried out. The purpose of the project is to enhance knowledge on their presence, sources, environmental fate and transport in both surface water and groundwater. The results will help identify farming practices that can minimize environmental risks related to the use of these new pesticides.

A partnership project between the Government of Quebec and the federal government provided an assessment of the impact of inflows from an agricultural tributary on the quality of the aquatic

environment and the health of certain fish populations in Baie Lavallière, one of the largest wetlands in the area surrounding Lake Saint-Pierre. An action plan for this tributary, Rivière Pot au Beurre, was proposed by key agriculture stakeholders. This action plan will enable farmers in this watershed to implement beneficial management practices that can be applied in the fields or around agricultural streams to limit inflow of nonpoint-source pollution of agricultural origin.

#### *Shore access*

Eight shore-access improvement projects were completed in riverside communities along the St. Lawrence, together with several projects to rebuild federal government marine infrastructures. A cartographic inventory of St. Lawrence access sites was developed with the help of government and community partners.

### 1.4.3 Atlantic Ecosystem Initiative

#### **Background**

Environment Canada's Atlantic Ecosystem Initiative consists of two programs: the Atlantic Coastal Action Program (ACAP), a unique community-based partnership program between Environment Canada and 16 multi-stakeholder community organizations in the four Atlantic provinces; and a program with three regional coalitions whose work positively impacts larger ecosystems in the Gulf of Maine, the Southern Gulf of the St. Lawrence and the Bay of Fundy. Both programs support initiatives that use local and regional expertise, and support people who are working in their own communities and regions to help build a better environment for Canadians.

Environment Canada contributes funding, technical and scientific expertise, and direct staff support with respect to four broad categories of projects relevant to the *Canada Water Act*: clean water, atmospheric depositions, toxics and natural habitat.

#### **Progress to March 31, 2010**

In 2009–2010, 34 projects (representing almost 60% of all projects) dealt with water issues. Topping the list of project activities were restoring, enhancing and improving water quality and watersheds through proactive activities such as

reducing pollution and raising awareness of the value of natural habitats through education, outreach and stewardship; improving and restoring aquatic and riparian habitat; and monitoring water quality.

Restoration and enhancement of watersheds were a high priority for many organizations working in Nova Scotia. Bluenose ACAP actively worked on three watersheds within their organization's boundaries. For example, the LaHave River watershed encompasses an area of approximately 1700 km<sup>2</sup>, crosses three counties, and hosts a high level of residential, industrial, and recreational activities. It is also the recipient of four sewage treatment plant outflows, and in some areas, houses still have direct pipes to the river for their wastewater. Long-term water quality monitoring aims to address the environmental impacts of these activities by providing a long-term record of the river's health; completing riparian health assessments along its riverbanks; and proactively reducing stressors by enhancing watershed education in the local community.

In southern New Brunswick, a science project studied the biological (including biodiversity), social, economic and physical characteristics of wetlands in greater Saint John. The project also studied the presence, distribution and relative abundance of invasive alien species and determined the relationship between these characteristics and the proximity of the wetland to urban development. The need for this research arose from widespread urbanization in the area, which negatively affects wetlands. The aim is to improve decisions taken by regulators, consultants, urban planners and the public on potential alterations to urban wetlands.

Coastal erosion and sea-level rise are realities facing the coastlines in the Southern Gulf of St. Lawrence. Consequently, the Southern Gulf of St. Lawrence Coalition on Sustainability worked with four community groups to spearhead a pilot coastal erosion monitoring and awareness project. With the guidance of federal and provincial coastal zone experts, the Coalition developed a tool kit to monitor and characterize various shoreline test sites with the aim of developing a regional sustainability atlas. This atlas highlights the vulnerability of these

shorelines and allows the community groups to work with local and provincial decision makers to develop adaptation strategies. Development of accessible and comprehensible outreach materials was an important part of this project.

Northeast Avalon ACAP, Humber Arm Environmental Association, Labrador Southeast Coastal Action Program, and Central Labrador Environmental Action Network in Newfoundland and Labrador joined forces to initiate a provincial forum to discuss the Council of Canadian Ministers of the Environment's new national strategy for the management of municipal wastewater effluents. This 30-year strategy establishes minimum standards and objectives to which jurisdictions must comply. The forum explored the implications of these new municipal wastewater effluent regulations for Newfoundland and Labrador communities, and shared information on the variety of treatment technologies that would best serve the diversity of the Newfoundland and Labrador landscapes. The main objective of this forum was to improve the municipal wastewater effluent standards of the province's communities and align them better with national standards.

Environment Canada also conducted a number of water research activities in the Atlantic Region, including the development of bioassessment approaches for CABIN, the assessment of transboundary river nutrient status, and the development of approaches for identifying the source of excessive sediment in rivers. CABIN work included the development of DNA libraries that will assist in the taxonomic identification of biomonitoring samples; the establishment of complementary field methods for watershed-scale biodiversity assessment; and the development of an approach that uses the biological traits of a species to assess ecohydrological impacts on rivers. A multi-year assessment of the nutrient status of the Saint John River was completed, and nitrogen and phosphorus nutrient levels of concern were identified. Collaborative work with Agriculture and Agri-food Canada furthered the development of novel techniques to identify the source of excessive sediments in tributaries of the transboundary Saint John River.

#### 1.4.4 Action Plan for Clean Water

##### **Background**

Environment Canada is carrying out its work under the Government of Canada's Action Plan for Clean Water through \$96 million in cleanup funding to restore Lake Simcoe and Lake Winnipeg, and to implement remediation plans for contaminated sediment in eight Canadian Areas of Concern in the Great Lakes.

The Action Plan for Clean Water also encompasses the Health of the Oceans Initiatives (HOTO). HOTO provides five years of funding to support various programs and activities that protect fragile marine environments, counter pollution and strengthen preventive measures. Although Fisheries and Oceans Canada is the formal federal lead for the HOTO, five federal departments and agencies, including Environment Canada, receive funding to advance the goals and objectives of the initiative.

##### **Progress to March 31, 2010**

###### *Great Lakes Areas of Concern*

The federal government provided funding to manage contaminated sediment in Lyons Creek East, a tributary of the Niagara River. Monitored natural recovery was selected for implementation, mainly because of the desire to protect the provincially significant wetlands. An administrative controls protocol, a long-term monitoring plan, and sediment and PCB fate and transport studies are underway.

The second year of a four-year sediment transport monitoring study in the Trent River, which flows into the Bay of Quinte, was completed. Monitored natural recovery was selected as the preferred sediment management option by the Trent River Mouth Investigation Steering Committee because the risk to humans and wildlife was found to be minimal. The upstream source of the dioxin and furan contamination of the sediment is still present but is being brought under control through cooperation between industry and the province.

###### *Lake Simcoe*

Environment Canada's Lake Simcoe Clean-up Fund ([www.ec.gc.ca/doc/eau-water/simcoe\\_e.html#a1](http://www.ec.gc.ca/doc/eau-water/simcoe_e.html#a1)), launched in 2008, is expected to improve water

quality for recreational use, reduce phosphorus loads, and advance the restoration of a sustainable coldwater fishery and the ecological integrity of Lake Simcoe. The fund is administered by the Department in consultation with Fisheries and Oceans Canada, Agriculture and Agri-Food Canada, the Province of Ontario, the Lake Simcoe Region Conservation Authority, and other key stakeholders. The Department is assisted by the Technical Review Committee, and the Protect and Preserve the Environment of Lake Simcoe Committee, which advises on priority actions and funding recommendations.

In 2009–2010, two rounds of funding provided \$5.5 million for 44 projects. The projects contribute to meeting the Lake Simcoe Clean-up Fund objectives of reducing rural and urban non-point sources of pollution; rehabilitating priority habitats to restore the health of the aquatic ecosystem and the coldwater fishery; and improving monitoring data and other information for decision makers. Working with local communities, groups, governments and individuals enhances the shared commitment and responsibility for a healthy and sustainable Lake Simcoe watershed.

The Department conducts additional science projects to improve understanding of Lake Simcoe and to assist in sound decision making. In addition to ongoing projects started in 2008–2009, a number of new projects were initiated in 2009–2010, including investigations to determine whether groundwater is a significant source of nutrients, and to assess the relationship of benthic invertebrates (an important food source for coldwater fisheries) to water and sediment quality.

