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# The Canada Water Act Annual Report

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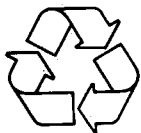
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# The Canada Water Act Annual Report

## 1989-1990



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Published by authority of  
the Minister of the Environment

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Cat No. En 36-426/1990

ISBN 0-662-57904-6

Minister of the Environment



Ministre de l'Environnement

His Excellency The Right Honourable  
Ramon J. Hnatyshyn, P.C., M.P.,  
C.M.M. C.D., Q.C.,  
Governor General of Canada,  
Rideau Hall,  
Ottawa, Ontario.  
K1A 0A1

Your Excellency:

I respectfully submit to Your Excellency and to the  
Parliament of Canada the annual report on operations under  
the Canada Water Act for the fiscal year 1989-1990.

I have the honour to be, Sir, Your Excellency's  
obedient servant.

A handwritten signature in cursive script, reading "Robert R. de Cotret".

Robert R. de Cotret



Deputy Minister  
Environment Canada

Sous-ministre  
Environnement Canada

The Honourable Robert R. de Cotret, P.C., M.P.,  
Minister of the Environment,  
Ottawa, Ontario.  
K1A 0A6

Dear Mr. de Cotret:

I have the honour to submit the Annual Report on  
operations under the Canada Water Act for the fiscal year  
1989-1990.

Yours truly,

Len Good

Canada

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# Introduction

The Canada Water Act, proclaimed on September 30, 1970, provides the framework for joint federal-provincial management of Canada's water resources. Section 38 (Revised Statutes of Canada, 1985) of the Act requires that a report on operations under the Act be laid before Parliament as soon as possible after the end of each fiscal year. This, the eighteenth annual report, covers operations to March 31, 1990.

On November 5, 1987, the Federal Water Policy was tabled in Parliament. Later in 1990, the Inter-departmental Committee on Water, itself restructured to serve as the focal point for coordinating the Federal Water Policy, will report to the Minister of the Environment on what action is under way to implement the provisions of the policy.

Up to and including fiscal year 1975-76, the Canada Water Act funding for federal-provincial projects was provided on the basis of

individual projects. In fiscal year 1976-77, Treasury Board established a ceiling on expenditures cost-shared with the provinces (for river basin planning and implementation, and flood damage reduction) at about an \$18 million per year level. Subsequent budget reductions and consequent adjustments to the program lowered the ceiling in 1984-85 to \$11 million per year. This total fell to \$9.2 million for 1985-86 and stayed near this level in fiscal years 1986-87, 1987-88, and 1988-89. In 1989-90, a budget of \$9.125 million was established. This budget does not include the federal cost of federal-provincial cost-shared monitoring and survey agreements (i.e., hydrometric and water quality).

In addition to joint federal-provincial undertakings, this report describes other federal activities under the Canada Water Act, including water research, data management, and public information programs.



# Provisions of the Canada Water Act

Part I of the Act provides for the establishment of federal-provincial consultative arrangements for water resource matters (section 4) and for cooperative agreements with the provinces to develop and implement plans for the management of water resources (sections 5 to 8). This part also enables the Minister, directly, or in cooperation with any provincial government, institution, or person, to conduct research, collect data, and establish inventories associated with the water resources.

Part II envisages federal-provincial management where water quality has become a matter of urgent national concern. It permits the establishment of joint federal-provincial incorporated agencies (although existing federal and provincial corporations might alternatively be used) to plan and implement approved water quality management programs.

Part III, Regulating Nutrient Inputs, was incorporated into the Canadian Environmental

Protection Act (CEPA) as a result of the Proclamation on June 30, 1988. The Canadian Environmental Protection Act is now responsible for regulating nutrient inputs to Canadian water courses. Information concerning the regulation of nutrients discharge to the aquatic environment will be reported in the CEPA Annual Report to Parliament.

The revocation of Part III of the Canada Water Act subsequent to the 1985 Statutes has no effect on the other Parts or sections unless specifically mentioned. Therefore, Part IV remains Part IV.

Part IV of the Canada Water Act contains provisions for its general administration. 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.

# Activities under the Canada Water Act

## Federal Water Policy

### Sustainable Development - A Global Imperative

The activities conducted under the Canada Water Act substantially contribute to our effort to achieve sustainable development, thereby maintaining the delicate balance between human activities and the health of our aquatic ecosystem. In the past century, man has distanced himself from the natural order, in many cases arbitrarily using what appeared to be an inexhaustible supply of water. The Federal Water Policy addresses this situation head-on, its goals being to protect and enhance the quality of the water resource and to promote the wise and efficient management and use of water. One of the Policy's strategies involves an integrated approach to planning and development of water resources, a prerequisite to sustainable development.

### The Integrated Planning Strategy

The integrated approach takes into account all water uses and water-related activities, within whatever political, administrative, economic or functional boundaries they are defined. Increasingly, watersheds, or river basins, are becoming the preferred spatial unit for water resource planning. The interdependence and growing competition among water users, and the recognition of recreation, social, environmental and heritage values are additional reasons for the growing importance of cooperative planning between the various levels of government agencies and institutions. To plan wisely for even the simplest natural unit such as a river basin requires the collaboration of engineers, scientists, lawyers, politicians, to name but a few.

### Scientific Research

The multidisciplinary approach to scientific research practised at Environment Canada's national research institutes aids the planning process. This research provides a sound knowledge

base for decision-making. Since 1986, the research program at the National Water Research Institute in Burlington, Ontario, has been organized into projects conducted by multidisciplinary teams of scientists. This past year, the National Hydrology Research Institute in Saskatoon, Saskatchewan, was reorganized along multidisciplinary lines. For details of research projects conducted by the Institutes, refer to page 22.

### Environmental Assessment

To achieve sustainable development, policies must be based on the precautionary principle. Environmental measures must anticipate, prevent and attack the causes of environmental degradation. Environmental assessment, as a planning tool, has been used by the Government of Canada since 1974.

The concept of environmental assessment is no more complex than the age-old common wisdom that 'an ounce of prevention is worth a pound of cure.'

Environmental assessment is a cornerstone of the Federal Water Policy. It ensures that the impacts of new projects, programs and policies on the productivity of water resources and related ecosystems are identified. By identifying adverse impacts before they occur, plans can be altered so that undesirable effects are reduced or eliminated. In some cases, project proposals would have to be abandoned if negative impacts are unacceptable and cannot be mitigated.

In 1989-90, approaches to environmental assessment were reformed. The environmental assessment reform package that has been recommended will ensure that environmental considerations are integrated into the decision-making process. The proposed Canadian Environmental Assessment Act is part of the package. It would for the first time set out in an Act passed by Parliament the federal government's responsibilities and procedures for the environmental assessment of projects.

### **Federal Water Policy**

The Federal Water Policy, the first of its kind in Canada, was formulated after several years of intensive consultation, both within and outside government. It addresses the management of water resources, balancing water uses with the requirements of the many interrelationships within our ecosystem.

The policy takes into account the needs of all Canadians in its overall objective:

- 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

To manage Canada's water resources, the federal government has defined two main goals:

- to protect and enhance the quality of the water resource
- to promote the wise and efficient management and use of water

The policy stresses that government action is not enough. Canadians at large must become aware of the true value of water in their daily lives and use it wisely. We cannot afford to continue undervaluing and therefore wasting our water resources.

Strategies of the Federal Water Policy are:

1. Water Pricing
2. Science Leadership
3. Integrated Planning
4. Legislation
5. Public Awareness

To obtain copies of the Federal Water Policy, write to the Inland Waters Directorate, Environment Canada, Ottawa, Ontario, K1A 0H3

joined the Program in 1979 and the Yukon has an agreement pending.

**The federal government is committed to alleviating human suffering caused by floods and minimizing the costs of flood damages.**  
- Federal Water Policy

The progressive approach taken in the Flood Damage Reduction Program not only reduces the potential loss of life and economic losses associated with flood disasters but also provides for opportunities to integrate these flood loss reduction goals with those for the protection of the natural functions of the floodplain such as providing wildlife habitat and recreation.

In 1989-90, the second in the series of Historical Flood Reviews of Indian Reserve lands in British Columbia proved to be extremely useful and has led to setting priorities for subsequent mapping of Indian lands. To date, 83 Indian communities in the province have been reviewed. For more information on the Flood Damage Reduction Program, see page 13.

### **Sustainable Development - An Individual Challenge**

The challenge of sustainable development to humanity requires action by individuals as well as nations.

**Sustainable development depends on individual Canadians changing their behaviour as it affects the environment.**

- The Green Plan, A National Challenge

The Federal Water Policy sets out strategies and commitments for sustainable development, involving all Canadians in the process. Through public consultation their views are considered in federal water management decisions, and through public information, individuals are empowered to make a difference by learning how to make lifestyle changes in water use.

### **Flood Damage Reduction Program**

Perhaps Canada's best example of sustainable development of water resources is our approach to flood damage reduction, where the senior levels of government agree to map and designate areas subject to flooding to discourage flood-vulnerable development. This information is provided to government agencies, zoning authorities, and the general public. Alberta joined the Program on April 3, 1989, bringing the total provincial participation to nine. Prince Edward Island is not involved because it does not experience riverine flooding. The Northwest Territories

# Part I: Comprehensive Water Resource Management

## FEDERAL-PROVINCIAL COOPERATION

The Canada Water Act calls for joint consultation between the federal and provincial governments in matters related to water resources. Discussed briefly in the following section are joint programs under the national Flood Damage Reduction Program as well as other projects involving the regulation, apportionment, monitoring or survey of water resources, and the preplanning, planning or implementation of water management programs.

Agreements for specific water programs provide for 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, it is usual for the federal government to meet half the costs and the provincial government(s) the other half. The planning studies encompass interprovincial, international or other basins where federal interests are important. Implementation of planning recommendations occurs on a federal, provincial, and federal-provincial basis. Cost-sharing of the construction of works often includes a contribution from local governments.

## INTERDEPARTMENTAL COMMITTEE ON WATER

The Interdepartmental Committee on Water (ICW) was established in 1968 to promote coordination and to provide advice on all federal water programs. Following a review of its mandate in 1987, the Committee was restructured and given a new direction in support of the Federal Water Policy.

Committee membership consists of the nine departments which have a significant interest in freshwater: Environment Canada, Fisheries and Oceans Canada; External Affairs Canada; Agriculture Canada; Health and Welfare Canada; Indian and Northern Affairs Canada; Industry, Science and Technology Canada; Energy, Mines and Resources Canada; and Transport Canada. Environment Canada

chairs and provides the Secretariat of the Committee.

In keeping with its advisory role in the development, coordination and implementation of federal policies on freshwater, much of the Committee's activity involves proposed legislative and policy initiatives. Recent activities include consideration of the proposed federal Policy on Wetland Conservation and the repeal of the Lac Seul Act.

The Committee has been designated in the Federal Water Policy as having the responsibility to monitor and advise the Minister of the Environment on the Policy's delivery. The Committee's first report recommends that the federal government:

- Increase federal research in support of the development of economic instruments in consultation with the provinces
- Strengthen federal research programs with better integration of natural and social sciences and linkages with external research partners
- Develop alternatives for the Supply and Services Canada Unsolicited Proposal program and Environment Canada's Water Resources Research Support program
- Improve data integration and monitoring, particularly in the North
- Develop a coordinated groundwater strategy
- Implement a federal program to address persistent aquatic debris
- Increase use of the Interdepartmental Committee on Water to enhance integrated federal decision-making with respect to water-related policies and programs
- Encourage national and provincial round tables
- Proceed with legislative initiatives in support of the Federal Water Policy (integration of the principles of sustainable development, ecosystem water management, fair value for water)
- Implement a federally coordinated water awareness program
- Amend the Interdepartmental Committee on Water reporting time frame for Federal Water Policy implementation to every two years.

**Table 1. Status of Federal and Federal-Provincial Water Management Programs**

**Regulation, Apportionment, Monitoring and Survey Programs**

<u>Under Negotiation</u>	<u>New During 1989-90</u>	<u>Ongoing During 1989-90</u>
Water quality monitoring agreements with Saskatchewan, Nova Scotia, Ontario, and Alberta	Water quality monitoring agreements with Manitoba and Prince Edward Island Water quality monitoring agreements reached with Northwest Territories and Yukon (no funding)	Water quantity surveys with all provinces Prairie Provinces Water Board Mackenzie River Basin Committee Water quality monitoring agreements with Quebec, British Columbia, Newfoundland, and New Brunswick Lake of the Woods Control Board* Ottawa River Regulation Planning Board Ottawa River Water Quality Coordinating Committee

**Water Management Programs**

<u>Under Negotiation</u>	<u>New During 1989-90</u>	<u>Ongoing During 1989-90</u>
Yukon and Alsek River Basins Implementation Agreement Mackenzie River Basin General and Master Agreements Amending Agreement for Qu'Appelle Conveyance Studies on Water Resource Management for Economic Development in New Brunswick Amending Agreement for the South Saskatchewan River Basin Study Study Agreement on Peace, Athabasca and Slave rivers		South Saskatchewan River Basin Study Saskatchewan Irrigation Development† Lower Fraser Valley Flood Control Canada-Ontario Agreement on Great Lakes Water Quality Qu'Appelle Conveyance‡ Fraser River Estuary Management Program Studies on Water Resource Management for Economic Development in Prince Edward Island

**Flood Damage Reduction Program**

<u>Under Negotiation</u>	<u>New During 1989-90</u>	<u>Ongoing During 1989-90</u>
Initial agreement with Yukon Territory Agreement to Implement Flood Control Measures for the Placentia Area in Newfoundland Revised General and Maintenance agreements with Nova Scotia Amending Flood Risk Mapping Agreement with Ontario	Amending Agreement for Manitoba Flood Protection Projects Initial Flood Risk Mapping Agreement with Alberta Amending Agreement with Manitoba (General, Mapping/Studies) Extension of Memorandum of Understanding re: Flood Risk Mapping of Indian Lands	General Agreement with Northwest Territories General/mapping agreements with Nova Scotia, Quebec, Ontario,§ Manitoba, Saskatchewan, and British Columbia General and Combined Mapping/Studies agreements with New Brunswick and Newfoundland Flood Forecasting agreements with New Brunswick and Manitoba Memorandum of Understanding on Indian Lands Manitoba Flood Protection Projects Studies agreements with Nova Scotia, Manitoba, and Saskatchewan Agreement with Saskatchewan on Community Floodplain Management Measures

\* Established under the Lake of the Woods Control Board Act.

† Not a Canada Water Act agreement but included here in the interest of completeness. Special funds were made available for this project under Economic and Regional Development Sub-Agreements.

‡ Canada-Saskatchewan Agreement on Qu'Appelle Conveyance expired March 31, 1989. It is included here because an extension is pending.

§ Flood Damage Reduction Agreement with Ontario includes a component for other measures.

Note: For convenience of presentation, some agreements have been separated into categories (general, mapping, studies). Often, they are combined.

Upon Ministerial approval, the Interdepartmental Committee on Water has scheduled publication of the report for the summer of 1990.

#### **FEDERAL-PROVINCIAL WATER RESOURCE MANAGEMENT PROGRAMS**

Table 1 shows a breakdown of current cost-shared federal-provincial water management programs and indicates the stage they have reached. Each of the programs is referred to briefly in the following few pages and described in more detail later in this report. Table 2 is a record of the achievements under the Act since its inception in 1970.

#### **Regulation, Apportionment, Monitoring and Survey Programs**

Although most federal-provincial agreements carry a time limit within which the objectives of the agreement are likely to be reached, there are some agreements involving monitoring and survey responsibilities that are projected to continue into the foreseeable future without termination.

#### **Water Quantity Data Collection**

The federal government has been involved in the collection of water quantity data since the late 1800s. In earlier years, hydrometric networks were operated under a variety of informal arrangements with the provinces. In 1964, the Quebec government took responsibility for most of the hydrometric network in that province. Beginning in April 1975, uniform cost-sharing Water Quantity Survey agreements were implemented with all provinces and Memoranda of Agreement with Indian and Northern Affairs Canada for the territories.

The agreements recognize that water quantity data may be collected to meet federal interests, provincial interests, or a combination of both. Hence funding for the operation of the networks is provided according to each party's needs. The water quantity networks and cost-sharing data are determined annually by federal-provincial coordinating committees. Also, a national meeting of all federal-provincial coordinating

committees is convened periodically to review annual progress reports and to discuss any concerns arising under the agreements.

During the year, a total of 2873 gauging stations, including 141 for sediment observations, were operated under the agreements in Canada, 2590 by the federal government and 283 by the province of Quebec. Data from these stations as well as from 633 stations operated mainly by other provincial agencies are contained in the national water data bank - HYDAT; the data bank also contains data for another 4179 discontinued stations.

Under the terms of the agreements, Canada is responsible for maintaining the computer database and for publishing the data. Water quantity data are essential to good water management and for the design and operation of bridges, dams, drainage facilities, and water supply works across the country. Ready access to reliable data is also essential to monitor and manage any adverse impact of development on the quality of the environment and to plan properly for sustainable development. The efficiency of the data collection program is enhanced significantly by network planning activities, by using standardized methodology, and by providing interpretative information that facilitates the application of the data for many users. To ensure that the data provided to the user are of the highest quality and precision, a quality assurance program has been implemented to monitor methods and procedures in field surveys and office automated computations against established national standards.