### *The Lake Winnipeg Basin Initiative*

Work continued throughout 2009–2010 on Environment Canada's four-year, \$18-million Lake Winnipeg Basin Initiative ([www.ec.gc.ca/doc/eau-water/winnipeg\\_e.html](http://www.ec.gc.ca/doc/eau-water/winnipeg_e.html)), intended to help restore the ecological integrity of Canada's sixth-largest lake. Lake Winnipeg is recognized as one of Canada's most eutrophic lakes, with widespread and recurrent harmful algal blooms. In addition, the lake has a highly complex and fragmented watershed spanning three provinces and two American states. The Lake Winnipeg Basin initiative encompasses three areas

of focus: facilitating governance throughout the watershed; the administration of the Lake Winnipeg Basin Stewardship Fund to support projects that reduce nutrient levels in the Lake; and a science program encompassing research, monitoring and information management.

The Lake Winnipeg Basin Office was established by Environment Canada in Winnipeg to oversee and coordinate the various components of the initiative.

Environment Canada continued to work with the Province of Manitoba to finalize the terms of a Canada–Manitoba Memorandum of Understanding Respecting Lake Winnipeg under section 4 of the *Canada Water Act*, in order to provide a long-term collaborative and coordinated approach between the two governments.

Environment Canada co-chaired the federal–provincial Lake Winnipeg Basin Committee and participated as an *ex-officio* member of Manitoba's Lake Winnipeg Basin Stewardship Board.

A public advisory committee, composed of representatives from key stakeholder groups within the Lake Winnipeg Basin, was established to provide funding recommendations to the Minister of the Environment concerning Lake Winnipeg Basin Stewardship Fund projects. Fourteen projects totalling over \$1 million in federal funding had been initiated by the end of 2009–2010 across Manitoba, Saskatchewan and Ontario. Projects encompassed agriculturally beneficial management practices, wetland and riparian restoration, and demonstration projects related to nutrient abatement.

Work continued on further developing an information portal to compile and promote data sharing with key partners and to ensure consistent, relevant and reliable access to information about the Lake Winnipeg Basin.

Research and monitoring activities continued in 2009–2010 on Lake Winnipeg and major sub-basins, in support of Environment Canada's Lake Winnipeg Basin science plan. The goal of the science program is to understand the gaps related to ecology and nutrient cycling, and the sources and transport mechanisms for nutrients, to provide

a basis to establish nutrient objectives and performance indicators for the lake. Examples of the science work underway include

- assays of major nutrients, particulate organic matter and dissolved oxygen in Lake Winnipeg—one of the first rigorous studies of dissolved oxygen in the lake;
- a report on physical limnology, based on 2007 and 2008 measurements;
- hydrodynamic and water quality models for Lake Winnipeg and Lake of the Woods;
- analysis and validation of remote sensing aquatic colour data for Lake Winnipeg and Lake of the Woods;
- continued assessment of major nutrient inputs, their transfer and bioavailability to plankton and their potential role in the development of noxious blooms;
- assessment of sediment mass and nutrient loading to Lake Winnipeg from external (tributary) and internal (re-suspended) sources, and their potential effects on water quality and algal bloom development;
- monitoring of the distribution, biomass, species composition and toxin content of harmful blooms of cyanobacteria in Lake Winnipeg and Lake of the Woods;
- analysis of sediment cores from Lake Winnipeg to assess long-term trends in sediment deposition, nutrients, planktonic algal and zooplankton species composition and productivity;
- assessment of water quality, dissolved oxygen, nutrients and planktonic food web in Lake of the Woods;
- research on nutrient sequestration in lakes and reservoirs;
- field studies and modelling to quantify the sources, transport and fate of nutrients from agriculturally dominated watersheds through tributaries of the Red and Assiniboine rivers; and
- analysis of the nature and variability of hydrologic inputs to Lake Winnipeg and the possible impacts of climate change on water cycle variation, with implications on nutrient transport.

Work also continued with Manitoba on a report describing Lake Winnipeg's physical, chemical

and biological characteristics from 1999 to 2007. The report will serve as a baseline for scientific information and investigations on the lake, and support the development of performance indicators and nutrient objectives.

Lake of the Woods is a key component of the Lake Winnipeg watershed, and is also shared by Ontario, Manitoba and Minnesota. Recently there have been water quality concerns, including the occurrence of toxic cyanobacteria blooms in some parts of the lake. Environment Canada provided essential input in assessing key knowledge gaps in the Lake of the Woods basin. Environment Canada also developed digital bathymetry from the existing navigation charts. Department researchers continued science-based monitoring and developed scenarios based on nutrient and water budget models for the lake. These models will provide the knowledge for describing the interactions of physical, chemical and biological processes in the lake.

#### *Health of the Oceans Initiatives (HOTO)*

As part of its involvement in HOTO, Environment Canada received a total of \$0.75 million over five years towards activities in the Gulf of Maine. The funding is designated to provide support to the Gulf of Maine Council on the Marine Environment (GOMC), a cooperative effort of federal, provincial and state governments, academic institutions, non-governmental organizations and private sector organizations throughout the Gulf of Maine transboundary ecosystem area, and implementation of its joint Canada–United States five-year action plan. In particular, HOTO supports activities associated with GOMC's Climate Change Network, Gulfwatch Chemical Contaminant Monitoring Program, Ecosystem Indicator Partnership, and the education and outreach program.

In 2009–2010, Environment Canada's HOTO support for the Gulf of Maine focused primarily on the GOMC's regional chemical contaminant monitoring program, ecosystem indicator project and activities to understand potential climate change impacts. Support for Gulfwatch enabled continuation of the program's sampling and analysis for 2009, and contribution to its long-term tracking and status on the spatial and temporal scope of select contaminants within the transboundary

Gulf of Maine region. The Ecosystem Indicator Partnership continued with identification and development of indicators to monitor and track ecosystem health within the Gulf of Maine for six theme areas (fisheries and aquaculture, contaminants, climate change, coastal development, eutrophication, and aquatic habitats) and with the development and population of an online indicator reporting tool to disseminate indicator information to stakeholders throughout the region. The Climate Change Network also produced reports identifying the possible effects of extreme precipitation and other climate change factors on streamflow and water quality in the Gulf of Maine.

## 2 Water research

Environment Canada water scientists conduct research across Canada, investigating environmental issues such as the impacts of agriculture, industry and urbanization on water quality; the effects of contaminants in lakes, rivers, groundwater and sediments; the extent of atmospherically transported persistent organic pollutants and metals in aquatic ecosystems; and the potential impact of climate change on water quantity and quality.

This section describes research activities conducted by Environment Canada's Water Science and Technology Directorate in support of *Canada Water Act* activities.

### 2.1 Methodologies

In 2009–2010, work continued on developing methods for invertebrate life-cycle tests. Standard toxicity tests are often short term, emphasizing survival and growth as endpoints, and they do not account for long-term effects, such as reproductive effects or changes in sex ratio. Life-cycle tests include all life stages that may be impacted by chemical exposure, as many compounds persist in the aquatic environment at low levels. Life-cycle tests conducted in the laboratory will mimic environmental exposures to these types of chemicals or effluents to more accurately assess the risks posed to indigenous freshwater invertebrate populations.

A new method of detecting traces of antibiotics (e.g., ciprofloxacin and enrofloxacin) and other organic contaminants in environmental waters is being developed. Low concentrations of these substances in drinking water, groundwater or surface water make preparation and detection methods long and difficult. Current methods can be used to detect several antibiotics and other organic contaminants (pharmaceuticals, pesticides) in municipal wastewater, surface water and drinking water at concentrations between 2 and 289 ng/L. However, the new method can detect these substances at concentrations as low as 0.5–60 ng/L.

Stormwater management ponds are used extensively to control stormwater flows from urban developments and to enhance their quality. At the same time, ponds also serve as aquatic habitats. In a search for assessment methods of such habitats, a new benthic index, standardized in France, was applied to the Terraview and Willowdale stormwater ponds in Toronto. The new index was found to be helpful in confirming toxic effects detected by sediment toxicity tests or benthos analysis, and also yielded new evidence of other pollutant effects and information on the diversity of the benthic community in the system. Further refinement of this methodology is being pursued in a collaborative study of urban ponds with the French research institute CEMAGREF and Trent University.

### 2.2 Wastewater treatment technologies

Ultraviolet (UV) disinfection of wastewater is widely used for reducing the risk of waterborne diseases. However, biological aggregates found in wastewater protect pathogens from UV light, thus increasing the required UV dose. This increases both the size of the UV system, its electrical energy usage, and greenhouse gas emissions. Biological aggregates can be removed by filtration or membrane separation; however, these technologies require significant capital investments. Recent research has confirmed that suspended aggregates can be effectively disrupted by hydrodynamic stress, rendering them less resistant to UV disinfection. Hydrodynamic particle disruption is potentially a cost-effective alternative to particle removal by filtration or

membrane treatment, with lower capital costs, smaller footprint, no sludge generation, and easier retrofitting. In the ongoing second phase study, the focus is on optimizing hydrodynamic particles disruption and UV exposure time to achieve maximum treatment efficiency with least energy consumption. A key outcome of this research is the development of a novel treatment system by integrating hydrodynamic particle disruption with existing UV technology.

In Canada, there is a desire for urban discharge treatment processes to include a disinfection procedure. In addition, the effluents from these treatment processes should be regulated by several toxicity tests. At the Montréal treatment plant, ozonolysis systems have been installed to disinfect urban discharges, and studies were conducted to assess whether ozonolysis produces an endocrine-disruptor effect (estrogens and serotonergic substances) or other deleterious effects in mussels and fish, such as immunosuppression, inflammation or genetic toxicity caused by the oxidation of the organic matrix of urban discharges.

Pilot-scale research was conducted to develop a new technology using an anaerobic membrane bioreactor to treat municipal wastewater. Anaerobic biological treatment is generally considered to be a sustainable wastewater treatment technology, but it is not typically applied to municipal wastewaters in North America, as they are dilute and often low in temperature. These obstacles may be overcome by the development of anaerobic membrane bioreactors.

Research was also conducted on novel gas-permeable membrane bioreactor technology that holds the promise of being one of the next-generation sustainable wastewater treatment technologies that are energy efficient and have superior contaminant removal capability, particularly for the removal of ammonia (a toxic substance under the *Canadian Environmental Protection Act, 1999*). The gas-permeable membranes studied are used for air delivery and as a biofilm support. An Environment Canada study found that the maximum oxygen transfer efficiency of this type of system was 70.6%, whereas maximum oxygen transfer efficiency for currently available aeration technologies is 25% or

less. The main purpose of this study is to investigate the application of novel gas-permeable membrane bioreactors for cost-effective nitrification and denitrification in wastewater.

Research was conducted to integrate external hollow-fibre and tubular membranes with anaerobic digesters to concurrently thicken and efficiently digest sludge. The use of membranes allowed the reactor size to be decreased by as much as 75% while maintaining treatment efficiency.

In practice, a membrane filter used for water treatment spends virtually all of its operating life fouled to some degree. Consequently, nanofiltration membranes are under development in specific attempts to minimize fouling. One research thrust is to tailor membranes to address specific major properties of the water being filtered. A joint study involving Environment Canada, the University of Waterloo and the Technical University of Berlin discovered a fouling mechanism that explains previous failed efforts at membrane development. The discovery is significant for a quantitative understanding of the relationship between fouling and flux, and for strategies to reduce or remove fouling.

A national wastewater monitoring program was initiated in support of Canada's Chemicals Management Plan, with the objective of improving our understanding and prediction of the occurrence and fate of emerging contaminants in typical Canadian municipal wastewater and solids treatment processes. The program also aims to determine whether control measures are needed to prevent these substances from entering the municipal wastewater system. Partial results show that polybrominated diphenyl ethers were removed from the liquid wastewater stream at levels ranging from 55% to 99%. Other partial results show that the removal success of bisphenol A from wastewater ranged from 15% to 92%, with no process type consistently showing higher removal than another. These results demonstrate the potential influence of both the substance's chemical characteristics and the characteristics of the wastewater treatment process in determining the substance's fate during treatment. Monitoring is continuing for another year with an expanded list of substances.

Research continued into methods to remove antibiotics from wastewater. The research focused on the development of micellar-enhanced ultrafiltration techniques. Partitioning the antibiotics into micelles enhanced the removal of contaminants from wastewater streams. In 2009, results indicated that sediments enhanced the process, leading to almost complete removal of the antibiotics, while natural organic matter had the opposite effect. In 2010, research efforts will focus on acquiring a better understanding of the contradictory impacts of sediment and natural organic matter. In furtherance of Environment Canada's objective of understanding the interactions between organic contaminants (such as antibiotics) and surfactants, thus enabling the optimization of a removal technique, the Department entered into a multi-year grant and contribution agreement with Queen's University. Under this agreement, researchers at the Department of Chemistry at Queen's University will complement ongoing research at Environment Canada by using nuclear magnetic resonance techniques to examine the nature of the binding (and hence, removal) process.

Several pilot-scale wastewater treatment trains have been set up to assess how various types of treatment processes alter the toxicology of the effluent. A unique strength of this project is the use of Canadian species for biological testing that are directly relevant to the country's diverse environments. Application of life-cycle tests on Fathead Minnows (*Pimephales promelas*) will allow an assessment of the reproductive responses of whole organisms. Cutting-edge molecular biology techniques will be used to rapidly assess gene expression in fish and amphibians. These techniques will be supported by the characterization of biochemical and physiological responses with standardized bioassays. This method presents an advantage over analyses of specific chemicals in the effluent in that the effects of all chemical constituents and their interactions are taken into account.

Research continued into assessing the effectiveness of methods that chemically treat ballast water to reduce the risk of introducing or transferring organisms while also evaluating the environmental risks of releasing chemically treated water. In

2009–2010, two chemical treatment techniques were analyzed in laboratory experiments by measuring the compound decomposition rate and performing toxicity tests on treated water. The results for a peracetic acid-based treatment process showed a very fast decomposition rate (< 2 days) in salt water, whereas decomposition took more than 10 days in freshwater, resulting in a residual toxicity of treated water, which indicates that its release into a natural environment should be limited.

## 2.3 Oil sands/related research

Studies into contaminants in the Athabasca River from oil sands mining activities began in autumn 2009. In areas with oil sands deposits, the surface and ground water naturally contain contaminants. The main challenge in oil sands aquatic research is to develop a method that can be used to trace the contaminants in freshwater systems back to their source (i.e. natural vs. anthropogenic deposits if any). This "fingerprinting" research was initiated in 2009–2010.

An assessment of historical climate and streamflow variability and trends within the Athabasca River watershed was also initiated. This research includes the determination of the water balance for the Athabasca River between Fort McMurray and the Athabasca Delta and an assessment of the potential implications of water withdrawals for downstream flows in deltaic channels.

In addition, fish and invertebrates from the Athabasca River were assessed for effects of exposure to oil sand chemicals from tailing ponds and sediments, and for exposure to surface and groundwater and sediments collected from the Athabasca River basin. The water and sediments from the tailings ponds were toxic, whereas the water and sediments from the Athabasca River basin were not.

## 2.4 Pharmaceuticals and personal care products

Research conducted on life-cycle exposures of fish to three municipal wastewater effluents that discharge into Lake Ontario showed that some

effluents can affect fish reproduction. Fathead Minnows grew normally and appeared healthy at 70% effluent yet, in two of the three effluents, they produced fewer eggs than reference fish. The municipal wastewater effluents contained a mixture of compounds: ammonia, oils, metals, nutrients and many pharmaceuticals and personal care products. High concentrations of the pharmaceutical drug furosemide (used to control blood pressure and kidney problems) were detected in all three effluents. Studies will next assess which advanced treatment technologies (UV sterilization, increased nitrification) can remove these compounds and, consequently, reduce the reproductive effects in fish.