#### **DCP Network**

In a move to improve upon data collection associated with the hydrometric survey, a five-year program to acquire and install data collection platforms (DCPs) at remote hydrometric sites across Canada received Treasury Board approval effective April 1, 1983. Through the use of satellites, DCPs permit the real-time acquisition of hydrometric data, which has resulted in more efficient service to client interests for real-time data needs such as

**Table 2. Programs or Studies Completed under the Canada Water Act**

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Peace-Athabasca Delta Planning	1972
Qu'Appelle River Basin Planning	1972
Saskatchewan-Nelson Basin Planning	1973
Okanagan Basin Planning	1974
Saint John Basin Planning	1975
Lake Winnipeg, Churchill and Nelson Rivers Planning	1975
Great Lakes Shore Damage Survey	1975
Fraser River Upstream Storage Planning	1976
Churchill River Basin Planning (Saskatchewan-Manitoba)	1976
Montreal Region Flow Regulation Planning Study	1976
Peace-Athabasca Delta Implementation	1976
Northern Ontario Water Resources Planning	1978
Southeastern New Brunswick Dyking Implementation	1978
St. Lawrence Water Quality Planning Study	1978
Souris Basin Planning	1978
Metropolitan Toronto Flood Control Implementation	1978
Lower Saskatchewan Basin Preplanning	1979
Southwestern Ontario Dyking Implementation	1979
Upper Thames Flood Control Implementation	1979
Yukon Basin Preplanning	1979
Ottawa River Regulation Planning Support	1980
Thompson Basin Preplanning	1981
Great Lakes Shore Damage Survey Implementation	1981
Dykes and Flow Regulation Works - Montreal Region	1981
Mackenzie Basin Planning	1982
Shubenacadie-Stewiacke Basin Planning	1982
Ottawa River Water Quality Report	1982
Okanagan Basin Implementation	1982
Prairie Provinces Water Board Water Demand Study	1983
North Shore (St. Lawrence) Ecological Inventories	1983
Winter River Preplanning	1983
Wabigoon-English Mercury Contamination Study	1984
Flood Prevention within the City of Quebec	1984
Fraser River Estuary Planning	1984
Studies and Implementation of Dykes and Flow Regulation Works - Montreal Region	1984
Waterford Urban Hydrology Study	1985
Yukon River Basin Planning	1986
Mercury in Churchill River Diversion System	1986
Winter River Basin Planning	1987
Flood Damage Reduction in the Town of Richmond (Quebec)	1987
Mille Iles River Flood Control Works	1989
Manitoba Flood Forecasting Agreement	1989

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navigation, reservoir operation, water allocation, and flood forecasting. When necessary, DCPs are being equipped with sensors to provide atmospheric and water quality information required by the Atmospheric Environment Service and other agencies. As of March 31, 1990, approximately 456 active DCPs were in operation.

A decision has been made to undertake a major modernization of the data service involving digital electronic data loggers instead of analog recorders. Called Project 2000, this endeavor will include an increase in telemetry. A three-year pilot study involving approximately 100 stations in one region will begin in 1991-92. The national implementation is projected for completion by the year 2000.

Currently, data from the DCP network are being retrieved directly from the GOES system of satellites via three Direct Readout Ground Stations (DRGS) incorporated into the Water Resources Branch (WRB) computer network of the Inland Waters Directorate, Environment Canada. The three DRGS are located in Vancouver, Downsview, and Gatineau. The stations are operated jointly with the Atmospheric Environment Service (AES) and distribute the data automatically to AES and WRB computers. In addition, users will have direct access to WRB computers to obtain the data in tabular or graphical form. The systems software improves on the earlier retrieval system by converting raw DCP transmissions of strings of characters into readable values and by providing summary statistics.

#### Water Quality Monitoring Agreements

Water quality monitoring provides the basis for identifying contamination in the aquatic environment and for assessing compliance with regulatory requirements. Environment Canada operates a national water quality monitoring program. Federal-provincial agreements provide the basis for data sharing in British Columbia, Manitoba, New Brunswick, Newfoundland, Quebec and Prince Edward Island. Similar arrangements will be made in Nova Scotia and Saskatchewan, and in the two

territories pending allocation of funding. Environment Canada is prepared to negotiate agreements with Alberta and Ontario.

#### Prairie Provinces Water Board

The Prairie Provinces Water Board, a federal-provincial board that administers the Prairie Provinces Master Agreement on Apportionment, continued to provide recommendations to Canada, Alberta, Saskatchewan, and Manitoba concerning the equitable apportionment of eastward flowing interprovincial prairie rivers. The Board's Committee on Hydrology has developed procedures for natural flow determination for apportionment purposes. The Committee also evaluates the effect that proposed projects might have on the balance of interprovincial waters. In addition, the Board's Committees on Water Quality and Groundwater provided technical advice on inter-provincial matters involving water quality and groundwater. A four-year study of historic and current water demands in the three Prairie provinces was completed in December 1982 and is updated every few years. The Board publishes an annual report of its activities.

#### Mackenzie River Basin Committee

The Mackenzie River Basin Committee, with representation from Canada, Alberta, Saskatchewan, British Columbia, and Yukon and Northwest Territories, met twice during the year to fulfill its liaison and ongoing information exchange responsibilities. The Committee has recommended a general agreement that will supersede the 1977 Memorandum of Understanding which formed the Committee; the new agreement would reconstitute the Committee, and give full member status to the Northwest Territories and Yukon Territory. As of March 31, 1990, federal authority had been obtained to sign the agreement.

The Committee is also working on a Master Agreement which will establish broad principles, goals and objectives for cooperative water sharing between the jurisdictions. The actual terms and conditions for water sharing will be contained in seven bilateral sub-agreements between adjacent jurisdictions.



### Ottawa River Regulation Planning Board

The Ottawa River Regulation Planning Board has a mandate to plan and recommend criteria for regulating the Ottawa River, taking into account hydropower production, flood protection, navigation, low water problems, water quality needs, and recreation. Studies are under way to develop risk management methodology for the Ottawa River basin and to assess the impacts of using flood reserves for the operation of the Mille Isles dam. Each year the Board publishes a report on its activities.

### Ottawa River Water Quality Coordinating Committee

The Ottawa River Water Quality Coordinating Committee was established early in 1983 to review data needs and coordinate data collection through a joint (Canada-Ontario-Quebec) monitoring program. The Board's 1989 report reviews progress made in controlling pollution from the forest industry and municipal sources.

### Garrison Diversion Studies

In September 1989, the United States/Canada Garrison Consultative Group met in Ottawa and reactivated the Garrison Joint Technical Committee to examine the engineering and biota transfer issues relating to the Garrison Diversion project in North Dakota. The Inland Waters Directorate of Environment Canada provides two members to the Garrison Joint Technical Committee and one to the Engineering Task Force (a subcommittee). The province of Manitoba continues to oppose the transfer of Missouri River water to the Hudson Bay drainage system.

Some of the issues to be addressed by the Technical Committee include:

- The possibility of interbasin transfer of water from the Missouri River to the Hudson Bay drainage system
- The introduction of foreign biota into Manitoba waters, which could seriously affect the fisheries in Manitoba
- The possibility that the Sykeson Canal supply system, which lies within the Hudson Bay

drainage basin, could fail and permit Missouri River water to enter Canada

- The proposal by North Dakota that the Mid Dakota Reservoir be used instead of the authorized Sykeson Canal system. The Mid Dakota Reservoir is also located in the Hudson Bay drainage system.

The Directorate is working with U.S. counterparts on a report to the Garrison Consultative Committee outlining the Canadian concerns about ongoing and proposed work on the Garrison Project. The scheduled completion of the report is September 1990.

### Lake of the Woods Control Board

The Lake of the Woods Control Board continued to regulate certain waterways in the Winnipeg River basin to balance the requirements of the various and sometimes conflicting interests that depend on the water in the basin. The Board was established under the Lake of the Woods Control Board Act, well before the Canada Water Act was passed, and is described here only to complete the picture on federal-provincial water management in Canada. It publishes a report on its activities annually.

### Water Management Programs

Depending upon the nature of the work being conducted, water management programs can fall within any of three stages - preplanning studies, planning studies or implementation activities. During 1989-90, several water management programs were continued, including a work-sharing arrangement for water resource management and development studies in Prince Edward Island.

**Preplanning Studies:** Preplanning studies are normally done as a result of public representation to resolve one or more problems perceived at the local level. The preplanning study has become the vehicle with which to investigate the concerns expressed. In this type of study, all of the emerging and potential opportunities and problems of the area in question are examined and recommendations concerning the desirability of a longer-term planning study are made.

**Planning Studies:** A preplanning study may or may not be followed by a planning study. Planning studies generally are directed toward the development or management of the water resources for the social betterment and economic growth of the basin or area under study. In May 1986, the Canada-Saskatchewan South Saskatchewan River Basin Study Agreement was signed to develop a framework plan to guide future water development in the basin. The plan will assess the impacts of future growth and ensure that the basin's limited supplies of water can meet the needs of the range of uses. A 15-month extension of the agreement to March 1991 has been negotiated.

In October 1987, a work-sharing arrangement between Environment Canada and the Prince Edward Island Department of Community and Cultural Affairs was signed respecting the conduct of Studies on Water Resource Management for Economic Development. This is a three-year agreement coordinated by a federal-provincial committee, with each party contributing \$500 000. A two-year extension with additional funding is expected to be signed in 1990.

The studies include special investigations and demonstration projects related to groundwater resources, inland surface water resources, estuarine water resources, and multi-sectoral and integrated water management. This past year a series of fact sheets, videos, and several technical reports have been produced.

In its final study report, which was released on March 26, 1986, the Yukon River Basin Committee's main recommendation was that a formal agreement be established to develop a framework for water resource planning and coordinate ongoing water planning and management activities in the Yukon River basin. During 1988-89, a working group met to review the status of water and related resource activities in the basin and develop a draft intergovernmental agreement, for the consideration of the parties, to implement the study recommendations. As of March 31, 1990, authority to conclude the agreement (expanded to include the coastal Alsek River) had not been obtained.

Canada, Manitoba, Manitoba Hydro, and the Northern Flood Committee, which comprises the five Indian bands of Cross Lake, Nelson House, Norway House, Split Lake and York Factory, signed the Northern Flood Agreement (NFA) in December 1977. This agreement, which is not under the Canada Water Act, is administered federally by Indian and Northern Affairs Canada to provide compensation for the effects of Nelson River hydropower developments, specifically Lake Winnipeg regulation and the Churchill River diversion. It also creates an opportunity for renewed economic and social development in the communities. Article 17 of the agreement commits Canada, Manitoba, and Manitoba Hydro (1) to act jointly for the implementation of the recommendations of the Lake Winnipeg, Churchill and Nelson Rivers Study Board Report, which deals with ecological concerns, and (2) to report annually to the Band Councils on progress made. In April 1986, Treasury Board approved \$1.76 million for Environment Canada to design and implement a five-year ecological monitoring program, subsequently called the Federal Ecological Monitoring Program (FEMP).

In November 1988, the appointment of the federal negotiator for the Manitoba Northern Flood Agreement negotiations was announced. The other three negotiators represent the Province of Manitoba, Manitoba Hydro, and the Northern Flood Committee. In March 1989, the negotiators agreed to pursue resolution of NFA environmental monitoring requirements. Accordingly, they established the Environmental Monitoring Steering Committee to provide them with advice, direction, and recommendations on this topic; the Steering Committee's report was transmitted to the negotiators in September 1989. While these negotiations were under way, work continued under FEMP.

During 1989-90, Environment Canada conducted studies on waterfowl, water quality, hydrology, sediment and mercury. An information program specific to NFA communities was also initiated. Results of FEMP have been published in the Northern Flood Agreement: Ecological Report Series, and given wide distribution. To date,

20 reports have been prepared and another 10 to 15 are planned. All study results have been submitted to a four-party Program Advisory Board for discussion.

In the area of computer simulation, updating analytical modelling tools has been the thrust of the 1989-90 period. To pursue sustainable resource development, models such as REGUSE, RIVICE and ONE-D continue to be improved and applied to more and varied problem areas. As water resource issues become more complex, models are employed to meet this challenge and provide alternative solutions to environmental issues.

**Implementation Programs:** Although no new implementation agreements were initiated in 1989-90, several programs continued owing to agreements in earlier years, including a renewed Canada-Ontario Agreement Respecting Great Lakes Water Quality which extends to March 31, 1991. This agreement provides for the cost-sharing of surveillance, upgraded sewage treatment and phosphorus control and reflects the commitments undertaken by Canada in the 1978 Canada-U.S. Great Lakes Water Quality Agreement. It also re-emphasizes the cooperative phosphorus control and Great Lakes surveillance programs and, in accordance with the 1978 Agreement, outlines programs for dealing with toxic substances and hazardous materials in the Great Lakes. On October 16, 1983, Canada and the United States signed a supplement to the 1978 Agreement for the purpose of lowering phosphate levels in Great Lakes waters. On November 18, 1987, the parties signed a Protocol amending the 1978 Agreement for the purpose of strengthening programs concerning all sources of toxic substances entering the Great Lakes ecosystem.

An Agreement Respecting a Fraser River Estuary Program was signed in October 1985 by Environment Canada, the Department of Environment of British Columbia, Fisheries and Oceans Canada, the Fraser River Harbour Commission, and the North Fraser Harbour Commission. To cost \$1 250 000 over five years, the program is based on a study conducted between 1977 and 1982. Well into its fifth year of operation, the program is designed to guide economic development while protecting the environment of the estuary.

To complete the conveyance work begun under the 1974-1984 Qu'Appelle Implementation Agreement, the Qu'Appelle Conveyance Agreement was signed by Canada and Saskatchewan in June 1984. The program is designed to improve the channel carrying capacity in restricted areas of the river. When completed, the improved channel will convey larger quantities of water with less overbank flooding. During 1989-90, construction of the walleye fish nursery to mitigate fisheries impacts was completed. Spoil pile leveling/cleanup work was also finished.

The termination date for the \$4.75 million agreement, which is cost-shared equally by the two governments, was March 31, 1989. In 1988-89, Canada and Saskatchewan negotiated a three-year extension of the agreement at an additional cost of \$550 000 equally shared. As of March 31, 1990, the extension had not been finalized.

The Peace-Athabasca Delta Implementation Committee in 1987 completed an evaluation of the performance of remedial weirs constructed in the delta on the outlet channels of Lake Athabasca. The two weirs had been constructed in 1976 as a major part of an implementation agreement between the governments of Canada, Alberta and Saskatchewan, to restore water levels in the delta and to mitigate the adverse impact that regulation of the Peace River has had on the delta regime. The Committee concluded that the weirs have performed as predicted, largely restoring the delta to natural conditions, and recommended continued biological monitoring and assessment of goldeye populations, vegetation and flow regime. This work is being coordinated by the Mackenzie River Basin Committee.

The Canada-British Columbia Fraser River Flood Control program, designed to reduce damages due to floods in the lower Fraser Valley and other areas upstream in British Columbia, continued during the year. Under the program, flood control structures such as dykes are constructed. Some \$139 million of a total joint commitment of \$161 million was spent by the end of March 1990.

## Flood Damage Reduction Program

During 1989-90, the Flood Damage Reduction (FDR) Program was active throughout most of Canada.

**Objective:** The Flood Damage Reduction Program follows the cooperative federal-provincial approach of the Canada Water Act. Its overall aim is to reduce flood damages. The approach taken is to identify flood risk areas and discourage further flood-vulnerable development in those areas. Where existing development warrants, remedial measures may be considered.

When joining the program, the provinces sign a General Agreement and a Mapping Agreement (or a combined mapping and studies agreement). The General Agreement outlines the basic approach that will be taken to reduce flood damages. The respective governments and their agencies agree not to engage in, or provide assistance to, undertakings vulnerable to flood damage in designated flood risk areas. In such areas, federal and provincial disaster assistance will be restricted to structures built before designation and, in some circumstances, for new structures built in accordance with specified floodproofing regulations. Local governments and municipalities are encouraged to zone on the basis of FDR flood risk mapping.

Mapping agreements provide for the flood risk mapping and designation of the areas to which the policies in the General Agreement will apply. Forming part of these agreements is a list of communities in the province which are to be mapped and specifications to be followed in conducting the hydrotechnical and mapping work. When maps not meeting these specifications are available, interim designation may be applied until such time as new maps are prepared. These agreements also require that information pertaining to the designated area be made available to governments, zoning authorities, the public, and anyone contemplating development in or near these areas. Under the agreements, pertinent information is provided to government agencies and local authorities for land use planning and zoning purposes. Designations to March 31, 1990, are listed in Table 3.

In some cases existing developments in designated areas will still require protection against flood damages and, for this reason, additional agreements to study such problems can also be negotiated with the provinces and territories. Where benefits exceed costs and where there is a national interest, federal-provincial agreements may subsequently be reached on implementation action. This action could include flood forecasting and warning, flood proofing, works to control flows and levels, acquisition of property, easements or land use planning. It should be noted that in examining alternatives, the best choice will be made on the basis of effectiveness, cost, and environmental impact. This could mean allowing some flooding to occur.

**Duration:** The original agreements generally covered a ten-year period, but an Amending Agreement in 1980-81 extended the General Agreement with Manitoba beyond the ten-year period. Similar extensions occurred in 1981-82 with the signing of an Amending Agreement with New Brunswick and in 1982-83 with the signing of an Amending Agreement with Ontario. In 1983-84, a Studies Agreement was signed with Newfoundland. As well, in 1983-84, the General and Mapping agreements with Newfoundland, the Mapping Agreement with Quebec and the Flood Forecasting Agreement with Manitoba were amended. In 1984-85, the General, Mapping, and Studies agreements with Nova Scotia were amended. In 1985-86, the Mapping Agreement with Ontario and the General, Mapping, Studies, and Ring Dyke Upgrading (now Construction of Flood Protection Projects) agreements with Manitoba were amended. In 1986-87, the General Agreement with Saskatchewan was amended while new Mapping, Studies and Community Floodplain Management Measures agreements with Saskatchewan were signed. In 1987-88, a Floodplain Mapping Agreement was concluded with British Columbia, and amendments to the programs in New Brunswick (General, Mapping, Studies, Forecasting), Newfoundland (General, Mapping, Studies), Quebec (General, Mapping), and Manitoba (Forecasting) were undertaken. In April 1989, a Floodplain Mapping Agreement was concluded with Alberta. During 1989-90, two agreements were extended in Manitoba: the General, Mapping and Studies

Agreement and the Agreement Respecting the Construction of Flood Protection Projects.