Laboratory toxicity tests conducted to evaluate the toxicity of four sulfonamide antibiotics to freshwater invertebrates showed that survival and growth were negatively affected by some sulfonamides at environmentally relevant concentrations, although growth did not appear to be a more sensitive estimate of toxicity than survival. Sulfonamides were more toxic after a four-week exposure than after a one-week exposure, which will be important if these compounds are found to persist in the environment. Further research is necessary to determine the risk that these compounds, both individually and as mixtures, pose to the long-term health of freshwater ecosystems.

Research conducted on life-cycle exposures of invertebrates to municipal wastewater effluents showed that effluents can affect survival, growth and reproduction. Freshwater amphipods (*Hyaella azteca*) exposed to 100% effluent for 10 weeks were larger and started reproducing earlier than control individuals. However, at the end of the exposure period, the exposed individuals showed decreased survival and were producing fewer juveniles per adult. The municipal wastewater effluents contained a mixture of compounds, including many pharmaceuticals and personal care products. Studies will next assess which treatment technologies can remove pharmaceuticals and personal care products.

Studies on municipal wastewater effluents from Wascana Creek have indicated that

pharmaceuticals were always present, in nanogram and sometimes microgram per litre concentrations, downstream of the sewage treatment plant. The mixture included antibiotics; analgesics; anti-inflammatories; a lipid regulator; metabolites of caffeine, cocaine and nicotine; and an insect repellent. Not surprisingly, concentrations of some pharmaceuticals were highest in winter when creek flow was almost 100% treated sewage effluent. Ibuprofen, naproxen, gemfibrozil, triclosan, erythromycin, trimethoprim and sulfamethoxazole were present at concentrations that may present a risk to aquatic organisms. The continual exposure to a mixture of pharmaceuticals, as well as to concentrations of un-ionized ammonia that far exceed Canadian and American water quality guidelines, suggests that Wascana Creek should be considered an ecosystem at risk. In fact, recent laboratory experiments indicate negative effects on creek microbial production at erythromycin concentrations as low as 1 µg/L. Although the Wascana Creek study is regional in nature, the results highlight the considerable risks posed to aquatic organisms in such effluent-dominated ecosystems.

Studies were conducted on the interactions of a variety of sulfonamide antibiotics with sediments. Sulfonamide antibiotics are used in both human and veterinary medicine, and make up one of the most prescribed classes of antibiotics in use globally. The results obtained in 2009 indicate that sulfonamide antibiotics bind preferentially to sediments, and that sediment-dwelling organisms are at a higher risk of exposure than aquatic organisms. In 2010, the interactions will be explored using additional sediments of varying characteristics both to better predict environmental exposure and to provide information to enable environmental risk assessment activities.

Detailed studies on wild fish continued on the Grand River watershed in southern Ontario upstream and downstream from a number of municipal wastewater treatment plant discharges. The Grand River, which flows through a highly urbanized area, receives input from 26 municipal wastewater treatment plant discharges and offers an ideal site to examine the influence of these discharges on fish populations. To date, the intersex condition (eggs in

male testes) has been documented in the river, and follow-up studies are confirming these results and examining the incidence rate found in reference populations of the same species. Estrogenic compounds in sewage have been shown to cause the intersex condition in other parts of the world and under controlled whole-lake exposure scenarios. The Grand River contains a diverse assemblage of freshwater mussels, including nine endangered species. Scientists have found that wild mussels collected downstream from municipal wastewater effluents have significantly altered immune function, which may impair their ability to resist disease. Investigations are ongoing to determine the impact of this exposure on the health of freshwater mussel populations.

In collaboration with external partners, toxicity tests and biomarkers sensitive to pharmaceuticals were examined in organisms exposed to municipal effluents in the laboratory and in the receiving body of water. The aim of collaboration with the Centre Interinstitutionnel de la Recherche en Écotoxicologie (CIRÉ) is to study the ecotoxicological impacts of urban discharges. These studies, which are conducted with the Canadian Water Network, aim to understand the effects of new substances on freshwater mussels and fish exposed to municipal discharges from three Canadian rivers: the North Saskatchewan River, the Grand River and the St. Lawrence River.

A study on pharmaceutical contamination and toxic stress factors in natural Maskinonge (*Esox masquinongy*) populations exposed to urban discharges from the greater Montréal area in the St. Lawrence River began in 2009. The Maskinonge is a long-lived species that can accumulate high levels of contaminants after prolonged exposure. The tissue samples collected will be analyzed in the laboratory in 2010–2011. This research project is also assessing the variation in toxicological response based on the different genetic strains of different populations of fish exposed to urban discharges.

Research continued on the occurrence and fate of the antibacterial agent triclosan and related halogenated triclosans in the Canadian environment. Sewage and sludge samples from representative sewage treatment plants were analyzed for the

above compounds. Elimination rates and stability of the triclosans in the sewage treatment processes will also be evaluated. Triclosan and chlorinated triclosans occurred in every municipal wastewater and sludge sample analysed from the Burlington–Hamilton–Toronto area. While triclosan was the major microbicide product, chlorinated and brominated triclosan were also detected. The formation of these byproducts may be due to the combined use of triclosan and household bleach.

Research was also conducted on method development and occurrence and fate of widely used cholesterol-lowering drugs, i.e., atorvastatin and rosuvastatin, in sewage. A method using liquid chromatography tandem mass spectrometry was selected for the determination of atorvastatin and rosuvastatin in sewage samples. A study on their occurrence in sewage samples has indicated that rosuvastatin was present at levels a few times higher than those of atorvastatin, although the latter is used more than the former. Indeed, rosuvastatin was one of the most abundant pharmaceuticals in wastewater, possibly due to its stability and lower degree of metabolism in the human body.

## 2.5 Pathogens and parasites

Environment Canada has an extensive history of research into eutrophication and algal blooms, and is now engaged in highly targeted work to characterize the key mechanisms that control severity, toxicity and harmful impacts of algal and cyanobacterial taxa in our freshwaters. The work is aimed towards the development of sustainable risk management and long-term mitigation and management in partnership with local, municipal, provincial, national and international government, private and academic sectors. Department scientists have made major achievements by developing methods and tools to probe the underlying mechanisms driving the variability and severity of these serious threats to our waters. There is now an increased capacity to identify and measure known and new toxins and compounds from mixed water samples using screening and advanced analytical methods. Methods to extract genetic material have been established, allowing harmful taxa and associated toxins to be distinguished among mixed species assemblages. For risk management and

screening applications, various molecular biology methods are being developed to qualitatively assess harmful algal communities. At a macroscale level, collaborative work using large-scale surveys, instrument deployment and remote satellite scanning has enabled the tracking of harmful bloom events from space to shoreline, and shows that physics plays a key, multi-modal role: weather, water movement and thermal stability significantly affect the development, persistence and translocation of these booms. New or invasive species have been linked to some of these outbreaks, which include hidden or widely dispersed cyanobacterial populations.

Researchers at Environment Canada developed remote sensing products by combining in situ and laboratory measurements to assess water clarity, suspended particulates and algal blooms. The data provided by these methods have provided insights into algal blooms dynamics and cycles of water quality in the Great Lakes and Lake of the Woods.

Environment Canada continued research collaborations with university partners and municipal agencies to investigate the occurrence of water-borne pathogens such as *Campylobacter*, *Cryptosporidium*, *Giardia*, and enteric viruses in Lake Ontario. Nearshore research has been investigating recreational waters and the occurrence of pathogens in Hamilton Harbour. Research continued at several Lake Ontario drinking water intakes located about 2 km offshore. This research is seeking to establish a benchmark for water quality that can be used to evaluate any future changes in water conditions resulting from climate change or continued urbanization in the Golden Horseshoe area. Environment Canada also completed a scientific review of methods for enumerating bacteria such as *E. coli* that are used as indicators of the occurrence of water-borne pathogens.

Microbial source tracking analyses are being conducted in parallel with water-borne pathogen surveillance to provide information on the sources of pathogens detected in Lake Ontario. Results from this research will be useful for guiding cost-effective steps to reduce the pathogen pollution entering Lake Ontario. A microbial source tracking study was completed with the City of Toronto

to investigate sources of human sewage contaminating the Don River watershed, including the identification of some stormwater outfalls with probable sanitary sewer cross-connections.