**Participants and Funding:** Canada and the provinces share the costs (Table 4).

**Related Agreements:** Several ongoing studies and implementation agreements dealing with flood prone areas in Canada were in force when the Flood Damage Reduction Program was launched in 1975. Only one such agreement remains; it is described elsewhere in this report in the section on federal-provincial cooperative agreements under the title "The Fraser River Flood Control Program."

#### **Report on Progress**

##### Alberta

The Canada-Alberta Flood Risk Mapping Agreement was signed in 1989-90. This \$5.5 million agreement, to be shared over five years, will use existing flood risk mapping of seven communities and will require new flood risk mapping for 45 others. Work proceeded on base map preparation and on designating five communities for 1990-91.

##### British Columbia

British Columbia and Canada entered into a Floodplain Mapping Agreement on December 3, 1987. The general terms of the agreement extend until 1998, with mapping to be carried out over the first five years at a shared total cost of \$5 million. Under the agreement, 35 floodplain areas in the province, previously mapped under British Columbia's unilateral program, were designated. Nine more designations were added in 1988-89.

During 1989-90, six newly mapped floodplains were designated, bringing the total number of designations to 50. In addition, six mapping studies were completed. Key plans for 20 designated floodplains were prepared for distribution to federal, provincial and municipal authorities. Also, a script was finalized for a video depicting the major features of this program.

##### Manitoba

The Flood Forecasting Agreement was amended on April 30, 1987, to extend the termination date of the Agreement Respecting Flood Forecasting to September 30, 1989, with additional funding of \$400 000. Work under this agreement was concluded at the termination date.

During 1988-89, Canada and Manitoba negotiated an extension of the General, Mapping, and Studies agreements, with additional funding of \$700 000 (federal share: \$350 000), and provision for the development of a low-cost maintenance phase for the program. The extension was signed on January 29, 1990. The termination date of the General Agreement is 1999 and for the Mapping and Studies agreements, 1996.

During 1988-89, Canada and Manitoba negotiated a two-year extension of an "Agreement Respecting the Construction of Flood Protection Projects in Manitoba," with additional funding of \$800 000 (federal share: \$360 000). The extension was signed on October 16, 1989.

Under the Flood Protection Projects Agreement, significant progress was made on the mitigation works at Ste. Rose du Lac, St. Adolphe and Emerson. The international dyke segment has also been completed at Emerson.

Other flood protection projects at Brunkild, Letellier, Morris, Rosenort and St. Jean Baptiste have been completed.

##### New Brunswick

Although there were ice jams in the Saint John River, there was little or no flooding during 1989. Breakup was early and the snowmelt gradual. In response to concerns raised following the ice jams of 1987, communications continued to be effective among the various federal, provincial, municipal, private and U.S. participants. The Flood Forecasting Technology Task Force produced a report this year. As well, flood documentation studies, which focused on delineating floodlines from historical floods, were completed for the

Newcastle and Sackville areas under the Mapping and Studies Agreement.

Efforts to inform the public about flooding and the aims of the Flood Damage Reduction program continued. A river ice manual was completed and a video on floods produced, entitled "Floods: New Brunswick, Canada/New Brunswick FDR Program."

#### Newfoundland

During 1989-90, designations took place for Stephenville Crossing/Black Duck, Waterford, and Parson's Pond. Public information maps are now available for these areas.

Hydrotechnical studies were completed for Glenwood/Appleton and Glovertown. Work is near completion on the Bishop's Falls and Codroy Valley studies and well under way on the Trout River study. Supplemental studies were finished for the Rushoon ice wall and Cox's Cove infilling.

In 1989-90, negotiations for funding of implementation works in the Placentia area were completed. Federal authority to sign the agreement was obtained in early 1990. As of March 31, 1990, the Province had not obtained its authority.

During the year, discussions took place regarding the form of future Flood Damage Reduction agreements, i.e., the extension of existing agreements and the phasing-in of a maintenance agreement.

#### Nova Scotia

During the year, the Westray Coal proposal to build a rail line across the floodplain of the East River at Pictou was evaluated by the federal-provincial technical committee.

In 1989-90, Canada and Nova Scotia completed negotiations to renew the General Agreement and provide for a maintenance agreement. Subject to Treasury Board approval, the agreements will be signed in 1990-91.

#### Ontario

During 1989-90, the Canada/Ontario FDR Program funded 48 projects. Of these, 21 were for flood risk mapping of riverine areas, 23 were for flood risk mapping of the Great Lakes shoreline, and the rest involved other FDR measures studies.

The Steering Committee recommended and the ministers agreed to designate 19 additional flood risk areas. Also approved were five Special Policy Areas within the Metropolitan Toronto designation.

To date, there have been 44 designations, involving 144 communities and 127 public information map sheets. Currently, work is in progress on behalf of 32 Conservation Authorities and 16 municipalities where no Conservation Authorities exist.

This past year, four studies were completed to determine and improve flood risk mapping procedures and the effectiveness of the program. Three regional hydrology studies on the Grand River, Spencer Creek and Niagara Peninsula watersheds were also finished.

In light of the serious flooding and erosion experienced periodically on the Great Lakes shoreline, the mapping of these shorelines has continued to be a high priority for the program. The database for the Great Lakes shoreline is now substantial enough to enable the development of digitally based topographic maps, which in turn will form the nucleus of a Geographic Information System.

Preparation of flood line maps for shoreline areas is proceeding on a priority basis. Design water levels to be used on the maps were calculated for various Great Lakes shoreline reaches.

During 1989-90, Canada and Ontario concluded the negotiation of an amended Flood Damage Reduction Agreement in order to complete high priority mapping. Treasury Board approval has been obtained and the amended agreement is expected to be signed early in 1990-91.

Table 3. Designations to March 31, 1990, under the Flood Damage Reduction Program

Location	Number of Communities Mapped	Number of Public Information Maps	Date of Designation
<b>British Columbia</b>			
Chilliwack: Vedder Crossing to Slesse Creek			December 1987
Columbia River: Columbia-Windermere lakes			December 1987
Columbia River at Golden			December 1987
Columbia River: Windermere Lake-Radium			December 1987
Coquitlam River: Coquitlam Lake-Fraser River			December 1987
Courtenay River			December 1987
Cowichan Lake			December 1987
Cowichan and Koksilah rivers at Duncan			December 1987
Eagle River			December 1987
Elk River at Fernie			December 1987
Elk River at Sparwood			December 1987
Kitimat River			December 1987
Kootenay River: Kootenay Lake-U.S. Border			December 1987
North Thompson River: Kamloops-Vavenby			December 1987
Salmon and White rivers			December 1987
Shuswap River: Mara Lake to Mabel Lake			December 1987
Skeena River: Lakelse-Terrace-Usk			December 1987
South Thompson River: Kamloops-Chase			December 1987
Thompson River: Kamloops area			December 1987
Tulameen River: Coalmont-Tulameen			December 1987
Okanagan Lake: Westbank to Peachland			December 1987
Columbia River at Revelstoke			December 1987
Fraser and Nechako rivers: Prince George			December 1987
Kaslo River at Kaslo			December 1987
Squamish River			December 1987
Goat River			December 1987
Mission Creek			December 1987
Nanaimo River			December 1987
Nechako River at Vanderhoof			December 1987
Bulkley and Telkwa rivers			December 1987
Bulkley River at Houston			December 1987
Cheakamus River			December 1987
Zymoetz (Copper) River			December 1987
Englishman River			December 1987
Vedder River (Vedder Canal to Vedder Crossing)			December 1987
Crawford Creek			September 1988
Coquihalla River at Hope			September 1988
Fraser and Quesnel rivers at Quesnel			September 1988
Shawnigan Lake			September 1988
Oyster River			September 1988
Salmon River near Prince George			September 1988
Peace River			September 1988
Fraser River near Hope			September 1988
Bulkley River Quick area			September 1988
Elk River near Elkford			September 1989
Bella Coola River			September 1989
Nicola River			September 1989
Campbell and Quinsam rivers			March 1990
Beaver Creek			March 1990
Slocan Creek			March 1990
50 designations			
<b>Manitoba</b>			
Melita	1	1	December 1979
Wawanesa	1	1	December 1979
Winnipeg	1	1	February 1980
Souris	1	1	October 1980
Elie	1	1	November 1980
Brandon	1	1	March 1982
La Salle - Sanford - Starbuck	3	1	November 1982
Swan River	1	1	May 1983
Dauphin	1	1	February 1984
Carman	1	1	June 1984
Lorette	1	1	September 1984
Arborg	1	1	November 1987
Fisher Branch	1	1	November 1987
Riverton	1	1	November 1987
16 designations			
	16	14	

\*These designations are on a regional or river basin basis and cover a number of municipalities or parts of municipalities.

Table 3. Continued

Location	Number of Communities Mapped	Number of Public Information Maps	Date of Designation
<b>New Brunswick</b>			
Fredericton*	10	1	February 1980
Perth/Andover	2	1	February 1980
Oromocto to Lower Jemseg*	16	1	March 1981
Lower Fredericton to Lincoln*	3	1	February 1982
Sussex*	15	1	September 1982
Keswick*	5	1	March 1983
Norton*	2	1	May 1985
<u>Walker Brook*</u>	<u>2</u>	<u>1</u>	March 1986
8 designations	55	8	
<b>Newfoundland</b>			
Stephenville*	2	1	June 1984
Steady Brook*	2	1	March 1985
Placentia*	2	1	March 1986
Badger	1	1	March 1986
Rushy Pond	1	1	March 1986
Rushoon	1	1	February 1987
Deer Lake*	4	1	March 1988
Parson's Pond	1	1	May 1989
Waterford	4	1	May 1989
<u>Stephenville Crossing/Black Duck</u>	<u>2</u>	<u>1</u>	May 1989
10 designations	20	10	
<b>Nova Scotia</b>			
East River*	5	1	February 1984
Sackville River*	3	1	February 1984
Antigonish*	2	1	November 1984
Little Sackville River*	3	1	May 1987
<u>Truro*</u>	<u>8</u>	<u>1</u>	March 1988
5 designations	21	5	
<b>Ontario</b>			
White River	1	1	August 1982
Toronto*	16	8	December 1982
Sturgeon River/Lake Nipissing/French River*	15	5	March 1983
Kaministiquia River*	2	1	August 1983
Nipigon	1	1	March 1986
Atikokan	1	1	March 1986
Grand River*	3	2	March 1987
Maitland Valley*	4	2	March 1987
Nickel District*	9	33	March 1987
North Monaghan	2	1	March 1987
Lakefield	1	1	March 1987
Lower Trent Region*	12	8	March 1987
Goulais River	4	1	August 1987
Espanola	1	1	August 1987
Thessalon	1	1	August 1987
Little Cataraqui Creek (Kingston)	1	1	March 1988
Moir River* (Hwy 401 north to Hwy 7 Bell Creek)	6	3	March 1988
Nith River*	6	2	March 1988
Conestogo River*	3	1	March 1988
Dresden	1	1	March 1988
Hornepayne	1	1	August 1988
McNab	1	1	October 1988
Petawawa	1	1	October 1988
Moir River (Hwy 401 - Bay of Quinte)	1	1	March 1989
Lake Simcoe	3	5	March 1989
Cooks Creek, Schreiber	1	1	May 1989
Agimak River and Lake, Ignace	1	1	May 1989
Wabigoon River and Lake, Swanson Creek, Dryden	1	1	May 1989
Mississagi River, Iron Bridge	1	1	May 1989
Kettle Creek, Port Stanley	1	1	May 1989
Otonabee River	1	1	May 1989
Indian River	1	1	May 1989



Table 3. Concluded

Location	Number of Communities Mapped	Number of Public Information Maps	Date of Designation
Ottawa River, Ottawa-Carleton	7	5	May 1989
Gull River	4	1	July 1989
Gananoque River	5	3	May 1989
Mississippi River	-	5	May 1989
Raisin Region Conservation Authority streams	12	10	May 1989
Muskoka River, Bracebridge	1	1	August 1989
Lake Ontario Shoreline, Toronto	3	3	August 1989
Kebsquasheshing and Nebskwashi rivers, Bucciarelli Creek, Chapleau	1	1	January 1990
Lake Huron Shoreline No. 3, Maitland Valley	1	1	January 1990
Mattawishkwia River, Hearst	1	1	January 1990
Root River, Sault Ste. Marie	1	1	January 1990
Welland River, Forks, Black and Beaver creeks	4	4	January 1990
44 designations	144	127	
<b>Quebec</b>			
Montreal Region*	38	22	May 1978
Chaudière Basin*	19	8	March 1979
Gatineau/Ottawa rivers*	19	15	October 1979
Haut-Richelieu/Baie Missisquoi*	19	11	April 1980
Rivière du Gouffre*	4	2	April 1980
Bas-Richelieu*	23	10	November 1981
Rivière L'Assomption*	12	4	May 1982
Rivière Saint-François*	14	6	October 1982
Rivière Yamaska*	22	12	June 1983
Rivière Bécancour*	4	2	May 1984
Rivière Nicolet*	10	3	May 1984
Trois-Rivières-Ouest	1	5	August 1984
12 designations	185	100	
<b>Saskatchewan</b>			
Estevan	1	1	August 1980
Oxbow	1	1	August 1980
Roche Percée	1	1	August 1980
Moose Jaw	1	1	October 1981
Melfort	1	1	April 1988
Radville	1	1	June 1988
La Ronge/Air Ronge	2	1	October 1989
Tisdale	1	1	November 1989
8 designations	9	8	
<b>Northwest Territories</b>			
Hay River*	2	1	May 1984
Fort Simpson	1	1	June 1985
Aklavik	1	1	June 1985
Fort McPherson	1	1	June 1985
Fort Good Hope	1	1	June 1985
Fort Liard	1	1	September 1987
Nahanni Butte	1	1	September 1987
Fort Norman	1	1	September 1987
Tuktoyaktuk	1	1	March 1988
9 designations	10	9	
<b>Total</b>			
162 designations	460	281	

## Quebec

The new agreement concerning mapping and flood-plain protection was signed on June 25, 1987. The termination date for the mapping component of this agreement will be March 31, 1992; the implementation of the intervention policy concerning flood risk areas designated on a final or an interim basis will come to an end on March 31, 1997. A total of \$4 800 000 in new resources will be required, with each party contributing 50% of the cost. Official exceptions and derogations are provided for exceptional cases and only for certain categories of works identified in the agreement (particular requests concerning municipal facilities among others).

Under the initial agreement, 12 designations were made concerning flood risk areas of 185 municipalities. The number of municipalities listed in Schedule A of the new agreement has increased to more than 500, with some including more than one basin. Hydraulic and hydrologic studies continued.

Flood risk maps for three municipalities were submitted to the ministers for their signature. The maps were prepared for the Jacques-Cartier, Batiscan and Malbaie rivers.

## Saskatchewan

The communities of La Ronge/Air Ronge were designated on October 18, 1989, and Tisdale on November 15, 1989. A floodplain management study for Regina was completed this past year. Hydraulic studies were initiated for Battleford and Fort Qu'Appelle.

## Northwest Territories

The Phase II Report was completed for a study of ice breakup, ice jamming and ice jam reduction methods on the Hay River at the Town of Hay River. The report was prepared by the University of Alberta, under contract to Environment Canada, and Indian and Northern Affairs Canada. The objectives of the study were to develop a method to add the effects of surges to the existing flood forecast system developed during Phase I

and to computerize both the original flood level algorithm and the surge estimates method.

Daily forecasts of water levels at three locations on the main stem of the Mackenzie River were prepared and issued to ten public and private agencies, between June 1 and October 18, 1989, under an agreement between Transport Canada and Environment Canada. The forecast is used mainly by navigational companies to plan and operate shipping activities.

On-site assistance, information and advice were provided during spring breakup to Mackenzie River communities designated under the Flood Damage Reduction Program.

## Yukon

An agreement with the Yukon Territory is under review.

## Indian Lands

A Memorandum of Understanding between Environment Canada and Indian and Northern Affairs Canada (INAC) was signed in May 1985, to allow interested Indian bands, with the support of regional offices in INAC, to take part in the flood risk mapping program. The work has a funding ceiling of \$300 000 per annum shared equally by the two federal departments. The program, which was to expire on March 31, 1990, has been extended for five more years at the same funding level. Designation, which is intended to restrict flood prone development in flood risk areas, is not required under this arrangement.

Two Manitoba pilot projects initiated in August 1985 included flood risk mapping of Lizard Point and Sioux Valley Indian reserves. Criteria for selection included the severity of flooding, existing flood prone development, the need for flood risk information, availability of hydro-metric data, past records, aerial photography, and other maps. The hydrology and hydraulic studies and flood risk mapping (eight sheets for Lizard Point and 12 sheets for Sioux Valley) showing the 1:100 and 1:500 year flood lines have been completed. The projects' costs amounted to

Table 4. Flood Damage Reduction Agreements to March 31, 1990

Government/Agency	Duration (years)	Total Commitment* (dollars)	Expiry Date
<b>Alberta</b>			
Flood Damage Reduction Agreement	(general 9) (mapping 5)	- 5 500 000	1998 1994
<b>British Columbia</b>			
Floodplain Mapping Agreement	(general 10) (mapping 5)	- 5 000 000	1998 1993
<b>Manitoba</b>			
General Agreement	22	-	1999
Flood Risk Mapping Agreement	19	2 850 000	1996
Studies Agreement	19	510 000	1996
Flood Forecasting	8.5	1 000 000	1991
Construction of Flood Protection Projects Agreement	7	6 900 000(b)	1991
<b>New Brunswick</b>			
General Agreement	24	-	2000
Flood Risk Mapping Agreement	10	2 000 000	1986
Studies Agreement	10	200 000	1986
Flood Forecasting Agreement-Saint John River Basin	15	2 300 000	1992
Flood Damage Reduction - Marsh Creek	6.5	2 010 000(a)	1984
Petitcodiac Sea Dykes Agreement	3 months	160 000	1979
Flood Risk Mapping and Studies Agreement	5	710 000	1992
<b>Newfoundland</b>			
General Agreement	14	-	1993
Flood Risk Mapping Agreement	7	1 470 000	1988
Studies Agreement	5	480 000	1988
Flood Risk Mapping and Studies Agreement	2	250 000	1990
<b>Nova Scotia</b>			
General Agreement	16	-	1994
Flood Risk Mapping Agreement	11	1 030 000	1989
Studies Agreement	11	670 000	1989
<b>Ontario</b>			
Flood Damage Reduction Agreement	(general 17) (mapping 12) (other 14)	- 15 400 000 2 200 000	1995 1990 1992
<b>Quebec</b>			
Flood Risk Mapping Agreement	(general 21) (mapping 16)	10 800 000	1997 1992
Dykes and Flow Regulation Works - Montreal Region	7.5	16 056 000(b)	1984
Quebec City Flood Prevention Agreement	2	833 000(b)	1985
Mille Iles River Agreement	5.5	13 100 000(b)	1989
Saint-François River Agreement - Town of Richmond	3	4 350 000(b)	1987
<b>Saskatchewan</b>			
General Agreement	20	-	1997
Flood Hazard Mapping and Studies Agreement	(mapping 5) (studies 5)	1 300 000 480 000	1982 1982
Flood Hazard Mapping and Studies	(mapping 5) (studies 5)	750 000 250 000	1992 1992
Community Floodplain Management Measures	5	580 000	1992
<b>Northwest Territories</b>			
Memorandum of Understanding	2	225 000(c)	1978
General Agreement	14	-	1993
Memorandum of Understanding	14 (mapping 9)	- 400 000(c)	1993 1988
<b>Indian and Northern Affairs Canada</b>			
Memorandum of Understanding Respecting Flood Risk Mapping of Indian Reserve Lands	10	300 000(d)	1995

\* These costs are to be shared equally by the federal and provincial governments except for:  
(a) 33 1/3% federal, 66 2/3% provincial/local; (b) 45% federal, 55% provincial/local;  
(c) costs shared equally by Environment Canada and Indian and Northern Affairs Canada;  
(d) maximum annual amount shared equally by Environment Canada and Indian and Northern Affairs Canada.

\$116 000 (well below the budgeted \$160 000). These pilot projects have indicated that the flood risk mapping of thinly populated, widely scattered reserves is prohibitively expensive. Recently, the focus has been changed to historical flood reviews. A historical flood review of Red Earth Indian Reserve in Saskatchewan was completed in 1988-89. A similar study of the Driftpile Indian Reserve in Alberta was completed in 1989-90.

This past year in Ontario two projects to obtain topographic mapping for the communities at Lansdowne House and Summer Beaver in the north were completed at a cost of \$83 000. The hydraulic information from an earlier historical review was retrieved and flood levels developed. The mapping and hydrologic analysis for the Rama Indian Reserve in southern Ontario progressed during the year. As well, seven more reserves were identified in southern Ontario, and work was initiated to create project files along the Lake Huron shoreline, and the Thames and Grand rivers.

In British Columbia, the second phase of the historical flood review was completed at a cost of \$80 000. This review covered 53 Indian communities, bringing the total number reviewed in the province to 83.

#### **FDR Program Guidelines**

After several years of experience with the program, the "Federal Guidelines for the National Flood Damage Reduction Program" were prepared by Environment Canada in 1984-85 and subsequently distributed.

The guidelines are intended as the main reference for federal managers of the Flood Damage Reduction Program and are based on the originally stated aims of the program, the experience gained, and the precedents established over the years. To the extent possible, the guidelines attempt to anticipate the program's foreseeable future needs.

## **WATER RESEARCH UNDER THE CANADA WATER ACT**

Scientific and socio-economic research, technological development and data collection are essential tools for dealing with the increasing scope and complexity of emerging resource problems.

- Federal Water Policy

Sound management requires a thorough understanding of our water resource and its uses. Scientific research, socio-economic studies and data collection systems all provide the information necessary for good management.

Much of the federal water research is supported by Environment Canada, most of which is carried out by the Inland Waters Directorate (IWD). Here, scientific research conducted by the two IWD research institutes is summarized; hydrogeological studies in the Maritimes are described; highlights of socio-economic studies are presented; and activities related to water data and data management systems are outlined.

### **NATIONAL WATER RESEARCH INSTITUTE**

The National Water Research Institute (NWRI), located in Burlington, Ontario, carries out water research under the Canada Water Act to advance understanding of water issues important to Canada. The knowledge and authoritative expertise developed from the Institute's research program are employed by Environment Canada to influence decisions affecting the wise management of our water resources. The Institute's role in Environment Canada is:

- To advise senior management on priority issues
- To provide leadership on rapidly developing or emerging science programs
- To represent Environment Canada in national and international water science organizations
- To provide functional guidance to operational water programs
- To provide expert spokespersons for public discussion of water science issues.

To achieve its goals, NWRI conducts a national, multidisciplinary program of targeted basic research, applied research, and experimental development in the full range of aquatic sciences, and develops research partnerships with the Canadian and international water science communities on priority issues.

A number of initiatives have also been taken to develop and strengthen Institute linkages with universities, the private sector, the media and environmental groups, and to position the Institute for more effective intervention in the management of priority issues, both within the Department and externally on behalf of Environment Canada.

Since 1986, the research program at NWRI has been organized into projects conducted by multidisciplinary teams of scientists. Each project focuses on the development of knowledge, expertise and institutional leverage for Environment Canada on a high priority issue or need.

The projects are grouped generically under three large multidisciplinary branches - the Lakes Research Branch, the Rivers Research Branch, and the Research and Applications Branch - which are supported by centralized Research Support, Science Liaison, and Staff Services divisions.

The Institute's current research projects address eight general water research issues. Highlights of the 1989-90 research program are summarized below. In total, NWRI scientists published over 300 journal articles, research contributions and data reports on the scientific aspects of these issues in 1989-90.

#### **Toxic Substances in the Great Lakes and St. Lawrence River Basin**

A major long-term research program continued on the sources, pathways, fate and ecosystem effects of organic and inorganic contaminants in the lakes and interconnecting channels of the Great Lakes - St. Lawrence River drainage basin.

Critical processes controlling the degradation, volatilization, adsorption and bioaccumulation of contaminants are studied to assess pollution impacts and the feasibility of remedial plans.

The concentration of PCBs (polychlorinated biphenyls) in the flesh of lake trout in Ontario lakes was studied in collaboration with the Ontario Ministries of the Environment and Natural Resources. Concentrations were scattered over three orders of magnitude and were highest in lakes where forage fish and Mysis relicta were both present. The standardization of PCB concentrations per unit of lipid somewhat reduced the differences among lakes but did not remove the influence of food chain length. In Lake Ontario, PCB concentrations in lake trout were similar to those in small lakes containing forage fish and Mysis.

Large-volume water samples collected at the mouth of the Yamaska and Saint-François rivers were analyzed for important industrial chemicals and pesticides. Results revealed that substantial inputs of atrazine and some organophosphate pesticides are discharged into the St. Lawrence River. Several other organic chemicals are found at low levels.

Mirex has been found in suspended sediment particles and water in the St. Lawrence River between Lake Ontario and Quebec City. Annual flux calculations indicate a small decline of mirex levels from the previous two years. Mirex concentrations between Lac Saint-François and Lac Saint-Pierre are consistently higher by a factor of 1.5 to 3.0 than in the upper or lower stretches of the river. This observation may indicate some sources within the river, possibly in the form of previously contaminated sediments which are slowly being eroded and/or released from biota in the river.

#### Lake Restoration

Research continued on the evaluation of remedial options for restoring the ecological integrity and human use of polluted lakes and embayments. This multidisciplinary activity requires the melding together of long-term water quality

information and new research results to develop the predictive models needed to select optimal solutions to water quality problems.

Attention is currently focused on Hamilton Harbour, which is severely polluted and has been designated by the International Joint Commission as an Area of Concern. A new sediment bioassay using the tubificid oligochaete Tubifex tubifex has been developed and used to assess sediment toxicity in Hamilton Harbour. Sediment samples were collected at 35 sites in the harbour. Toxicity was identified in four geographical areas, with the highest toxicity at the site of a coal tar deposit. As much as 70 000 cubic metres of sediments in the deposit has concentrations of polynuclear aromatic hydrocarbons above 200 micrograms per gram. These sediments were also found to be acutely toxic to zooplankton, mayflies, bacteria and fish.

A study of ammonia contamination in Hamilton Harbour revealed that nitrification is inhibited by high concentrations of toxic un-ionized ammonia. In late spring and midsummer, concentrations of un-ionized ammonia frequently exceed the toxic level of 300 micrograms per litre ( $\mu\text{g/L}$ ). Nitrate concentrations also exceed the chronic toxicity threshold of 30  $\mu\text{g/L}$  for brief periods during summer, with peaks surpassing the acute toxicity levels of 250  $\mu\text{g/L}$ .

#### Contaminated Sediments

Previously contaminated bottom sediments are a major source of toxic substances to the overlying waters and biota of lakes. Research is being conducted on the composition and distribution of toxic substances in sediments, and on the physical and biogeochemical processes controlling lake sediment-water interactions. The focus is on sediment deposition and resuspension, chemical release rates, microbial degradation, bioaccumulation, and biotoxicity. Ongoing results will be used for evaluating remediation options in the Great Lakes and elsewhere.

The nepheloid layer of Lake Ontario was studied to evaluate its potential as a medium for contaminant transport in the lake. The layer, a

turbid zone near the bottom, is present throughout the lake at depths greater than 60 metres. Its average thickness varies from 22 to 45 metres, depending on the season. Geochemical composition, trace elements and PCB concentrations were analyzed in suspended solids in the layer at stations located in the western, central and eastern basins. Polychlorinated biphenyl and lower chlorinated biphenyl concentrations in the nepheloid layer were greater than those found in the surficial sediments. Results from geochemical composition and trace element studies indicate that most of the particles did not originate from sediment resuspension. The nepheloid layer is thus an important medium for the transport of contaminants in Lake Ontario.

### Groundwater Contamination

Groundwater research at NWRI focuses on the physical and chemical processes controlling the migration, fate and effects of toxic contaminants in sub-surface sedimentary rock aquifers, primarily in eastern and central Canada. Results are used to improve both general and site-specific protocols for aquifer monitoring and decontamination and to develop waste-site rehabilitation plans.

Joint hydrological studies with the U.S. Geological Survey were carried out to synthesize information on geology, hydrogeology and geochemistry near the Niagara River. Boreholes intersecting the entire length of the Lockport dolostone were drilled in Niagara Falls, New York, and tests were conducted to examine the nature of fracturing and fracture permeability in the bedrock. The information is being used to develop a conceptual model for groundwater flow in the Niagara area.

During the past year, physical, chemical and biological processes influencing contaminant transport in granular aquifers have been studied. Results were used to optimize the remediation of the outwash aquifer at the Gloucester landfill, near Ottawa. The occurrence and fate of residues originating from the disposal of laboratory solvent wastes at the Gloucester landfill was

also investigated. Toxic degradation products of freon-113 were identified, suggesting that it may not be as inert metabolically as previously thought. Two collaborative studies with U.S. researchers have been initiated to test the proposed freon-113 biodegradation pathway.

In 1989-90, initiatives were undertaken to develop techniques for the assessment and remediation of contaminated groundwaters in the Great Lakes basin and to develop an expert system for predicting the effects of pesticides on groundwater aquifers.

A cooperative research agreement has been renewed with the Conservation and Protection Service, Environment Canada, Atlantic Region; the New Brunswick government; and the University of New Brunswick. The Institute will continue its involvement in teaching and research on hydrogeology and groundwater contamination in the Atlantic Region.

### Pesticide Assessment

NWRI pesticide research contributes to the development of new analytical methods and knowledge on the occurrence, persistence, fate, and ecotoxicological effects of pesticides in lakes and rivers. Increasing emphasis is being placed on community and ecosystem level effects. The information and expertise are used to advise Environment Canada, Agriculture Canada, and other federal agencies concerned with pesticide registration, impact assessment, water quality objectives, and environmental surveillance.

This past year, more emphasis was directed toward the study of the persistence, fate and effects of highly degradable synthetic pesticides such as deltamethrin. Studies were initiated to examine the chemistry and toxic effects of degradation products and the role of dissolved organic carbon in the attenuation of the toxic effects.

Native freshwater mussels provided information on the origin, bioavailability and persistence of pesticides in the St. Lawrence River ecosystem. Mussels were analyzed for seven organochlorine pesticides. Bioconcentration patterns in mussel

tissues implicated Lake Ontario as the source of mirex and DDT derivatives.

### Acid Rain

NWRI research on acid rain focuses on the development of ecosystem knowledge required for federal policy formulation. Contributions to the National LRTAP (Long Range Transport of Airborne Pollutants) Assessment have been completed. The National Assessment Report was required by the federal/provincial Research and Monitoring Coordinating Committee. At NWRI, a working group was organized, with participants from the Atmospheric Environment Service, Fisheries and Oceans Canada, the Inland Waters Directorate, provincial ministries of environment and other agencies. Over 17 000 data records on atmospheric deposition, soil types and sensitivity, and water chemistry and biological information were assembled and used for integrative studies on aquatic effects of acidic deposition. NWRI provided a leadership role on a number of experimental and modelling studies:

- Evaluation of critical watershed acidification and recovery processes (based on field results from the Turkey Lakes and other watershed studies)
- Spatial/temporal definition of aquatic resources-at-risk
- Review of Canadian and American predictive models and development of Canadian alternatives
- Scientific assessment of the national acid rain monitoring program
- Preparation of scenario predictions for emission control strategies.

### Air-Water Interactions

Evidence is mounting that pollutants in the atmosphere are changing the climate and that the atmosphere is a major source of toxic substances to Canada's lakes, in particular, the Great Lakes. The expanding air-water research program at NWRI is investigating the processes controlling the rates of deposition of persistent

organic substances onto lakes and snow, and volatilization to the atmosphere.

In past years, spatial deposition of trace organic contaminants has been studied in the eastern and high Arctic regions. Work has continued on the quantification of the deposition rates at high Arctic stations. A number of Arctic lakes were sampled to determine the fate of contaminants in snowmelt. Results showed that substantial amounts of contaminants, in particular hexachlorocyclohexanes (HCHs), enter the lake waters and remain in the water throughout the winter.

The construction of a new, closed, recirculating wind tunnel/water flume with a hydraulic wave maker has been completed. The system is equipped with sophisticated physical and chemical sampling instrumentation and is being used to quantify and model the air-water exchange of toxic gases. Preliminary experiments have been completed for the determination of transfer coefficients for lindane and chlorobenzene and the effects of turbulence on gas transfer processes.

A major study headed by the Canadian Institute for Research in Atmospheric Chemistry and coordinated through NWRI has been initiated to determine the role of wetlands in the global methane budget. Release of methane, a "greenhouse" gas, from wetlands could account for as much as 15% to 40% of global emissions. This interdisciplinary and inter-agency study will focus on Canada's Hudson Bay Lowlands. A major field program is planned for 1990.

A master research and monitoring station has been set up at Point Petre on Lake Ontario. It will collect precipitation and air samples for contaminant analyses. Various federal and provincial agencies are collaborating on the project. The station will not only produce regional data for the calculation of atmospheric contaminant loadings to the lower Great Lakes but also will be used to develop a standardized methodology for the assessment of toxic rain.

A modelling framework, capable of analyzing the



climatic effects on the Lower Great Lakes over a climatological time frame, is being developed. An empirical temperature diffusion model was combined with 30 years of climatological data and a heat balance model to simulate vertical temperature profiles on a daily and lakewide basis in Lake Ontario. Based on observations and temperature simulations from the models, implications of anticipated climate warming were described for Lake Ontario.

The thermal budget of Lake Erie during two particularly warm periods in the 1980s was re-evaluated. There were significant increases in the lake's heat storage that led to higher water temperature, less ice, an earlier disappearance of the thermal bar, and an increase in the length of the thermally stratified period.

#### **Aquatic Assessment and Modelling**

Improvements in aquatic surveillance, monitoring and assessment programs within Environment Canada are critically dependent on new methods, instruments, protocols and predictive simulation models. A number of major NWRI projects serve this broad operational need and, at the same time, contribute to the Institute's research on other issues.

The Analytical Chemistry Project develops new, improved methods to measure organic and inorganic compounds in water, sediments and biota, while the Quality Assurance Project provides a national focus for quality control/quality assurance activities. The Ecotoxicology Project provides new biological assessment procedures for detecting the toxic and mutagenic effects of contaminants in lakes and rivers. A variety of statistical and process simulation models that permit reliable trend assessment, analysis and prediction of aquatic processes are being developed in the River Modelling Project and Hydraulics Project, and in several other studies. Expertise on the design, rationalization and interpretation of monitoring and surveillance programs is also developed.

Major analytical methods and techniques were developed in 1989-90:

- Flow injection technology incorporated into a method for the determination of ammonia in water samples
- Radioimmunoassay techniques for the analysis of pentachlorophenol and atrazine
- A gas chromatography method for the determination of resin and fatty acids in effluents from pulp and paper mills
- Ion chromatography applied to the analysis of organic acids in precipitation samples
- Supercritical fluid chromatography used in the quantitation of chlorinated acid pesticides.

The Institute also provided expert advice and assistance during the major fire at a tire disposal site in Hagersville, Ontario, where numerous samples of oil and water were analyzed for the presence of organic contaminants. The toxicity of water samples was also evaluated.