The application of DNA barcoding and other molecular markers to larval flatworm parasites in the St. Lawrence River has shown that fish were infected with at least 47 species of these parasites. Previously, only 12 species were known to infect freshwater fish species across Canada. The parasites include numerous pathogens such as eye flukes, which cause cataracts and blindness in fish and are problematic for aquaculture and recreational fishermen. This project is linked to the Canadian Barcode of Life Network and the International Barcode of Life Project, and is now being expanded to include fish from different freshwater ecosystems across Canada. Correctly identifying pathogen and parasite species is the first step in any management, treatment or control initiative.

Results from studies on myxozoan fish parasites—microscopic organisms that infect different fish tissues—have shown an increase in the species richness and prevalence of these parasites downstream from the municipal effluents from Montréal. The high organic load stemming from the sewage effluent promotes populations of benthic worms called oligochaetes, which transmit the parasites to fish. At the same time, the overall species richness of these parasites in the St. Lawrence River is inversely related to water levels. Increased flow rates resulting from high water levels likely reduce the transmission of the parasite from the benthic worm to the fish. Thus, while the municipal effluents contribute to increasing parasites in fish, the overall level of parasites in the fish in the St. Lawrence River is determined by climatic conditions and hydrology.

## 2.6 Nutrients

Research by Environment Canada scientists sought to identify impacts of point sources of nutrients on the health and ecology of receiving freshwater ecosystems. Studies on effluent-dominated aquatic ecosystems (e.g., Wascana Creek, Saskatchewan) indicated increased nitrogen and phosphorus

concentrations downstream from the Regina sewage treatment plant. In fact, nitrate and nitrite concentrations far exceeded World Health Organization limits for drinking water (10 mg NO<sub>3</sub>-N/L) and sensitive taxa; furthermore, un-ionized ammonia, nitrate and nitrite far exceeded Canadian Water Quality Guidelines for Protection of Aquatic Life and those for the U.S. Environmental Protection Agency. As well, high levels of ammonia, originating from the sewage treatment plant, may be responsible for negative impacts on microbial community structure and production observed at downstream sites.

Research investigating the impact of excess nutrients on the aquatic environment in Lake of the Woods included three field trips during 2009–2010 to assess the spatial and seasonal variation in nutrients. Measurements included basic water chemistry, sediment chemistry, and analysis of algae and benthic invertebrates. Results were presented to stakeholders at the annual Lake of the Woods Water Quality Forum and supported continued collaborative study efforts among stakeholders.

Lake Winnipeg is fed by a vast water basin extending over four provinces and four American states. The Lake is experiencing increased eutrophication, with blue-green algae covering more than half the surface area at times, severely affecting water quality. Decision makers require advice on the costs and benefits of measures to reduce excess nutrients and improve water quality. Environment Canada is therefore conducting research under the Science Plan (\$65,000 has been spent to date) to assess three different types of possible solutions—agricultural best management practices, wetlands restoration and infrastructure investments in wastewater treatment. Environment Canada's proposed analytical framework for ecological goods and services is being applied in the assessments, to allow a focus on the trade-offs involved when making policy decisions that involve different possible uses of ecological goods and services. In applying this framework, this work will differ from typical cost-benefit analysis in that it will evaluate the benefits of the three different options in terms of ecological goods and services, including both market and non-market values. The project

includes the co-benefits that occur in addition to nutrient reductions, for instance habitat provision and carbon storage. The benefits of each intervention can then be compared with the costs involved to determine which provides the best results for a given investment.

Aquatic ecosystem impacts research focuses on the cumulative effects of nutrients on aquatic ecosystems. Nutrients from urban and agricultural sources result in the proliferation of some types of algae, to the detriment of several others. More specifically, in several areas of the St. Lawrence, an excess of nutrients first results in excessive growth of green algae and plants, which are then replaced by cyanobacterial carpets. The presence of cyanobacteria coincides with a reduction in the biomass of the aquatic plants that form the habitat of invertebrates and young fish. Research findings indicate that this habitat change could also lead to a reduction in the carrying capacity of the ecosystem through a reduction in the biomass of the invertebrates on which fish feed. Filamentous cyanobacteria also negatively influence human activity along the banks of the St. Lawrence, since they are slightly toxic, they give drinking water an earthy taste and smell, and they form unsightly piles on shores. The work conducted in 2009–2010 will shed more light on the relationship among climate, water quantity and quality, and the structure and productivity of the St. Lawrence's aquatic ecosystems.

## 2.7 Pesticides and agricultural runoff

Research conducted in 2008–2009 to assess the impacts of current-use pesticides on freshwater ecosystems within the Great Lakes Basin was expanded in 2009–2010. The use of short-term *in situ* (caged) invertebrate exposures is being developed as a tool to predict long-term population-level impacts of pesticides on ecosystem health. Significant impacts on *in situ* survival and biomarkers associated with pesticide exposure occurred during periods of peak pesticide application, particularly when organophosphate and carbamate insecticides were measured in surface waters, indicating that pesticide use is negatively

affecting some freshwater streams. Laboratory research with pesticides of concern at these sites is currently underway to establish cause–effect relationships for these compounds, both individually and as mixtures.

Environment Canada scientists, in conjunction with researchers at the University of Manitoba and the University of Saskatchewan, are investigating the fate, dissipation and effects of a mixture of bromoxynil, dicamba, 2,4-D, clopyralid, MCPA, mecoprop, dichlorprop and glyphosate in prairie wetlands. The first seven herbicides are those most commonly found in prairie aquatic ecosystems. Results from this research indicate that the time at which half of a particular herbicide dissipated from wetland water columns varied from 2 to 31 days, with mecoprop and dichlorprop being the most persistent. Additionally, effects studies have indicated that changes in community structure, production and biomass occur after attached microbial communities (algae and bacteria) are exposed to glyphosate for three weeks. Biomass and production of algae and bacteria living in the water column (planktonic) were negatively affected by varying concentrations of the mix of all seven herbicides during the first three days of exposure but showed recovery thereafter.

Riparian buffer zones reduce runoff, which can carry pesticides, and therefore help to minimize the impacts of pesticides on aquatic ecosystems. The effectiveness of buffer widths ranging from 10 to 40 metres in reducing toxicity, pesticide and nutrient loads to nearby aquatic ecosystems was evaluated through a number of field trials. On moderate slopes (<5%), buffer zones of 10 metres were generally effective at reducing pesticide and nutrient concentrations but not always below concentrations that are lethal to aquatic life. When data from all field trials were combined, the concentrations of the studied pesticides were reduced by 27%–98% and 60%–98% in water and particles, respectively, within 10 metres. In addition, with a 10-metre buffer, nitrate-nitrogen and total suspended solids were reduced by 40% and 57%, respectively. Results indicate that pesticides that have a greater tendency to become bound to soil particles (highly sorbed) are removed by narrow buffers more efficiently than moderately

sorbed pesticides. This finding can be used to make buffer zones more effective under various conditions.

Sulfonylurea herbicides are a relatively new class of herbicides used to control weeds in a variety of crops but little is known about their occurrence, fate or transport in surface and ground waters in Canada. These herbicides, which have low mammalian toxicity, are highly toxic to plants and, consequently, are used at low application. Surface waters within agricultural watersheds are susceptible to surface runoff, spray drift deposition, and occasional overspraying of sulfonylurea herbicides. Because they are highly toxic to plants, environmentally relevant concentrations of these herbicides may significantly reduce primary production or alter plant communities in highly productive prairie aquatic ecosystems. In 2009–2010, a monitoring survey of sulfonylurea herbicides was undertaken in the vicinity of the St. Francois Bay (Lake St-Pierre) at the outflow of the Yamaska River, which drains a major agricultural watershed in Canada. This program aims to understand the dynamics of these herbicides in the environment using a multimedia approach (including water, air, soil and ground vegetation) and to assess risk to human health. Samples are being analysed at the National Hydrology Research Centre in Saskatoon.