Interlaboratory quality assurance studies were completed for the Upper Great Lakes Connecting Channels Program, the Great Lakes Water Quality Surveillance Program, the Federal/Provincial Agreements Program, the Prairie Provinces Water Board, and the Long Range Transport of Airborne Pollutants Program. General data quality has been improved through these studies, and problems with data comparability and accuracy quickly identified to responsible managers for corrective action. Quality assurance studies on the analysis of organochlorines in water and atrazine in sediment extracts were also conducted.

Ecotoxicological and biomonitoring research continued. Biomonitoring studies were conducted in the Yamaska River basin, Quebec, and elsewhere in Canada, on the use of caged leeches, snapping turtles, freshwater mussels, benthic macro-invertebrate community structure, and a variety of biochemical tests to monitor for food-chain impact from toxic contaminants.

A new project, partially funded by PERD (Panel on Energy Research and Development; Energy, Mines and Resources Canada), has been initiated on the Athabasca River to study the fate, pathways and effects of chemicals released from the exploitation of oil sands. Predictive models will be

worked on and used for the design of sustainable tar sand development projects. The Institute has played a major role in the design and initial implementation of studies to address emerging concerns related to the development of pulp and paper mills on the Peace-Athabasca-Slave Basin.

With the assistance of the International Development Research Centre, combined coliphage/coliform procedures were evaluated as simple, inexpensive tests for potable water in developing countries and rural areas without centralized water supplies.

Existing models of the hydrodynamics and transport of fine sediment particles have been critically evaluated in support of a major new research program on fine particle contaminant interactions. A numerical model, which takes into account the settling of fine sediments, has been developed and provides predictions that compare favourably with experimental data. Also, in support of the sediment program, a field version of a Malvern particle size analyzer was designed and constructed. A large, circular, rotating flume was installed in the Hydraulics Laboratory and will be used to study the formation of flocs and the role of fine organic particles in flocculation processes.

Work has continued to focus on the analysis of mixing processes beneath the water surface, the properties of directional waves, and the statistics of shoaling waves.

#### NATIONAL HYDROLOGY RESEARCH INSTITUTE

The mission of the National Hydrology Research Institute (NHRI), located in Saskatoon, Saskatchewan, is:

- to conduct scientific research and provide national leadership on surface and groundwater systems
- to address problems of water and environmental processes related to climate and socio-economic development in western and northern Canada within the mandate of Environment Canada.

Scientists carry out investigations to understand the physical, chemical and biological processes that influence or that are affected by the hydrologic cycle. This new knowledge is then incorporated into models of various segments of the hydrologic and aquatic environments. Thus, the consequences of changes in the cycle or system through external forces (such as climatic change or the impact of human activity) can be assessed, and measures can be developed for their mitigation.

In the past year, NHRI research activities have been organized into programs involving five major projects:

- Climate and Hydrology Project
- Surface and Groundwater Project
- Northern Environment Project
- Biological Response to Nutrients and Contaminants in Aquatic Ecosystems Project
- Contamination of Surface and Groundwater Project.

Organization according to project allows Institute scientists to examine environmental issues and problems from a multidisciplinary point of view.

The Institute consists of two scientific divisions: a Hydrological Sciences Division and an Environmental Sciences Division, both of which are supported by a Science Liaison Division, which is responsible for providing communication and information services to internal and external groups.

The Institute is located at the National Hydrology Research Centre, which also houses the Hydrometeorological Research Division, the Canadian Climate Centre and the Meteorological Inspection Office (both of the Atmospheric Environment Service), and the Water Quality Branch Laboratory of the Inland Waters Directorate, Western & Northern Region. A communications officer with the Communications Branch, Western & Northern Region, is located at the Centre, to assist NHRI and other tenant groups with communications activities.

## Climate and Hydrology Project

### Satellite Snowpack Monitoring

The microwave satellite forecasting of runoff from mountain and prairie watersheds is being investigated using Nimbus 5 and Nimbus 7 satellite observations. Snow cover loss is determined through comparing microwave radiation measurements from snow cover with resulting spring runoff as measured by streamflow. Runoff forecasts using this method are compared to forecasts using conventional snow-course measurements. Prairie winter snowpack estimates are combined with previous moisture observations to determine spring runoff from these watersheds.

The microwave satellite observations are calibrated using different ocean areas or icefield targets. The accuracy of the ocean calibration targets is estimated from an ocean-atmosphere model. A cross-correlation analysis is being done between the microwave signal, snowfall, snowpack, and streamflow to compare the spatial scale of these interrelated variables as a test of instrument stability. Tests of the forecast procedure are being extended to basins in the Foothills, plateaux, Coast Mountains, northern and southern Ontario, and New Brunswick, as well as to basin areas varying from 8000 square kilometres to 250 square kilometres.

### Satellite Water Cycle Monitoring

Microwave satellite correlations are being investigated for monitoring monthly streamflow and basin moisture status in prairie watersheds. A microwave emissivity index is determined from the ratio of observed microwave brightness, and surface temperature is estimated from surface air temperature observations. Monthly streamflow shows an inverse power law relationship with the emissivity index. Three watersheds, 3000 square kilometres in size, have been investigated to date.

### Proxy Climate Data from Ice Cores

An ice core obtained from Mount Logan in the

Yukon contains a record of precipitation, gases and aerosols in the atmosphere for about the last 300 years. Preliminary studies of the core show a good correlation with precipitation data from prairie stations as well as with distant regions such as Eurasia.

A new core site has been identified on Mount Logan. The site, known as PR Col, is at about 5300 metres a.s.l. Work continued on processing upper air data, obtaining cross-correlation coefficients between Mount Logan precipitation time series and instrumental data from the Northern Hemisphere, and analyzing meteorological data for Alaska and the Yukon.

### Glaciological Investigations

Winter and summer mass balance data have been collected for Sentinel, Helm and Place glaciers. A glacier mass-balance network was re-established on the Tiedmann and Bench glaciers in the Homathko River basin and winter balance measurements were made in the second half of May. Interim and final reports were received from the University of British Columbia, Department of Geophysics and Astronomy, on mass-balance determination of Sentinel, Helm and Place glaciers.

### Surface and Groundwater Project

#### Irrigation Return Flow

A three-year study begun in 1986 was conducted to determine the herbicide, nutrient and water losses from a typical irrigated field. Most of the losses of herbicides (MCPA, dicamba, diclofop and 2,4-D) occurred during the first irrigation of the season with the first flush of drainage water. The losses in terms of the amount applied were all less than 1%, which is comparable to amounts observed in spring runoff from dryland agricultural fields.

The main negative impact of surface irrigation appears to be the flush of applied herbicides and nutrients that occurred with the first irrigation. If drain water is to be re-used, it may be advantageous to avoid using drainage water from the first irrigation.

## Agricultural Land Drainage Process

Data from the Mannes-Domain watershed in Manitoba have been reviewed and a method developed to reduce soil moisture data from different sources to a common base. Using the reduced data set, it has been possible to calibrate the DRAIN model and obtain a reasonable match between observed and predicted soil moisture.

## Snow Management and Snowmelt Infiltration

In cooperation with the University of Saskatchewan and the Agriculture Canada Research Station at Swift Current, a final report on snow management and meltwater enhancement was completed. The report covers blowing snow redistribution on the prairies, quantifies the loss of snow to sublimation during wind transport, and details techniques that estimate the effectiveness of agricultural snow management practices at different locations on the prairies. In cooperation with the Prairie Farm Rehabilitation Administration, an alfalfa field was managed to increase snowcover depth and infiltration of the resulting snowmelt water was measured in a coarse-textured soil overlying a shallow aquifer. The results show that increasing snow accumulation through snow management can significantly help the recharging of shallow groundwater supplies.

In a new experimental program, blowing snow transport and wind speeds were measured over a snow-managed field consisting of wheat stubble cropped at alternative heights. The program results are being used to develop a two-phase blowing snow model which assesses the effect of stubble height on wind near the surface and on the amount of wind energy available to erode surface snow.

## Transport of Suspended Sediments in Rivers

Samplers with a glass liner have been designed to trap sediment efficiently in a wide range of river flows for toxic chemical analyses and suspended sediment concentrations in rivers. These samplers are currently undergoing field tests at sites across Canada in cooperation with

the Water Quality Branch of Environment Canada and the Centre Saint-Laurent.

## Northern Environment Project

### Snowmelt Runoff in Permafrost Basins

Ongoing field and laboratory work is aimed at improving the ability to model snowmelt runoff in permafrost environments. This capability is essential for predictions of water supply and environmental change due to climate warming. Data collection at Resolute Bay, N.W.T., included snow surface energy balance, snow and soil temperature, snow survey, monitoring changes in the snow, total soil moisture (frozen plus liquid) using gamma probes, and liquid water in the frozen soil using TDR (time-domain reflectometry). These data provide good information on the movement of meltwater through the snowpack into the frozen soil, and the subsequent runoff.

Analysis of these data will provide an understanding of the annual cycle of the changes in soil moisture. This includes infiltration of snowmelt water into the frozen active layer, drying of the active layer over the winter, and exchange of water between the active layer and the underlying permafrost, snow energy balance, and snowmelt runoff. Reports on infiltration of meltwater into frozen soils and a comprehensive review paper on snowmelt runoff have been published.

### River Ice Formation and Breakup

A field device was constructed to measure the flexure properties of ice and later tested on large-scale samples of deteriorating ice. Information from the tests has been incorporated into a strength model for the breakup of ice. In addition, a system was developed to measure heat balance and radiation balance over and within river ice cover. A review of existing models of radiation in ice indicated a suitable model that could be incorporated into present studies.

Survey data for the Liard River have been analyzed and information provided at a number of scientific meetings over the past year.

## Mackenzie Delta Hydrology

Ongoing work on the hydrology of lakes in the Mackenzie Delta is important in determining the environmental aspect of climate change, sea level rise, and/or hydroelectric development on the lakes of the Mackenzie Delta. In 1989, work concentrated on analyzing five years of lake water balance for a number of lakes in the delta, and on evaluating the interactions between hydrologic sources of water and biogeochemical processes within the delta ecosystem. In addition, analysis is proceeding in determining the effect of changes in sea level on the delta hydrology. Results have been published on the flooding hydrology of delta lakes, the evaporation from delta lakes, and the initial work on the supply of nutrients to delta lakes.

## **Biological Response to Nutrients and Contaminants in Aquatic Ecosystems Project**

### Impacts of Nutrients on Rivers

A multi-year program is now under way to determine the impact of phosphorus loading on the ecological balance of the Thompson River. The first phase will define the existing state of the river with respect to phosphorus availability and production of algae, insects and fish in the river. Both in situ surveys of the river and experimental flume studies are being used to determine the relative roles of phosphorus and insect-grazing activities in controlling algal biomass in the river.

Surveys of dissolved reactive phosphorus and dissolved nitrogen at five profiles across the river show that under conditions of low flow during the late spring, nutrient levels in the river decline downstream. Trials at four experimental flume sites located along a 60-kilometre length of the lower Thompson River indicate that the growth of benthic algae near Kamloops Lake is less affected by increases in phosphorus than the algae 20 to 30 kilometres downstream. This finding suggests that the river as a whole would be more sensitive to increased phosphorus than previously thought based on existing research.

Additional studies are to be conducted in the Thompson River to determine the distribution, fate and effects of chlorinated organic compounds from the pulp mill in Kamloops. One aspect of particular importance is the role of the algal biofilm in removing such compounds from the water and the determination of whether or not this mechanism might influence the degree of contamination of fish.

## Prairie Rivers Study

Increased nutrient loading due to sewage discharge and agricultural and industrial inputs together with return flows from irrigation systems have resulted in the abundant growth of rooted aquatic plants in many rivers on the prairies. This proliferation of aquatic weeds has had serious consequences, including fishkills, blockage of water flow, deterioration of water quality for human and livestock consumption, and impairment of recreational activities. Present methods to control the growth of rooted aquatic plants are costly and, at best, only temporary.

The aim of the Prairie Rivers Study is to examine the impact of nutrient loading and changes in flow on prairie rivers, in particular the role of nutrients and current velocity in controlling aquatic weed growth. In 1989, a multi-year research program was established to quantify factors controlling the growth and distribution of aquatic weeds in three prairie rivers: the Pembina River in central Alberta; the Bow River downstream from Calgary, Alberta; and the South Saskatchewan River downstream from Saskatoon, Saskatchewan. These rivers show a range in flow patterns and external nutrient loading. To date, transplant studies conducted on all three rivers have shown that the bottom sediments are the primary source of nutrients to rooted aquatic plants. In addition, studies on the Bow and Pembina rivers have shown that the total weed growth is inversely correlated with current velocity up to speeds of 1 metre per second. At current speeds in excess of this, aquatic macrophytes are rare. Current velocity seems an

important factor in controlling aquatic macrophyte biomass in prairie rivers, indicating that even a relatively modest increase in current velocity can reduce the abundance of rooted aquatic plants.

#### Two Prairie Lakes Compared

Highly eutrophic lakes typically have nuisance algal scums. The major factor accounting for nuisance algal blooms is a high concentration of plant nutrients. Contributing factors include resuspension and insufficient zooplankton grazing. The relative importance of these factors is being investigated in two central Saskatchewan lakes: Humboldt Lake, a hypereutrophic (nutrient-rich) lake and Redberry Lake, a saline, low-productivity lake.

Preliminary results indicate that sedimentation and resuspension rates are high in Humboldt Lake. Moreover, the lake supports an abundant zooplankton community. As in Redberry Lake, there appears to be a strong relationship to periods in which large-bodied zooplankton grazers (*Daphnia*) are abundant and water clarity high. This study also provides evidence of the adverse effects of blue-green algal blooms on zooplankton population dynamics and energy content.

#### Effect of Food Quality and Quantity on Energy Reserves of Plankton

Lipids (fatty material) are an important component of all organisms, affecting both ability to reproduce and ultimately to withstand periods of stress. Moreover, some toxicants are strongly associated with this fatty material. Relatively little is known about the lipid content of freshwater organisms and the purpose of this research is to determine the relationship between lipid content in zooplankton and two sources of environmental stress: low food abundance and high salinity. Preliminary results indicate that zooplankton inhabiting Humboldt Lake have higher lipid levels than the same species in Redberry Lake. Techniques also have been developed for more rapid estimation of lipid reserves.

#### The Impact of Physical Events and Zooplankton Grazers on Water Clarity

Redberry Lake is an unusual saline lake in that its waters are especially clear. This clarity may be due to the lake's sheltered location which minimizes resuspension of plant nutrients and/or the presence of large-bodied zooplankton grazers which prevent the development of excessive algal growth.

Meteorological stations have been established on a hill overlooking the lake and on an island in the lake. Wind speed and direction are two of the parameters being measured locally, and sedimentation rates are being measured through the use of sediment traps. Zooplankton community structure, numerical abundance, and biomass are being determined, as well as dissolved nutrients, and suspended particles.

Preliminary results indicate that sedimentation and resuspension rates are very low in the lake. Nutrients, especially nitrate concentrations, are low. There appears to be a strong relationship to periods in which large-bodied zooplankton grazers (*Daphnia*) are abundant and water clarity is high.

#### Paleolimnology Studies

Preliminary work continues on the investigation of the usefulness of saline lakes for providing proxy records for paleoclimatic change and the implications of such changes in climate to lake productivity. A 100-centimetre core from Redberry Lake was sectioned into 2-centimetre intervals for mineral analysis, carbon and oxygen isotope analysis (argonite and calcite fractions), and carbon dating.

Preliminary analyses suggest that there were two relatively warm and dry periods, one of them possibly reflecting changes in land use. Also indicated are fluctuating periods of high (85 to 100 centimetres) and lower productivity. Salinity has increased markedly in Redberry Lake over the last one hundred years as the lake level has dropped.

## Algal and Bacterial Production and Summer Deoxygenation

Two theories for the cause of summer fish kill in hypertrophic prairie lakes are that (1) in late summer, the phytoplankton population dies off and the resulting increase in bacterial numbers and activity consumes the dissolved oxygen or (2) the phytoplankton are diluted throughout the water column, resulting in a reduction in primary production. The former appears to be generally accepted, but there does not appear to be any published data to support it.

In this study, rates of phytoplankton production and bacterial production were measured throughout the summer and winter along with dissolved oxygen concentration and other biological, chemical and physical parameters. During the summer, and peaking in July/August, a large population of cyanobacteria developed in the lake and remained the dominant primary producers until fall. Primary production rates peaked in August as did the rate of bacterial production. The dissolved oxygen concentration during the peak bacterial production period remained well over 100% saturation. Under the ice both bacterial and primary production dropped to low levels but dissolved oxygen fell only to 26% at the sediment-water interface in late March.

## Bacterial and Phytoplankton Production in Redberry Lake

Redberry Lake is an unusual saline lake in that its waters are clear. The saline lakes of the prairies are important but relatively unstudied. Because these saline systems do not conform to commonly used nutrient load models, additional information is essential to ensure the sustainable development of prairie saline lakes.

In this study, algal and bacterial production were measured in summer and winter and throughout the water column. Bacterial production was lower in Redberry Lake than in Humboldt Lake. Because of the high transparency of the water, light usually penetrated to the bottom of Redberry Lake, creating a favourable growth environment for phytoplankton. The phytoplankton, however,

did not develop appreciably. In a preliminary experiment, Redberry water samples were spiked with nitrogen but this did not increase the phytoplankton concentration. Therefore, it was concluded that factors other than the availability of nitrogen must be limiting the growth of the primary producers in this saline lake.

## Measuring the Heterogeneous Populations of Bacteria in Aquatic Systems

Methodology continues to be a major factor regulating progress in the field of aquatic microbial ecology. Aquatic environments, i.e., rivers, lakes, groundwater, sewage treatment plants, and biofilms, contain heterogeneous populations of bacteria with diverse abilities to use organic compounds. Bacterial populations may exist in various metabolic states, ranging from starvation in very nutrient-poor waters, to active but non-growing states, to states of active growth.

Recently, [methyl-3H] thymidine and [3H] leucine have been proposed as universal substrates to measure production. While these substrates, particularly thymidine, have found wide acceptance by microbial ecologists, many problems remain in data interpretation.

Production and growth rates in these studies were controlled and measured with thymidine and leucine. These data will provide more accurate estimates of growth and production of heterogeneous populations which are necessary, for example, to maximize production in treatment and biotechnology systems, to control nuisance biofilms or to use bacteria as bioindicators in toxicity testing and other environmental studies to predict the impact of pollution.

## Limnology of Great Slave Lake

Great Slave Lake is a large, relatively pristine lake located in the Canadian Arctic. It is important to the local economy which supports commercial and sport fishery. Certain regions of the lake have received low levels of contamination from mines located in the drainage basin. The limnological properties of the lake are

strongly affected by the Slave River, which provides water and sediment to the western basin.

#### Biogeochemistry of Heavy Metals

An experimental study was completed on the effects of different heavy metals and selenium on the microbial methylation of mercury and other microbial activities in the sediments of a lake polluted with fallout from the smelter at Flin Flon, Manitoba. The project included investigation of synergistic and antagonistic effects of mixtures of pollutants and is relevant to natural environments contaminated with several different toxic pollutants. This study also dealt with the bioavailability of sediment-bound heavy metals in eight lakes near Flin Flon to examine relationships between solvent-extractable metal fractions (and other geochemical variables) and the metal concentrations found in the tissues of different species of fish.

#### Toxic Chemical Effects on Freshwater Ecosystems

Biological techniques to detect and assess acute and chronic effects of contaminants in freshwater ecosystems are being developed based on the structure and responses of benthic communities. The techniques include traditional community parameters but focus on the morphological responses of individual organisms, particularly members of the chironomid (midge) community, to provide an earlier warning of potential contamination problems. To date, indices for assessing the frequency and severity of deformation in the antennae and ligulae on Chironomus and Procladius have been developed and applied to a number of environments of differing levels of contamination. In a St. Lawrence River study, these indices have successfully identified contaminant hot spots and indicate that it is very heavily stressed. Chironomid larvae have been shown to be responsive to subtle seasonal changes in the availability of heavy metals like mercury.

Studies of species from Southern Indian Lake-Notigi Reservoir in Manitoba and Tobin Lake in Saskatchewan are designed to develop an early warning system to detect biological changes before the waters and sediment are severely

contaminated. Because of the widespread distribution of the chironomid family, these techniques also are applicable to monitoring the state of ecosystem health in the general environment. The more specific findings are relevant to the interpretation of chemical data in sediment and highlight the vulnerability of freshwater communities to contaminants. Because chironomids are an important source of food for fish and ducks, they play an important role in the bioaccumulation and transmission of toxic chemicals through the food chain.

#### Contamination of Surface and Groundwater Project

##### Hydrology of Fractured Clays

Distinct major ion profiles were obtained in extracts of the uppermost three metres of fractured clay sediments sampled at three sites near Saskatoon. These sites have completely different hydrologic settings: (a) a discharge area in a shallow aquifer, (b) a recharge area over a shallow aquifer, (c) thick till which is virtually impervious. This extraction method promises to be an inexpensive and easy method to determine shallow groundwater flow conditions in various prairie environments. Ongoing studies will focus on analyses of piezometer and lysimeter samples from several prairie sites, to provide more information on the controlling reactions and transport fluxes of dissolved species in soils and shallow groundwater. Stable isotope techniques will be used in addition to major ion analyses.

##### Facility for Indoor Aquifer Testing (FIAT)

This apparatus is essentially a very large, experimental tank, with the capacity for fine control of water inputs and outputs. It is fitted with numerous water and soil sampling ports. FIAT was conceived as a general purpose test facility for hydrogeological and hydrogeochemical investigations on a variety of aquifer materials under highly controlled conditions. Because of its size (4.6 metres high and 2.44 metres in diameter), it avoids most of the edge effects and sampling disturbance problems associated with smaller experimental columns.



During 1989-90, an experiment on leaching of chemical ions from a sample of fluidized bed combustion wastes was conducted. Samples collected regularly at several depths in the profile of the waste and underlying materials were analyzed for pH, calcium, magnesium, sodium, potassium, iron, sulphate and alkalinity. Preliminary analyses of the results from the experiment show movement of chemical fronts through the subsurface for a number of the ionic species. Detailed analyses of these results will continue in 1990-91.

#### Acid Mine Drainage

During 1989-90, research conducted at the Mount Washington site on Vancouver Island, British Columbia clarified the mobilization and attenuation of copper and arsenic in seeps and a stream emanating from an abandoned mine site. Waste rocks have a more heterogeneous system for water-mineral interaction than the mine tailings. The prediction of acid generation in waste rocks requires quantifiable information on the nature and mode of occurrence of sulphides and the associated gangue minerals. Future activity will address the role of shallow groundwater in the process of metal leaching.

#### Organic Contaminants in Groundwater

During the year NHRI continued to assess the capability of the MICROTOX technique to detect low levels of pesticides and their breakdown products in groundwater. The technique is based on the response of a sensitive, bioluminescent microorganism to low levels of chemical contamination and has the potential for use as a low-cost fast-screening tool. It could enable the screening of samples with zero or insignificant levels of contamination and to reduce the number of samples that require very costly (and often unreliable) traditional chemical analyses using GC/MS (gas chromatography/mass spectrometry) or equivalent techniques.

Groundwater and soil water samples from the hydrogeological studies at the Sheffield Farm in Nova Scotia, the South Saskatchewan irrigation Centre in Saskatchewan, and from several field

sites in southern British Columbia were cross-checked with this technique. As well, the EC50 (the concentration of the sample causing 50% reduction in light output from the luminescent bacteria) was determined for approximately 35 chlorinated herbicides and insecticides. These tests are designed to measure the sensitivity of the MICROTOX bioassay and to allow ranking of the pesticides according to toxicity.

#### Pesticides in Groundwater

NHRI has conducted sampling surveys for groundwater and surface water in Saskatchewan, Alberta, and British Columbia, to determine whether there is a widespread problem concerning pesticide/ groundwater interactions. Initial work conducted over the period 1987-1989 shows that some small traces of pesticide can be found in the groundwater beneath irrigated prairie lands where there is pesticide use. The preliminary results indicate that there is no immediate serious problem with groundwater contamination due to pesticides in the prairies. However, pesticide traces were found in the shallow saturated and unsaturated zones and show the need to monitor some sites on the prairies.

In southern British Columbia, pesticide sampling surveys showed trace amounts of organonitrogen and organophosphorus pesticides in groundwater at Osoyoos in the Okanagan Valley. At Abbotsford, on the Fraser Lowland, sampling conducted in 1984, 1987 and 1989 indicated trace amounts of organonitrogen and organophosphorus compounds in some domestic wells. The most consistent pesticide or breakdown products were for the organochlorine compound 1,2-DCP, detected in the vicinity of Agriculture Canada's Agassiz Research Substation, south of Clearbrook. In 1989, groundwater samples from the Abbotsford Aquifer, and from drainage ditches in the Serpentine and Nicomekl River drainage basins were subjected to MICROTOX testing (see above) and pesticide analyses. Most of the samples showed toxicity levels below detection, but a few showed measurable toxicity. It must be noted that these high observed toxicities have not yet been

attributed to the presence of pesticides in the groundwater. Further sampling is currently under way in the Abbotsford, Langley, and Richmond areas to determine the cause.

#### Permafrost

Surface and groundwater chemical data collected from two study sites located in the fringe zone of discontinuous permafrost in northern Alberta have been analyzed. It was found that the water chemistry is highly dependent on the thermal regime under which water-mineral interactions occur. With progressive degradation of permafrost, the aquatic chemistry evolves from waters dominated by calcium bicarbonate to sodium-sulphate type waters. Furthermore, the apparent increase in organic acids in surface waters would result in the acceleration of mineral weathering and affect water quality in the North under any warming conditions associated with climate change.

#### **NHRI Continues to Progress**

During 1989-90, the National Hydrology Research Institute held a series of seminars and organized or sponsored meetings in cooperation with other organizations and professional associations. These meetings included a Symposium on Groundwater Contamination on June 14 and 15, 1989; a Workshop on the Mackenzie Delta on October 17 and 18, 1989; and a Workshop on the Application of Remote Sensing in Hydrology on February 13 and 14, 1990. Information on these meetings and copies of available Proceedings may be obtained by writing to the Science Liaison Division at the Institute located in Saskatoon, Saskatchewan, S7N 3H5.

The National Hydrology Research Institute continued to recruit new staff and to develop stronger links with universities, provincial agencies and other federal agencies. These collaborative arrangements contribute to efforts to broaden the scale of research and to develop comprehensive, multidisciplinary approaches to major environmental problems related to water.

#### **GROUNDWATER CONTAMINATION STUDIES IN NOVA SCOTIA**

Environment Canada, in cooperation with Agriculture Canada, is undertaking a five-year program to determine the environmental behaviour of pesticides and nitrates under Atlantic conditions. This approach is intended:

- to provide interested parties with the needed protocols for evaluating the chemistry and fate of agrichemicals (chemicals used in agricultural industry), particularly as they relate to the new guidelines for the registration of pesticides in Canada, and
- to determine under what agricultural practices particular pesticides and fertilizers can be applied without causing unacceptable contamination of groundwaters.

The pesticide atrazine, which is suspected of being soluble and persistent enough to contaminate groundwaters, will be subject to controlled field applications in 1990-91.

During 1989-90, reconnaissance hydrogeological studies were completed at the Sheffield Farm in the Annapolis Valley of Nova Scotia. Thirty-nine lysimeters were placed in the field experiment area and soil materials were analyzed.

In addition, a computerized database was developed; spatial analysis of the data using GIS (Geographic Information Systems) SPANS was completed; six monitoring wells were constructed; surface water hydrometric data studies were initiated; the soils mapping, surficial and bedrock geology, and land use data were updated; and an overall area water balance study was started. Much of this work is being coordinated with the Centre for Water Resources Studies of the Technical University of Nova Scotia in Halifax, the Nova Scotia Department of Environment, the National Hydrology Research Institute, and the National Water Research Institute.

#### **WATER SCIENCE AND TECHNOLOGY**

In 1989-90, the Inland Waters Directorate of Environment Canada continued to support water

science and technology by identifying new sources of funding and potential partners for water-related research. The Directorate is leading the establishment of a special fund for university-based research in the Great Lakes. The Great Lakes University Research Subvention will use money from the Great Lakes Action Plan and matching funds from the Natural Sciences and Engineering Research Council to provide grants to universities over a four-year period, beginning in the summer of 1990. The research will focus on the development of the knowledge needed to identify the sources of pollution and to develop the strategies required to stem pollution in the Great Lakes. Other Directorate strategies to encourage water research partnerships with the private sector and academic community are being incorporated into the Government of Canada's "Green Plan."

### **SOCIO-ECONOMIC STUDIES**

Socio-economic studies continued to play an important role in federal water programs, in keeping with the intent of the Federal Water Policy, which is to promote and support sustainable development of the water resource. Several important areas of study continued to develop.

#### **Water Use Studies**

##### Water Use and Water Resource Economics

The National Water Use Analysis Program underwent further development during 1989-90, with respect to both data collection and economic research. Much of the effort was spent to implement the "realistic pricing" strategy of the Federal Water Policy.

##### Data Collection

Data collection efforts focused on the municipal sector, with the undertaking of surveys of both municipal water use and retail water prices for 1989. A technical paper dealing with the latter subject for 1986 was published, along with a public information brochure. These publications were widely distributed. In addition, a report

was prepared summarizing the results of the 1986 survey of industrial water uses.

##### Database Construction

The National Water Use Database, which will hold all of the water use data of the Inland Waters Directorate, was produced in a prototype format for testing. It is now being completed under contract and should be operational during 1990-91.

##### Water Demand Management and Modelling

A monograph on water demand management was completed. It outlines the characteristics of water demand management, how it can be applied by public agencies, and a supporting program of research. Another project applied the concepts of demand management to the South Saskatchewan River basin. The Water Use Analysis Model developed by the Inland Waters Directorate (IWD) was further augmented with respect to preparation for public dissemination. The model was also distributed to regional IWD offices, several of which have applied it to individual river basin areas.

##### Water Resource Economics

In addition to the work reported above on municipal water pricing, research was begun to specify price: demand relationships for various major Canadian water using industries. Research was also carried out on various municipal water demand issues, such as effective methods of municipal water pricing. Papers on the economic aspects of water use were presented at several national and international conferences.

#### **Acid Rain**

In 1989-90, activities related to acid rain or the long range transport of airborne pollutants (LRTAP) continued. The major focus was the preparation of the Socio-economic Studies Section of the 1990 LRTAP Assessment Report. The report deals with the industrial impacts of the emission control program, the resource benefits accruing

from reductions in acidic precipitation, and the future direction of socio-economic research on the effects of acidic precipitation. Industrial impacts of smelters and utilities are related to emission controls, fuel/ore and combustion technology. Although industry requires a long lead time to make the necessary adjustments, emission controls are being implemented without undue socio-economic disruption and dislocation. Socio-economic benefits can be described by damages avoided and resource recovery, added uses or enjoyment gained, reduced cost of control/abatement efforts, and lowered exposure to health hazards.

### Climate Change

Activities related to long-term climate change, or the greenhouse effect, continued in 1989-90. At the national level, federal water interests were represented at the biannual meetings of the Socio-Economic Impacts Committee (SEIC) of the Canadian Climate Program (CCP). The SEIC is a special advisory committee responsible for scientific coordination and review with regard to the Canadian Climate Impacts Program, one of the four program areas of CCP.

At the Service level of Environment Canada, Inland Waters Directorate representation and Secretariat services on the Conservation and Protection Service (C&P) Science and Operations Committee on Atmospheric Change (SOCAC) included input on activities related to climate change, coordination of C&P input to the Atmospheric Environment Service Memorandum to Cabinet on Atmospheric Change (no longer in preparation), and the production of the report "Toward a C&P Strategy to Address the Issue of Atmospheric Change" (November 1989).

Presentations to the C&P Executive Committee and C&P management Board based on the recommendations of the SOCAC report resulted in a new C&P committee structure as of February 1990.

### CCME Water Advisory Committee

In 1989-90, the Water Advisory Committee of the Canadian Council of Ministers of the Environment

(CCME) continued to work toward a statement of national water management principles. At the same time, the Committee considered possible changes in its role which might be instigated following a review of all advisory committees by the Deputy Ministers for CCME.

### International Involvement

Representatives from Canada attended the 1989 annual meeting of the Economic Commission for Europe (ECE) Committee on Water Problems. The Committee noted the Commission's adoption of the "Charter on Groundwater Management" and accepted Norway's offer to host a seminar on the "Ecosystem Approach to Water Management" in Oslo on May 27-31, 1991. Canada will host a preparatory experts meeting in April 1990 and is doing a case study on the Great Lakes ecosystem approach for the seminar.

### WATER DATA

Programs for the systematic collection and compilation of data on streamflow, water levels, sediment transport, groundwater, water quality, and related information on glaciers, snow and ice predated the Canada Water Act but have continued to operate in support of water management basin studies and implementation programs. A newer innovation is the collection of background data on water use by municipal and industrial users in Canada.

At the National Water Research Institute, water data activities in support of water data collection include programs of quality assurance and analytical methods adaptation for the water quality program and current meter calibration for the water quantity program.

At the National Hydrology Research Institute, data collection activities support specific research programs relating to surface and groundwater, and to aquatic ecology. Up-to-date information on glaciers and snow and ice continues to be maintained.

## DATA MANAGEMENT SYSTEMS

Data and information reference systems are essential to water resource planning and management. Federal and provincial governments, universities and the private sector depend on this information. The water-related databases and information systems in operation during 1989-90 are listed in the table on page 39. One of these databases, AQUAREF, is produced by WATDOC, a section of the Inland Waters Directorate (IWD).

### WATDOC

Through the AQUAREF database, WATDOC provides the scientific and technical community, as well as the general public, with French and English bibliographic references to Canadian water resources publications and other environment-related documents. For example, AQUAREF includes over 3900 references cited in the Canadian Water Quality Guidelines. WATDOC has referenced all reports produced to date under the Canada Water Act as well as those related to the Federal Water Policy and the Inquiry on Federal Water Policy.

Microfiche copies of all reports pertaining to the Canada Water Act are deposited with Environment Canada's Departmental Library in Hull, Quebec, K1A 0H3, as well as with the Canada Institute for Scientific and Technical Information in Ottawa, Ontario, K1A 0S2.

WATDOC also produces bibliographies and inventories from subsets of AQUAREF. In 1989-90, WATDOC and the Water Quality Branch of IWD worked together to produce the "Publications 1988" listing.

During 1989-90, WATDOC was highly visible to the public. WATDOC personnel organized displays at several water-related conferences across Canada. They gave demonstrations on AQUAREF and on the techniques for searching the file. To provide more comprehensive marketing of the IWD databases, WATDOC continued to work with other sections of the Water Planning and Management Branch, the Water Resources Branch, and the Water Quality Branch of IWD in presenting the water use databases, the HYDAT databank, and the NAQUADAT database.

The growing interest in WATDOC is reflected by the increase in online searching of AQUAREF on CAN/OLE, which is a retrieval system offered by the Canada Institute for Scientific and Technical Information (CISTI). In December 1989, CISTI released the CAN/OLE II version. The advantages of CAN/OLE II include enhanced commands, better indexing, improved customer support, and a dynamic system with long-term potential for enhancements. As well as responding to many specific information requests, WATDOC produces a newsletter highlighting recent developments and sample searches.