Intensive farming of potatoes in Prince Edward Island relies on the repeated and widespread application of pesticides. Research examined whether pesticides or their degradation products accumulate in the sediment of riverine estuaries where they could impact benthic health. *Mya arenaria* (the softshell clam or steamer) is a vital benthic component of estuarine ecosystems and, as a filter feeder, *M. arenaria* could be vulnerable to contaminants in the sediment. The species is also susceptible to haemic neoplasia, more commonly known as leukemia, which can be associated with environmental stressors. In 2009, Department scientists established that haemic neoplasia rates were generally higher in estuaries located downstream from high-intensity potato farming (Dunk and Wilmot estuaries) than in estuaries downstream from areas with low- to moderate-intensity farming. Sediment samples were collected in the spring and during the peak spraying period

for pesticide residue analyses. Results from fall sampling confirmed results from the data obtained in the spring that haemic neoplasia rates were higher in the Dunk and Wilmot estuaries than at the reference estuary (Souris). Moreover, rates of the disease declined with distance from the pesticide source within the Dunk and Wilmot estuaries. Remarkably, the disease was not detected in Blue Mussels (*Mytilus edulis*) from the Dunk and Wilmot estuaries. These results have broad implications both for the aquatic benthic ecosystem as well as for human health, since parts of the mechanisms that underlie neoplasia in bivalves are similar to known cancer mechanisms in humans.

To determine the levels, fate and trends of current-use pesticides in selected priority watersheds in Canada, a surveillance project on pesticides was conducted. Preliminary investigations by Environment Canada found that streams close to agricultural land have elevated pesticide concentrations and a high frequency of pesticide detections. However, information on the levels, fate and trends of current-use pesticides in Canadian waters influenced by agriculture remains scarce. In 2009–2010, a national surveillance study on current-use pesticides focusing on priority agricultural watersheds was conducted. The study evaluated acid herbicides and glyphosate in water and pyrethroids and endosulfan in sediments. Samples were collected from spring through to late summer at consistent, regular intervals across all sites. Maximum concentrations observed in the three Ontario rivers were 7200 ng/L for glyphosate; 1500 ng/L for dicamba; 820 ng/L for AMPA; 820 ng/L for MCPA; 800 ng/L for 2,4-D; 590 ng/L for 2,4-DP; and 520 ng/L for 2,4-DB. Only two pyrethroids were detected in the three Ontario sediment samples. Total cypermethrin was found in Nissouri Creek at 0.6 ng/g, as well as trace amounts of cinerin I. No other pyrethroids were found in any of the samples collected in Ontario streams.

Environment Canada's research on the Abbotsford transboundary aquifer was reinitiated in 2009 as part of a three-year collaborative effort with Agriculture and Agri-food Canada. The goal of the research is to focus on the groundwater nitrate hot spots previously identified by Environment Canada, and to evaluate the factors that affect rapid

nitrate leaching from the soil zone into the aquifer. Analyses of vulnerable wells are being conducted to correlate data with seasonal factors, fertilizer application and land-use practices. Approximately 12 wells have been identified in hot spot areas, and these were sampled bi-weekly to monthly throughout 2009. Chemical and isotopic analyses are partially complete. Groundwater collections will continue in 2010, with experimental plot-scale leaching tests starting in summer of 2010 at the Agassiz substation.

A study was undertaken from 2007 to 2009 to investigate the contribution of runoff from sprayer track rows and evaluate whether a best management practice (mulch treatment) could reduce the contaminant export from these rows. Following rainfall-induced runoff events, runoff volumes, toxicity to *Daphnia magna*, and sediment, pesticide and nutrient concentrations were measured in compacted rows, uncompacted rows and compacted rows that had been covered by mulch. Mulch treatment resulted in significant reductions in nitrate-nitrogen, total suspended solids, and aqueous chlorothalonil concentrations as well as sediment-associated pesticide (dithiocarbamate and metribuzin) concentrations. The treatments therefore show promise in reducing the risk to aquatic systems created by rain-induced runoff.

## 2.8 Nanoparticles

The growing production and widespread use of nanoparticles in commercial products inevitably leads to their release into the environment. Some laboratory-based studies have reported that many nanoparticles (e.g., silver nanoparticles) are toxic to bacteria. This finding has raised concerns over the effects of nanoparticles on natural bacterial assemblages in freshwater environments (e.g., water, sediment). To investigate the fate and effects of silver nanoparticles in freshwater environments, silver nanoparticles were added to microcosm tanks consisting of river water overlying river sediment cores. Results show that the nanoparticles were rapidly removed from overlying water and precipitated onto the top layer of the sediments. Therefore, natural bacterial communities in the top layer of the river sediment cores were receiving a

continuous and cumulative exposure to silver nanoparticles. However, nanoparticles did not have observable effects on microbial enzyme activity, the genetic structure of the bacterial community, and functional gene abundance in the top layer of the sediment cores. This study suggests that it is necessary to consider the physical and chemical nature of nanoparticles under relevant environmental conditions when the potential effects of nanoparticles on natural bacterial communities are investigated.

In 2009–2010 Environment Canada researchers carried out an extensive characterization of a variety of nanoparticles using scanning transmission X-ray spectromicroscopy. Silver, zinc oxide, titanium oxide, copper oxide and carbon nanotubes were successfully detected and identified. Studies were carried out to evaluate the effect of nanomaterials on aquatic microbial communities. For example, the effects of copper oxide nanoparticles on the development and community composition of complex river microbial communities were assessed by microscale and molecular methods. These analyses revealed significant changes in community composition, and showed that these changes were related to the chemical behaviour of the nanoparticles and their interaction with the microbes.

In 2007, Environment Canada developed an aquatic nanotoxicology research program to assess the environmental impacts of the release of nanoparticles into the environment, as well as their conversion and fate, particularly in wastewater and environmental waters. To meet a great need for analytical approaches to the physical and chemical characterization of these nanoparticles and the influence the receiving body of water has on them, preliminary physical and chemical characterization work was initiated and helped document the use of separation techniques (ultrafiltration, chromatography) to assess the size distribution of nanoparticles and their conversion products in various media. The fractions obtained helped better assess the fate and bioavailability of nanoparticles in aqueous media. The influence of the receiving waters' properties on the aggregation and degradation of particles needs to be better assessed. Results have shown that the type and quantity of

natural organic matter or matter from municipal wastewater play a significant role in the conversion and fate of particles in the aquatic environment.

The research program also involves developing nanoparticle microbioassays and biomarkers to assess the risk of these substances. These studies focus on various aquatic organisms across an experimental food chain (bacterium, alga, hydra, mussel, microcrustacean (*H. azteca*) and fish) to determine which organisms would be most at risk. Initial work pertained to cadmium telluride quantum dots as a model substance. Subsequently, in view of international initiatives sponsored by the OECD, research work shifted to nanosilver, promoted by Canada.

## 2.9 Mercury

Environment Canada participated in research on the biogeochemistry and bioaccumulation of mercury in freshwater ecosystems conducted under the Northern Contaminants Program. Mercury concentrations were demonstrated to be increasing in fish in Great Slave Lake and also in other lakes in the southwestern section of the Northwest Territories. Increases were greater in smaller, shallower, warmer lakes. No increases in mercury were found in Arctic Char (*Salvelinus alpinus*) from lakes in Nunavut. Climate-related factors, such as the longer ice-free period, may be influencing the amount of mercury in the lake food webs in the western Arctic region. However, this region is also receiving more mercury from Asian sources than other Canadian arctic locations, according to global atmospheric transport modelling results. These results will contribute to the arctic monitoring and assessment report on mercury that will be published in 2011.

Mercury was also the main focus of research conducted on sediment from lakes near the smelter in Rouyn-Noranda, Quebec. The isotope composition of mercury was shown to vary with distance from the smelter and also with date of deposition inferred from dating the sediment cores. The results suggest mercury isotope composition may be used to determine the sources of mercury to aquatic environments. If confirmed by additional study, this would aid our understanding of the

anthropogenic sources of mercury contamination of the aquatic environment. Work is continuing to develop comparable data for cores from other lakes polluted with mercury from nearby industrial point sources (Wabamun Lake, Alberta; Clay Lake, northern Ontario; and Lake Ontario).