## Water-Related Databases and Information Systems

Name	Data Provided
AQUAREF	References to Canadian water resources documents and environment-related articles and reports
NAQUADAT	Water quality data, including chemical, physical, bacteriological, biological, hydrometric data, collected for the national water quality monitoring program
STAR	Limnological data on the Great Lakes
WATENIS	National inventory of industrial and municipal water pollution sources including data on physical, chemical and toxicological characteristics of effluents, and information on water effluent regulations and guidelines
MUNDAT	Information about municipal waterworks and wastewater systems in Canada, compiled in cooperation with provincial governments and the Federation of Associations on the Canadian Environment
HYDAT	Data on streamflow, water levels, and sediment transport collected through federal-provincial water quantity agreements; it also includes water quantity data contributed by other organizations that meet national standards in data collection procedures and accuracy
HOMS	Inventory and summary description of selected operational techniques and procedures used to collect, process, manipulate and analyze hydrological data for water resources studies. The Hydrological Operational Multipurpose System (HOMS) was developed by the World Meteorological Organization (WMO) for the organized transfer of operational technology used in water resources investigations by member countries of WMO.
Glacier Data and Information System	Compilation of physical dimensions of Canadian glaciers and a bibliography of Canadian glacier documents

## Part II: Water Quality Management

The federal government, in concert with provincial governments, has completed the development of water quality management strategies for the St. Lawrence River (Quebec), the Souris River (Manitoba-Saskatchewan), and the Shubenacadie-Stewiacke rivers (Nova Scotia). Also, a Canada-Ontario-Quebec Coordinating Committee is working to establish a water quality monitoring plan for the Ottawa River; a Canada-British Columbia Committee is overseeing the implementation of a management program in the Fraser River Estuary; and a Canada-Manitoba Team has completed a mercury study in the Churchill River diversion. Federal-provincial programs with the objective of maintaining and improving water quality are in place in the Great Lakes basin and in the Okanagan and Qu'Appelle basins.

### Canadian Water Quality Guidelines

In 1987, the Canadian Council of Resource and Environment Ministers (CCREM) published the first edition of the Canadian Water Quality Guidelines. The Guidelines, prepared by the CCREM Task Force on Water Quality Guidelines, are a compilation of information on specific water quality parameters that indicate whether water is suitable for the following major uses: raw water for drinking water supply; recreational water quality and aesthetics; freshwater aquatic life; agricultural uses; and industrial water supplies.

The Guidelines address more than 50 specific substances of concern, including many toxic substances, and are designed to harmonize water quality efforts throughout the country. Associated environmental information for some 120 water quality parameters is also provided. The intent of the Guidelines is to describe the effects of water quality parameters on water uses and to assist in the preparation of site-specific water quality objectives which take local environmental and socio-economic conditions into consideration.

The federal departments of Environment and National Health and Welfare have collaborated to

produce a brochure and poster which summarize the Canadian Water Quality Guidelines and the Guidelines for Canadian Drinking Water Quality, entitled "How Safe is Our Water?" These publications should prove useful in answering requests concerning human health and environmental aspects of water quality. As well, they are convenient reference material for professionals working in the water field. These publications can be obtained from Environment Canada's Water Quality Branch in Ottawa, Ontario, K1A 0H3.

### New Guidelines

The Task Force on Water Quality Guidelines continues to recommend water quality guidelines. Guidelines for the pesticides atrazine, carbofuran, glyphosate, picloram, metribuzin, and cyanazine were published in 1989-90 by the Canadian Council of Ministers of the Environment (CCME, formerly CCREM). Guidelines will be published in 1990-91 for nutrients in flowing water; organotins, trichloroethylene, halogenated methanes and chlorinated ethanes in freshwater; PCBs in the marine environment; and for the pesticides metolachlor, simazine, trifluralin, triallate, diclofop-methyl, dinoseb and captan.

The new Canadian Environmental Protection Act requires that the Minister of the Environment develop environmental quality objectives and guidelines. The Department of the Environment will be generating guidelines that reflect the needs of the Priority Substance List. The CCME has also initiated a National Contaminated Sites Cleanup Program and has asked the federal government to coordinate development of site assessment, ranking and cleanup criteria for "orphan" sites, the cleanup costs of which will be shared by provincial and federal governments. The criteria to be developed will probably include soil quality guidelines and groundwater quality guidelines as part of a "system" for performing the evaluation, ranking and post-cleanup assessment.

## Part IV: Public Information Program

The last threat is ourselves. My parents grew up in the 1930s and were taught to reuse products. I have grown up in a disposable society, and because of this attitude, we have a serious problem. People are now recognizing that we play a role in the environment and how we act will determine the outcome.

- Alberta resident

In order to live again in harmony with the environment, Canadians are voicing the realization that our culture must change. The public information program provides a means for Canadians to look at themselves and their surroundings in new ways, enabling this change. During the past year, an increased number of publications on the environment were targeted to the general public and students.

### A Primer on Water - Questions and Answers

In response to requests for information about water that are received daily by Environment Canada, A Primer on Water was conceived. The questions were categorized to complement the major issues identified in the Federal Water Policy.

Beginning with the question "What is water?", the Primer answers 123 questions which cover different aspects of water: its physical characteristics; its availability both above and below ground; the uses we make of it; and how we share and manage it. The Primer also contains practical advice on what we, as individuals, can do to help conserve water.

### Fact Sheets for Everyone

Up-to-date scientific and socio-economic information on water is necessary for making informed decisions. To fulfill this need, a series of general fact sheets are in progress that describe the hydrologic cycle; state where water is plentiful and where it is scarce in Canada; explain how water quality is determined; compare its

industrial, agricultural, domestic and instream uses; and illuminate the role water has played culturally throughout the ages. The fact sheets published this past year have been well received by students and the general public alike.

To obtain the fact sheet series on water or the Primer on Water: Questions and Answers, write to:

Editorial and Publications Division  
Inland Waters Directorate  
Environment Canada  
Ottawa, Ontario  
K1A 0H3

### Public Information under the Canada-P.E.I. Agreement

In the fall of 1987, a unique three-year agreement was signed by the federal government and the Province of Prince Edward Island. Known as the Canada-P.E.I. Water Resource Management Agreement, its aim is to study present uses of water on the Island to help safeguard the future of the water resource. Under the agreement, a series of four fact sheets have been prepared about Prince Edward Island on the following: surface water, coastal estuaries, groundwater, and domestic sewage and septic systems. Each fact sheet contains a section on "What You Can Do." These fact sheets may be obtained by writing to:

Inland Waters Directorate  
Environment Canada  
15th Floor, Queen Square  
45 Alderney Drive  
Dartmouth, Nova Scotia  
B2Y 2N6

In 1989-90, two videos were produced, entitled "Estuaries" and "Water and the Economy." Also, a display was developed for water resource issues in Prince Edward Island for use in group presentations. Due to their mobility, displays are proving to be an effective means of reaching Canadians across the country.



**Principal Federal-Provincial Cooperative  
Arrangements under the  
Canada Water Act**

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## REGULATION, APPORTIONMENT, MONITORING AND SURVEY PROGRAMS

### 1. WATER QUANTITY SURVEY AGREEMENTS

**Objective:** To maintain a viable and efficient national water quantity survey network and to give recognition to joint federal and provincial responsibilities in this activity.

**Duration of Agreements:**

Agreements between Canada and each province were signed in 1975 and letters were exchanged between Environment Canada and Indian and Northern Affairs Canada agreeing to joint survey operations in the provinces and territories. The programs are continuous, but there is a provision in each agreement for termination on 18 months' written notice.

**Participants:** CANADA.....Environment Canada, and Indian and Northern Affairs  
Canada representing the Yukon and Northwest Territories.  
ALL PROVINCES

**Arrangements:** Data are gathered, analyzed and interpreted to meet client's needs in the hydrologic community. This is a shared-cost program, with the federal government carrying out field and office procedures and invoicing the provinces quarterly. An exception is Quebec, which operates the program in that province and invoices the federal government quarterly except for international and navigable waters, and waters crossing federal land in Quebec, which are surveyed by the federal government. Indian and Northern Affairs Canada transfers funds annually to Environment Canada for the territories' share of costs.

**Funding:** 1989-90 (provisional costs)

Total Program Costs	\$22 050 000
Total Recovered from Provinces	5 796 500
Total Paid to Quebec by Canada	756 200

Total Program Costs are the expenditures required to conduct the National Water Management Data Program.

The Total Recovered from Provinces is the amount reimbursed by the provinces, except Quebec, to Canada. The Total Paid to Quebec by Canada is the amount paid by Canada to the province of Quebec for operating stations of federal interest in that province.

**Status:** Coordinating Committees, established for each province, convene at least annually but normally more frequently to review the water quantity survey networks and to determine annual cost sharing. National meetings of all Coordinating Committees are convened periodically to ensure common practices are followed in administering the agreements. The eighth National Coordinators meeting was held in January 1990. The Water Resources Branch of the Inland Waters Directorate, Environment Canada, presented plans for modernizing the

collection, processing and distribution of hydrometric data, which were supported in principle by the Coordinators.

## **2. WATER QUALITY MONITORING AGREEMENTS**

**Objective:** To establish a nationwide water quality monitoring network that will make it possible to assess water quality on a national basis and at the same time meet the needs of the provinces and territories.

**Duration of Agreements:**

Agreements have been signed with Quebec, British Columbia, Newfoundland, Manitoba, New Brunswick, and Prince Edward Island. The agreements contain no termination date, but there is provision for termination by either party within a specified period of time after written notice. Agreements with other provinces and territories will contain similar provisions.

**Participants:**

CANADA.....Environment Canada  
ALL PROVINCES AND TERRITORIES

**Arrangements:**

In designing the agreements to meet the needs of the federal, territorial and provincial governments, the party(s) who will conduct the work are identified, and the costs of the program are shared in accordance with the value of the information to each party.

**Funding:**

Costs are determined according to the schedules appended to each agreement. Federal stations will be funded 100% by Canada; provincial stations will be funded 100% by the province and territorial stations, 100% by the territory; federal-provincial and federal-territorial stations will be funded equally by each party. In 1985-86, Treasury Board authorized the Department to spend up to \$2 139 000 annually to fund agreements.

**Status:**

Agreements with Quebec became effective in 1983; British Columbia, 1985; Newfoundland, 1986; Manitoba and New Brunswick, 1988; and Prince Edward Island, 1989. Negotiations for agreements with Saskatchewan and Nova Scotia are complete. Negotiations with Alberta and Ontario are progressing. At the administrative level, negotiations with Yukon and the Northwest Territories are complete. However, major questions concerning funding have yet to be addressed.

## **3. PRAIRIE PROVINCES WATER BOARD**

**Objective:** The equitable apportionment of eastward flowing interprovincial prairie waters. The agreement ensures that one-half the natural eastward flow of waters arising in or flowing through Alberta is reserved for Saskatchewan, and that one-half the eastward flow arising in or flowing through Saskatchewan is reserved for Manitoba.

**Duration of Agreement:**

Continuous since October 30, 1969.

Participants and Funding:

CANADA  
ALBERTA  
MANITOBA  
SASKATCHEWAN

(Funding to be borne one half by Canada and one sixth by each of the provinces.)

Arrangement:

Schedule C of the Master Agreement on Apportionment provides for the reconstitution of the Prairie Provinces Water Board (PPWB) whose responsibility is to oversee and report on apportionment of waters flowing from one province into another province; to take under consideration comprehensive planning, water quality management and other management problems referred to it by the entities concerned; to recommend appropriate action to investigate such matters; and to submit recommendations for resolution of the problems.

Status:

The agreement is administered through the Prairie Provinces Water Board, its Committees, and its Secretariat.

The Board, through its Committee on Hydrology, has established procedures for the determination of natural flow for eight interprovincial streams: South Saskatchewan River, North Saskatchewan River, Saskatchewan River, Qu'Appelle River, Churchill River, Battle Creek, Lodge Creek and Middle Creek. Natural flows are calculated for these streams. Procedures for computing natural flow for 20 other small interprovincial streams have been prepared and documented. The procedures will be used when monitoring of apportionment is required for these streams.

At the request of the Board, the Water Quality Branch of Environment Canada monitors water quality monthly at 11 interprovincial monitoring sites. These stations are part of the Board's long-term network to monitor water quality in the Prairie provinces. The Board's Committee on Water Quality (COWQ) updated the PPWB water quality contingency plan developed in 1984 and reported spills and unusual water quality conditions on interjurisdictional streams to the Board and its Member Agencies. The COWQ prepared new water quality objectives for use at each of the 11 stations in 1989. A report summarizing water quality monitoring results from all 11 stations for the period from April 1974 to December 1988 was completed. The Committee's Task Force on Analytical Methodology provides a means of quality assurance and coordinates water quality laboratory results for the Prairie provinces.

The Board's "fixed term" Committee on Water Quality Policy has recommended a water quality strategy for the Board and the Board is currently reviewing its recommendations.

The report entitled "Water Demand Study - Historical and Current Water Uses in the Saskatchewan-Nelson Basin" was released to the public on February 10, 1983. The water use information in that report is updated annually and both the study results and the updated information are being stored in a computerized format for retrieval by interested agencies and individuals.

The Board's Committee on Groundwater has prepared reports showing cross sections, or profiles, of groundwater conditions along the Alberta-Saskatchewan boundary and the Saskatchewan-Manitoba boundary. The Committee is reviewing groundwater related legislation for the Prairie provinces to see how the legislation responds to potential interprovincial groundwater concerns. The Committee also coordinates the tabulation of a bibliography of groundwater reports and data related to interprovincial groundwater evaluations.

With respect to maintaining and updating historical streamflow and natural flow data files for selected hydrometric stations in the Saskatchewan-Nelson Basin, the Secretariat has completed updating 93% of its files to 1986. In addition, the Secretariat maintains historical meteorological data including precipitation, gross evaporation and net evaporation for 14 selected sites in the Prairie provinces.

The Board also examines the quantity and quality effects that proposed projects might have on interprovincial streams at the boundaries. The results of each evaluation are reported to the Member Agencies.

#### **4. OTTAWA RIVER REGULATION PLANNING BOARD**

**Objective:** To plan and recommend criteria for regulating the Ottawa River, taking into account hydropower production, flood protection, navigation, low water problems, water quality needs, and recreation.

**Duration of Agreement:** Continuous since March 1983.

**Participants:** CANADA (3 members)  
ONTARIO (2 members)  
QUEBEC (2 members)

Canada assumes initial responsibility for financing the cost of the agreement, with Ontario and Quebec each contributing 25%.

**Prior Action:** As a result of recommendations made following a study of flooding in the Montreal region in 1976, a Canada-Ontario-Quebec Ottawa River Regulation Planning Committee was established in 1977 by an exchange of letters between the federal Minister of the Environment, the Quebec Minister of the Environment, and the Ontario Minister of Natural Resources. The final report of the Planning Committee was submitted in December 1980, recommending that a tripartite regulation agreement be negotiated. Negotiations then followed, culminating in the signing on March 2, 1983, of a Canada-Ontario-Quebec Agreement respecting Ottawa River Basin Regulation.

**Arrangement:** The Ottawa River Regulation Planning Board administers the agreement. It also formulates and reviews regulation policies and criteria concerning integrated management of the principal reservoirs in the basin.

A regulating committee, composed of operators of the principal reservoirs, is responsible for ongoing operation of the reservoirs, within the guidelines established by the Board.

Status: A Secretariat has been established within Environment Canada to act as the executive arm of the Board.

During the spring flood period (March 1 - May 30), forecasts on a real-time basis are provided daily for the principal reservoirs in the Ottawa River basin and at selected points where flooding takes place.

The mathematical regulation model is operated on a real-time basis during the spring flood period to serve as a guide to reservoir operations. In 1986, flood reserves were implemented in three reservoirs, on a trial basis, to facilitate the operation of the Grand Moulin Dam at the upstream end of the Mille Iles River.

Subcommittees have been established to study the possibility of using extra flood reserves in some reservoirs, to develop risk management methodology for the Ottawa River basin, and to develop bylaws and procedures for the Board.

#### 5. OTTAWA RIVER WATER QUALITY COORDINATING COMMITTEE

Objective: To review monitoring data and other information on water quality of the river; to undertake or recommend special studies as needed; to recommend water quality objectives for the river; to recommend and evaluate pollution control activities.

Duration of Agreement: Continuous from 1983.

Participants: CANADA  
QUEBEC  
ONTARIO

Status: The Ottawa River Water Quality Coordinating Committee was formed in 1983 to provide a permanent means of coordinating monitoring and pollution control. Its first report noted some improvement in water quality in the river, particularly in bacterial quality, and recommended adoption of water quality objectives and emphasis on control of nutrients, bacteria, dissolved oxygen, and PCBs (polychlorinated biphenyls). The second report, released in 1989, deals specifically with pollution from the forest industry and municipal sources. The Committee plans to produce further progress reports approximately once every five years, and is currently preparing a proposal to acquire data for its next report.

#### 6. MACKENZIE RIVER BASIN COMMITTEE

Objective: To exchange information on potential water-related developments in the basin and to recommend to the ministers studies which would gather data on the basin's water and related resources.

Duration of Agreement: Continuous since 1973.

Participants: CANADA.....Environment Canada, Transport Canada, Indian and Northern Affairs Canada, Yukon Territory, and Northwest Territories.  
ALBERTA  
BRITISH COLUMBIA  
SASKATCHEWAN

Prior Action: The Mackenzie Basin Intergovernmental Liaison Committee was established in 1973 and reconstituted as the Mackenzie River Basin Committee in a Memorandum of Understanding between the participating governments in May 1977. In May 1978, a \$1 600 000 program to study the water and related resources of the basin was endorsed.

The study has been completed and the final report was released by the ministers on February 26, 1982. The main recommendations call for early negotiations toward a transboundary water management agreement, an expanded network of water data stations, follow-up field studies on ice breakup, and a major study of the Mackenzie Delta.