Under the Clean Air Regulatory Agenda, research was conducted on the deposition of mercury in lake sediments and in fish near smelters (Manitoba) and coal-burning power plants (Alberta), as well as in background locations like the Experimental Lakes Area (northwestern Ontario). Preliminary results show much higher mercury deposition in lakes near the smelter in Flin Flon, Manitoba; however, high mercury deposition was not detected near coal-fired plants. Mercury concentrations in fish from lakes near the smelter were generally lower. Higher mercury concentrations were found in fish from lakes to the northwest of Flin Flon—a finding that may be related to factors such as the pH in Canadian Shield lake waters. Research continues in order to understand the pathways of accumulation of mercury and the reasons for the relatively low concentrations in fish.

## **2.10 Health of the aquatic ecosystem**

Because parasites have complex life cycles and are transmitted by predation from one host to the next, they can be used as indicators of food web structure, biodiversity and ecosystem stress. Currently, parasites of different fishes are being examined in various rivers and lakes, including the Areas of Concern in the lower Great Lakes, the St. Lawrence River, and the Athabasca River, to help evaluate the state of these key Canadian ecosystems. Results so far show that fish in impacted sites host a lower diversity of parasites than fish in non-impacted sites. These results imply that food webs at the impacted sites are compromised and biodiversity is reduced, which are signs of stressed ecosystems.

Studies conducted in 2009–2010 to measure the combined effects of parasites and pollution on Yellow Perch in the St. Lawrence River demonstrate that fish exposed to contaminants and high levels of parasites are under more stress than fish exposed to either stressor alone. Thus, certain kinds of

parasites become more pathogenic in polluted ecosystems, whereas they have little or no detectable effect in unpolluted conditions. These results are important to help evaluate the overall effects of contaminants on ecosystem health, and show that the effects of contaminants should not be evaluated in isolation, in order to better protect ecosystems and natural resources.

An ongoing study of urban groundwater in Canada focused on assessing the occurrence and distribution of groundwater contaminants discharging to streams. A second component of this study under development will assess the effects of the seepage of contaminated groundwater on aquatic ecosystems. Samples were collected along six streams at urban locations in Ontario, Alberta and Nova Scotia. Parameters analyzed included nutrients, metals, chlorinated and petroleum hydrocarbons, pesticides, pharmaceutical compounds and other trace organics. A laboratory method was developed to analyze artificial sweeteners as potential tracers of groundwater contaminated by urban wastewater sources. The results collected in 2009–2010 supported earlier findings that suggest the effects of contaminated groundwater may be an important and overlooked concern for aquatic ecosystems of streams in urban areas of Canada.

A research project on the cumulative impacts of environment and habitat pollution and the deterioration and presence of invasive aquatic species in the Port of Montréal area continued in 2009–2010. Ports are preferred sites for the introduction and establishment of new aquatic species, but they are also characterized by severe pollution impacts. Measurements of contaminants in sediments (including metals, PCBs, polycyclic aromatic hydrocarbons and organotins) and samples of biological diversity in port and non-port areas were analyzed to determine the relative presence of the various man-made disturbances that can affect the biological integrity of freshwater environments. Analysis of biological samples revealed the presence of a new species of planktonic crustacean in the St. Lawrence River, at a density of 10 to 100 times that previously reported in the Great Lakes.

## 2.11 Northern Canada

A research study to assess the performance of wastewater treatment systems in Canada's Arctic began in 2009. Field research is being conducted to develop an inventory of wastewater system facilities and their current treatment capabilities. Results from this study, coupled with associated risk assessment input, will be used to formulate discharge standards for the Arctic Component of the Canada-Wide Strategy for the Management of Municipal Wastewater Effluent, which, in turn, will be incorporated into regulations under the *Fisheries Act*. Preliminary data show that lagoon effluent in the North has consistently exceeded the Canadian Council of Ministers of the Environment's proposed standards for both carbonaceous biochemical oxygen demand and total suspended solids. Partial results show seasonal variation in the effluent quality. Other factors that affect wastewater treatment, such as retention time, loading and sludge volume in the lagoon, will continue to be identified and evaluated. Preliminary work has also shown that wetlands can provide additional treatment, though their role needs to be better understood from both scientific and regulatory perspectives.

Arctic Freshwater Systems: Hydrology and Ecology was launched in 2007 as one of 44 Canadian projects funded by the Government of Canada to contribute to the International Polar Year initiative. Through integrated, multidisciplinary, hydrological, climatological and ecological field studies and laboratory analyses, the project is producing peer-reviewed scientific publications on freshwater and nutrient flows to the Arctic Ocean, unique legacy databases of freshwater biodiversity and related environmental information on Arctic freshwater ecosystems.

Environment Canada scientists, in partnership with several universities, industry and territorial governments, investigated key aspects of the water cycle in northern Canada as part of the Canadian Foundation for Climate and Atmospheric Sciences' Improved Processes, Parameterization and Prediction in Cold Regions (IP3) program. Research concentrated on characterizing spatial variability of energy fluxes in the southern Arctic with the goal of

developing better parameterization schemes for predictive hydrological and hydro-meteorological models; developing a new model capable of predicting hourly evaporation rates from lakes; and characterizing the relationships among ground frost, surface wetness and streamflow in the Canadian Shield to predict runoff volumes. These studies will help Environment Canada better understand the hydrologic regime of northern Canada, and improve key models for improved environmental prediction.

The proposed Mackenzie Valley Natural Gas Project will operate wells at two gas fields in the Kendall Island Bird Sanctuary of the outer Mackenzie Delta, an area with extremely important bird habitat. Over the life of the project, industry predicts that natural gas extraction will result in significant subsidence around the wells. Since much of the bird sanctuary is located no more than 2 m above sea level, such subsidence will likely increase flooding with a negative impact on bird habitat. Environment Canada scientists, in collaboration with scientists from Natural Resources Canada, carried out a study to quantify the area that would be affected by induced subsidence. This included considering the effects of discharge from the Mackenzie and Peel rivers; the interactions of river channel and offshore ice during spring breakup; changes in sea level; variations in storm surges; and variations in the elevation of the terrestrial areas of the Kendall Island Bird Sanctuary due to sedimentation and natural subsidence. This study will provide a better understanding of the links and interactions among induced subsidence, natural subsidence, changes in sea level and storm surges, and changes in habitat in the bird sanctuary, and provide the information necessary to sustainably manage the Kendall Island Bird Sanctuary.

Other studies were conducted by the Department to consider the potential impact of the proposed Mackenzie Valley Natural Gas Project on the hydrology of the Mackenzie Valley and Delta, and to provide the necessary information for Environment Canada to review the proposed project. These studies included an analysis of the role of ice jams in controlling peak water levels in the Mackenzie Delta; a study of the hydrology of the uplands to the east of the Mackenzie Delta where the proposed Mackenzie Valley Natural Gas Project will cross ice-

rich upland terrain; and the application of hydrologic models to consider the hydrologic regime of streams that the proposed pipeline would cross as it moved gas southward up the Mackenzie Valley. Some of the information gathered by these studies will supplement data from the Water Survey of Canada.

## 2.12 Hydro-meteorological modelling and prediction

### Background

Applied science makes extensive use of models as tools for predictions about the physical world. For several years, researchers and scientists at Environment Canada and many partner agencies have used atmospheric and weather data as input for day-to-day operational forecasting models, and hydrologic data collected under the hydrometric agreements as input for hydrologic models. Concerted efforts have been made to couple atmospheric and hydrological models, and these models and eco-hydraulic modelling systems have been tested. These models demonstrate how regional hydro-meteorological modelling and ensemble forecasting systems can help improve weather prediction and water resources management.

### Progress to March 31, 2010

Environment Canada's atmospheric researchers continued to improve methods for coupled hydro-meteorological modelling and prediction under an expanded environmental prediction framework. The model and prediction system enables an improved understanding of interactions between the atmosphere and the land surface. This work supports improved water management using the *Modélisation environnementale de Surface et Hydrologie* (MESH) system and also supports the International Hydrological Ensemble Prediction Experiment.

The expanded environmental prediction framework contributed directly towards an International Joint Commission program focused on assessing the contribution of climate to the low water levels in lakes Michigan and Huron. Environment Canada used coupled regional climate and hydrology

modelling to assess long-term climate change as well as numerical weather and hydrological modelling systems to study uncertainty and water balance closure. The study included the hydrodynamic modelling of the St. Clair River. The development and operationalization of Environment Canada's eco-hydraulic modelling system for major portions of the St. Lawrence River continued during 2009–2010.

Ongoing studies have focused on improving our understanding of water availability in Canada through the development of new methods for modelling the hydrological cycle at a variety of scales, from small basins to large rivers. In 2009–2010, research continued on developing physically based models for predicting snow-cover development, melt and runoff, and improved techniques for predicting evaporation from lakes of various sizes.

The Okanagan Basin, a semi-desertic region of western Canada, is currently experiencing rapidly increasing pressure on its water resources from development and population increases, exacerbated by changes in climate. The major source of freshwater in the region originates from the melt of high-elevation snowpacks, about which little is currently known, including the proportion of the peak snowpack lost to sublimation. Ongoing modelling studies continued in 2009–2010 to help provide information on a number of characteristics of the snow resource, including snow distribution and snowmelt rates, that will allow water managers to better predict the amount of water available for ecological, agricultural and municipal needs.

Environment Canada scientists also initiated a study in 2009 to improve understanding of water availability and sustainability of streamflow in the Athabasca River basin, which is experiencing multiple stressors from climate change and variability and industrial water uses (e.g., water abstraction for oil sands processing). The initial phase of this study focused on gathering climatic and hydrometric data to create a master archive, as well as assessing historical streamflow trends and variability for 33 hydro-ecologically relevant hydrological indicators of alteration on the Athabasca River mainstem and tributaries.

Spatial assessment of historical climatic and hydrological controls on streamflow generation for the Athabasca River basin is ongoing. Environment Canada completed a study that examined the effects of flow regulation and climate variability on obstructed drainage and reverse flow contribution from the Peace River to Lake Athabasca and Peace–Athabasca Delta during the spring breakup and open-water periods. Examination of climate, flow regulation and water abstraction impacts on instream flows from the Peace and Athabasca River basins to the Peace–Athabasca Delta will continue in 2010–2011.

The Department continued to develop water supply indicators in support of the National Water Atlas Project and contributed to ecosystem trends studies that focused on water resources.

Environment Canada scientists and regional hydrologists continued to make significant contributions to programs funded by the Canadian Foundation for Climate and Atmospheric Sciences, such as the Drought Research Initiative. The main objective of this initiative is to better understand the causes and impacts of major hydro-climatologic extremes over Canada, with a focus on the severe 1999–2005 drought that impacted the Canadian Prairies. Specific contributions from Department scientists include research towards acquiring a better understanding of past variability and projected future occurrences of extreme droughts on the Canadian Prairies, and of groundwater variability associated with extreme Prairie drought events.

## 2.13 The State of the Strait Conference

### ***Background***

The State of the Strait Conference is a Canada–United States event held approximately every two years that brings together government managers, researchers, students, members of environmental and conservation organizations, corporations, planning organizations, communities and concerned citizens to assess ecosystem status and provide advice to improve research, monitoring and management programs for the Detroit River and western Lake Erie. The conference alternates locations between Canada and the United States, and a report is issued following the conference.

### ***Progress to March 31, 2010***

The 2009 conference was held at the University of Windsor, Ontario, on April 28, 2009. The conference theme was Ecological Benefits of Habitat Modification. A report, which summarizes the recommendations from 12 habitat modification case studies, was released at the end of January 2010. This report, as well as previous conference reports, is available for download from the State of the Strait website at the University of Windsor (<http://web4.uwindsor.ca/softs>). In addition, an article that synthesized the results from the previous conference was released in November 2009.

# PUBLIC INFORMATION PROGRAM

## (Part IV of the *Canada Water Act*)

Responsible decision making and widespread engagement of the public are critical to successful water resource management. Education and outreach are complementary instruments that are used to encourage water conservation and water quality protection measures. Informational and educational materials can promote responsible behaviour and inform Canadians about the status of our water resources and the health of aquatic ecosystems. Public awareness campaigns, comprehensive websites, information workshops, dissemination of educational programming and materials, and a wide range of field activities are among the many ways in which Canadians and their communities receive information and learn how to act on it. This section describes some of the ways through which Environment Canada and its partners engage Canadians to learn more about the country's water resources and provide information on its sustainable use and conservation at a national level. Public information campaigns are also undertaken at the project level and within specific regions. These activities are discussed throughout the annual report, including in the section on the ecosystem initiatives.

### 1 Environment Canada's Water website

As part of the Internet Content Renovation Initiative at Environment Canada, the Freshwater website and other water-related websites in the Department, such as the RésEau website and the Water Survey of Canada website, are being integrated into the single, client-centered Environment Canada Water website ([www.ec.gc.ca/eau-water](http://www.ec.gc.ca/eau-water)). The upper pages of this site continue to provide basic information on a wide range of water-related topics, comprehensive educational materials (e.g., *A Primer on Fresh Water*, Water Fact Sheets), and the full text of key water publications (e.g., *Canada Water Act Annual Report*, Federal Water Policy, municipal water use

and pricing reports). There is also content on specific Environment Canada activities and links to water-related program areas in the Department. The Water website will continue to undergo significant enhancement with the addition of new information, tools and functionality.

### 2 Biosphère Environment Museum

The only environment museum of its kind in North America, the Biosphère, located in Montréal, offers fun-filled exhibitions and guided activities as a way for visitors to better understand major environmental issues and learn about solutions for living a green lifestyle, whether they live in the city or the country. Water, air, biodiversity, climate change, transportation, responsible consumption and sustainable development are just a few of the areas covered.

In 2009–2010, more than 100 000 people toured the museum's exhibits or took part in its off-site activities.

Also during 2009–2010, the Biosphère welcomed three new activities that focused on water:

- *Drop by Drop*, an interactive videoconference aimed at high schools across Canada focusing on water chemistry, pollution, the water cycle and ideas on how to conserve water.
- *Canada's Waterscapes—Yours to Enjoy, Explore and Protect*, an exhibition produced by the Canadian Museum of Nature and presented at the Biosphère from February 1 to April 30, 2010.
- Evening seminars on water-related issues, presented free of charge at the Biosphère on the occasion of World Water Day, in cooperation with the Canadian Museum of Nature.

The Biosphère's regular programming includes other water-related activities:

- *Adopt-a-River*, an awareness-raising program aimed at young people aged 11 to 18, coordinated by the Education and Water Monitoring Action Group and supported by the Biosphère and a broad network of coordinators in five provinces. The program celebrated its 10th anniversary in 2010.
- *Sur la piste de l'eau*, a guided exhibit on the St. Lawrence River for 10- and 11-year-olds.
- Three exhibitions: *Water Wonders!*, *Moving Giant: The Great Lakes–St. Lawrence Ecosystem* and *Blue-green Algae*.

## Appendix A. Agreements

The following *Canada Water Act* Agreements<sup>2</sup> were ongoing during 2009–2010.

### Apportionment and Monitoring Programs

- Agreements on water quantity surveys with all provinces, and with Indian and Northern Affairs Canada for the territories  
Canada–Quebec Protocol on Administrative Arrangements under the Canada–Quebec Agreement on Hydrometric and Sedimentological Networks in Quebec  
Master Agreement on Apportionment in the Prairie Provinces (Prairie Provinces Water Board)  
Water quality monitoring agreements with British Columbia, Newfoundland and Labrador, New Brunswick and Manitoba  
Canada – Prince Edward Island Memorandum of Agreement on Water  
Agreement Respecting Ottawa River Basin Regulation

Note that, on behalf of the federal government, the 2007 Canada–Ontario Agreement Respecting the Great Lakes Basin Ecosystem was made pursuant to the *Canadian Environmental Protection Act, 1999* and the Canada–Quebec Agreement pertaining to the St. Lawrence (2005–2010) was made pursuant to the *Department of the Environment Act* and the *Department of Fisheries and Oceans Act*.

### Water Management Programs

- Mackenzie River Basin Transboundary Waters Master Agreement

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<sup>2</sup> For which *Canada Water Act* authority exists (in most cases, by order in council).

**[www.ec.gc.ca](http://www.ec.gc.ca)**

Additional information can be obtained at:

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