Status: The Mackenzie River Basin Committee continued to meet during 1989-90 to fulfill its liaison and information exchange responsibilities, as well as to implement recommendations of the final report. A general agreement that would grant member status to the governments of the Northwest Territories and Yukon has been developed. As of March 31, 1990, authority to sign this general agreement had been obtained by all the parties. Implementation of Recommendation 1, an agreement through which transboundary water management issues can be handled, is being addressed through development of a "master" agreement which will establish broad principles, goals and objectives for cooperative water sharing. Under this agreement a water management board will be established for the basin. Seven bilateral sub-agreements between the various jurisdictions are being developed in tandem with the master agreement.

## 7. LAKE OF THE WOODS CONTROL BOARD

Objective: To control and regulate certain major waterways in the Winnipeg River drainage basin to achieve water flow and level conditions that are reasonably acceptable to the various interests.

Duration of Agreement: Continuous. The Board was established in 1919 under a Dominion Order-in-Council, and was confirmed by federal legislation in 1921 and by Ontario legislation in 1922. At that time, jurisdiction of the natural resources of the four western provinces was vested in Canada, and therefore the member for Canada acted on behalf of Manitoba. Manitoba gained active membership in 1958.

The Board was established under the Lake of the Woods Control Board Act and is reported upon here only because of its association with other water management programs.



**Participants and Funding:**

CANADA - one member  
ONTARIO - two members  
MANITOBA - one member

Canada pays one third of the Board's annual operating costs in the interest of navigation. The remaining two thirds is paid by Manitoba and Ontario in the proportion of developed hydropower head in the basin in each province.

**Arrangements:**

The Board fulfills its responsibilities by directing what the outflows from Lake of the Woods and Lac Seul (and at times the flows diverted from Lake St. Joseph) should be.

To assist it in making its decisions, the Board has traditionally maintained a full-time engineering support group in Ottawa within the Inland Waters Directorate of Environment Canada. This group was formally established as the Board's Secretariat with the signing of a Memorandum of Understanding in 1981.

To ensure two-way communication with interests within the basin, the Board has recognized a number of specific interest groups, each of which has appointed a representative to the Board. Groups represented include hydropower utilities, pulp and paper industries, native people, cottage owners, and tourist outfitters.

The Board holds public meetings each year to provide detailed information to the public and to obtain feedback on the effects of levels and flows. A phone-in information service is maintained to ensure that the public has ready access to information on current conditions in the basin. Also available are a brochure on water regulation in the basin and fact sheets on water levels for anyone planning to build a dock.

Since the Lake of the Woods is an international boundary water, the federal member of the Board serves as Member for Canada on the International Control Boards for Rainy Lake and Lake of the Woods, to ensure coordination with the United States.

**Status:**

The Board continued to manage the outflows from Lake of the Woods and Lac Seul and kept the public advised of conditions. Apart from direct regulation activities, the Board continues to improve its data collection and analysis procedures and plans to introduce mathematical modelling to assist its deliberations.

**WATER MANAGEMENT PROGRAMS**

**1. FRASER RIVER ESTUARY MANAGEMENT PROGRAM**

**Objective:**

To guide economic development while protecting the environment of the Fraser River Estuary.

**Duration of Agreement:**

October 1985 to December 31, 1990.

Participants and Funding:

A Management Committee Executive has been established representing:  
ENVIRONMENT CANADA  
FISHERIES AND OCEANS CANADA  
MINISTRY OF ENVIRONMENT AND PARKS (B.C.)  
THE FRASER RIVER HARBOUR COMMISSION  
THE NORTH FRASER HARBOUR COMMISSION

The agreed total cost is \$1 250 000; annual costs to be shared equally by the five parties are not to exceed \$250 000.

The agreement also established a management committee with representation from the federal and provincial governments, municipalities, regional districts, port authorities, and Indian bands located around the estuary to oversee the implementation of the management program.

Prior Action:

The Fraser River Estuary Management Program is based on a study conducted between 1977 to 1982. The Fraser River Estuary Study examined means for accommodating a growing population and economy while maintaining the quality and productivity of the Fraser Estuary's natural environment.

Status:

The agreement provides for the implementation of several program activities: the coordinated Project Review Process, Activity Programs, a Water Quality Plan, Area Designation, and Public Consultation. Discussions are in progress to review options for renewal of the agreement, which is scheduled to expire December 31, 1990.

The Standing Committee on the Fraser River Estuary Water Quality Plan has addressed coordination of water quality work in the estuary. It has prepared a Status Report and is developing a Water Quality Plan. Key components of the plan will be water quality monitoring and the establishment of water quality objectives.

A coordinated interagency referral process is now in formal operation and so is an Environmental Review Committee. Coordination of project review is supported by a computerized central project registry.

Six Activity Programs have developed Terms of Reference and are under way. The programs involve log management, waste management, emergency management, habitat management, recreation management, and navigation and dredging.

**2. QU'APPELLE CONVEYANCE AGREEMENT**

Objective:

To complete the conveyance works begun under the Qu'Appelle Implementation Agreement (1974-1984).

Duration of Agreement:

April 1, 1984 to March 31, 1989.

Participants and Funding:

CANADA.....\$2 375 000  
SASKATCHEWAN.....\$2 375 000

**Status:** A total of \$202 530 was spent on the project in 1989-90. Some money paid for spoil pile leveling and cleanup work. The largest portion was used for the completion of the walleye fish nursery, which is required to mitigate the loss of fish spawning areas. The termination date for the agreement was March 31, 1989. As of that date the work at the project was approximately 70% finished, with \$4.1 million of the \$4.75 million spent. An amending agreement to extend the project by two years and increase funding by \$550 000 has not yet been concluded by the parties.

### **3. FRASER RIVER FLOOD CONTROL PROGRAM**

**Objectives:** To provide protection from flooding of land in the lower reaches of the Fraser River Valley and other areas upstream by rehabilitating existing dykes, constructing new dykes, increasing river bank protection, and improving internal drainage facilities.

**Duration of Agreement:** 1968 to March 31, 1995 (extended).

**Participants and Funding:** CANADA.....50%  
BRITISH COLUMBIA.....50%

(Local authorities are responsible for providing construction and access right-of-way.)

In 1974, the federal government increased its contribution to the Flood Control Program and Storage Studies from \$18 000 000 to \$30 500 000, and British Columbia agreed to increase its share by the same amount. In fiscal year 1976-77, both parties agreed to increase the funding to \$60 000 000 for each party, and to extend the agreement to March 31, 1984. In 1983-84, the agreement was extended to December 31, 1986, with no increase in funds. In 1985-86, the agreement was extended to March 1995 and funding was increased by \$41 000 000. Total funding committed to the program by both governments increased to \$161 000 000.

**Status:** Construction has been completed at Kent, Matsqui, Surrey (Serpentine-Nicomekl dams), New Westminster, Coquitlam, Abbotsford, Kamloops (Oak Hills), Surrey-South Westminster, Richmond, Pitt Meadows, Pitt Meadows No. 2, Delta, Chilliwack (Phase I), Vedder River, South Dewdney, and Glenn Valley. Construction is well advanced at Chilliwack (Phase II) and at Mission, and is about one-third complete at Coquitlam River. Estimated expenditures under the program to March 31, 1990, are \$139 000 000. The current annual funding rate is \$2 500 000 from each government.

### **4. CANADA-ONTARIO AGREEMENT RESPECTING GREAT LAKES WATER QUALITY**

**Objectives:** To renew and strengthen cooperation between Canada and Ontario in meeting the obligations under the revised 1978 Canada-U.S. Agreement and to provide for cost-sharing of specific programs that the province will undertake with the federal government in meeting these obligations, particularly nearshore surveillance, phosphorus control, and research.

Duration of Agreement:

April 1971 to March 31, 1991;  
agreement renewed in 1976, 1982 and 1986.

An initial agreement from August 1971 to December 31, 1975, authorized \$3 million for feasibility studies and joint sewage treatment technology and urban drainage research. Loans totalling \$250 million for sewage treatment facilities from the Canada Mortgage and Housing Corporation (CMHC) and the Ontario Government were also called for in the initial agreement. (Funding for municipal sewage treatment between 1976 and the signing of the new agreement in 1982 was the subject of a separate agreement with CMHC under the National Housing Act.)

The agreement was renewed in March 1976, retroactive to January 1, 1976, as a basis for establishing joint water quality objectives, and to serve to coordinate and implement federal and provincial input to Canadian responsibilities under the international agreement, and to conduct research. This agreement expired on March 31, 1980, but because a revised agreement was then under negotiation, the 1976 Agreement was extended to March 31, 1982, through exchanges of letters between ministers. The agreement was renewed in July 1982 and again on March 6, 1986.

Participants and Funding:

CANADA  
ONTARIO

The participants each pay half the cost associated with the research and surveillance programs. For each fiscal year, the total amount payable by Canada shall not exceed an amount to be agreed upon between Canada and Ontario, taking into account:

- (a) The recommendations made by the International Joint Commission relevant to the Great Lakes International Surveillance Plan as developed under the revised Canada-U.S. Agreement;
- (b) The decisions made, as a result of such recommendations, by the parties to the Canada-U.S. Agreement with respect to such surveillance;
- (c) The recommendations of the Board of Review.

The renewed agreement provides \$82.1 million for surveillance, upgraded sewage treatment, and phosphorus control programs. Each of the governments will contribute \$9.6 million for surveillance to determine concentrations of pollutants in the Great Lakes. In addition, each will give \$1.4 million to a new program to control phosphorus. Special funding in the amount of \$65 million was made available to Ontario for the period 1982-1985 to assist in the completion of municipal sewage facilities construction to meet the requirements of the Canada-U.S. Agreement. This extra funding was formalized under the 1982 Canada-Ontario Agreement. Some \$9.7 million of the original funds were not expended, and this amount was committed under the 1986 renewal agreement. Ontario and area municipalities will contribute an additional \$50.4 million to upgrade present sewage treatment facilities or build new ones.

**Status:**

In February 1981, a joint Canada-U.S. team of scientists began a comprehensive investigation of toxic substances in the Niagara River. The final report on this investigation, released in November 1984, contained 24 recommendations pertaining to point source and non-point source control, further investigations and monitoring. A detailed long-term water quality monitoring program was included. On October 30, 1986, the Niagara River Toxics Management Plan was announced and formalized by the signing of a "Declaration of Intent" in February 1987. In 1987-88, the plan was implemented. Four-party status reports on activities are released on an annual basis.

Because, as already noted, the Canada-Ontario Agreement is being undertaken to provide a basis for implementing the Canada-U.S. Agreement on Great Lakes Water Quality, a brief outline of activities under the latter agreement is also provided.

**CANADA-U.S. GREAT LAKES WATER QUALITY AGREEMENT**

**Objectives:**

To improve the quality of the water in the areas of the Great Lakes now suffering from pollution; to ensure that Great Lakes water quality will be protected in the future; and to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes basin ecosystem.

**Duration of Agreement:**

Continuous since April 1972; revised agreement signed November 22, 1978; amended 1983; 1987 Protocol signed November 1987.

**Participants:**

CANADA  
UNITED STATES

**Commitment:**

The concept of the Great Lakes basin and its human resources as an ecosystem is explicitly recognized in the new agreement. Numerical water quality objectives for some 40 compounds have been specified. Approximately 99% of the sewered population on the Canadian side of the basin is now served by adequate municipal wastewater treatment facilities. Programs to control and prevent pollution from industrial sources entering the Great Lakes System have been designed and are being implemented. A commitment has been made to eliminate the discharge of toxic substances into the Great Lakes. New interim phosphorus loading targets, defined for each lake, are designed to achieve desirable levels of water quality. Binational negotiations to ratify the loading targets and reach agreement on Canadian and U.S. programs to meet these targets were partially completed in 1983. The Protocol signed in 1987 consists of new provisions that strengthen the two governments' attack on toxic substances with new requirements to address contaminated sediments, groundwater, airborne toxic substances, and non-point sources.

**Arrangement:**

The International Joint Commission was given primary responsibility for overseeing implementation of this international water quality agreement. The Commission has established a number of boards and committees to carry out the various provisions of the agreement. Activities are carried out under four programs: Objectives Development, Controls, Assessment, and Special Projects

(including toxics, eutrophication, health hazards, etc.). The 1987 Protocol commits the two governments to coordinate implementation and evaluate progress under the agreement through semi-annual meetings.

**Status:**

In 1986, Canada and Ontario agreed on the implementation of a Phosphorus Control Supplement as recommended under Annex III of the 1978 Agreement. The Control Supplement agreed to on October 16, 1983, includes measures to both protect the upper Great Lakes and further reduce phosphorus discharges to the lower Great Lakes. The agreement ratifies the phosphorus loading targets and allocates the residual load reductions to Lake Erie between the United States and Canada.

The 1978 Agreement was reviewed following receipt and examination of the International Joint Commission's third biennial report. This report was presented to the governments of Canada and the U.S. in the spring of 1987. The review of the agreement by the two federal governments was undertaken, as in the past, in full consultation with the provinces of Ontario and Quebec, the eight Great Lakes states, and interested publics. During the latter part of 1985, the Royal Society of Canada and the U.S. National Academy of Science jointly reviewed the progress by the jurisdictions in implementing the 1978 Agreement. This joint report was helpful in the review by the governments.

The 1978 Canada-U.S. Great Lakes Water Quality Agreement was amended with the signing of the Protocol in November 1987. The Protocol reaffirms the commitment to the cleanup of the Great Lakes and outlines expanded responsibilities for the parties. Canada reports biennially to the Commission on progress made in implementing the Protocol. The first report was completed for December 1988, and the second, December 1990.

**5. SOUTH SASKATCHEWAN RIVER BASIN STUDY**

**Objective:**

To document current and emerging water and related issues in the South Saskatchewan River basin in Saskatchewan; to carry out an assessment of the water and related resources of the basin, and their current and future use; and to develop a framework plan for the conservation and management of the water in the South Saskatchewan Basin in Saskatchewan that would include the evaluation of water resource projects.

**Duration of Agreement:**

May 1986 to December 31, 1989.

**Participants and Funding:**

CANADA.....\$800 000  
SASKATCHEWAN.....\$800 000

**Status:**

During 1989-90, a report documenting the water resource management issues in the study area was completed. Several studies were also done on water quality, quantity and use.

The framework plan, which is one of the study objectives, has three components: Basin Management Strategies; Project Evaluation Procedures; and Interagency Implementation Plan.

The Basin Management Strategies consist of both long-term and short-term strategies. The latter strategies, which focus on the water resource management issues in the basin, were completed during the year. Work on the long-term strategies, which involve water resource development opportunities in the basin, was begun in early 1990.

The Project Evaluation Procedures are made up of a set of tools that enable managers to evaluate future water resource development proposals for the basin. The models (i.e., water quality, water quantity, water use) developed for the study are being documented for inclusion in a report on these procedures.

The Interagency Implementation Plan will be developed upon the finalization of the Basin Management Strategies. A detailed summary of the agencies, mandates, legislation, policies and programs as they apply to water management in the basin has been completed.

Federal and provincial authorities have been obtained to extend the study timetable from December 31, 1989, to March 31, 1991.

#### **6. CANADA-PRINCE EDWARD ISLAND ARRANGEMENT RESPECTING WATER MANAGEMENT FOR ECONOMIC DEVELOPMENT**

**Objective:** To evaluate existing water use demands and constraints; to demonstrate means of increasing water's sustainable contribution to economic development on Prince Edward Island; and to identify future development potential in the province's water resources bases, i.e., groundwater, surface water, and estuaries.

**Duration:** April 1, 1987 to March 31, 1990.

**Participants and Funding:**

CANADA.....	\$500 000
PRINCE EDWARD ISLAND....	\$500 000

**Status:** The arrangement was signed by the Minister of Environment Canada and the Minister of the Prince Edward Island Department of Community and Cultural Affairs on October 26, 1987. On the same date, a Memorandum of Understanding on Conservation and Development between several key federal and provincial government agencies was signed.

An amending agreement to increase the total funding to \$1.4 million (from \$1.0 million) and extend the expiry date by two years to March 31, 1992, has been drafted for signature by the ministers.

The work-shared arrangement deals with key water issues on the Island concerning groundwater, surface water, and estuaries.

The groundwater program addressed several problems and included drilling and testing in areas where groundwater availability is limiting economic growth; an assessment of pesticides in groundwater; and the introduction of techniques to prevent contamination of individual wells. Information from the latter project

is being used in the development of well drilling regulations for Prince Edward Island. During the next two years, the economic implications of the establishment of groundwater protection zones will be examined. Pesticide assessment will be expanded, and a study relating nitrate in groundwater to land use will be undertaken as well as remedial techniques to remove hydrocarbons from contaminated soil.

The surface water program assessed the impacts of various land use patterns on water quality and on fish habitat. Pilot projects were implemented to demonstrate techniques to improve water courses for fish habitat. Watershed inventories and water use fact sheets were produced during the year.

The estuary program continued to address several problems that affect the health of the Island estuaries vital to finfish and shellfish production. They range from obstructions such as causeways to poor water quality, in particular, bacterial contamination.

The arrangement also dealt with the problems and economics of water and wastewater systems, especially the design and operation of on-site sewage disposal. A report comparing the economics of on-site versus central site treatment was completed.

Some of the budget was designated for environmental education. In 1989-90, two videos were produced: "Water and the Economy" and "Estuaries." A display was produced on water resource issues in Prince Edward Island for group presentations.

#### **FLOOD DAMAGE REDUCTION PROGRAM**

##### **1. CANADA-MANITOBA FLOOD PROTECTION PROJECTS**

**Objective:** To increase the level of protection afforded by ring dykes in the Red River Valley communities of Rosenort, Morris, St. Adolphe, Dominion City, Emerson, St. Jean Baptiste, Letellier and Brunkild, and to provide protection to the community of Ste. Rose du Lac and the water treatment facility at Souris.

**Duration:** March 10, 1983 to March 31, 1991.

**Participants and Funding:**

CANADA.....	\$3 105 000
MANITOBA.....	\$3 795 000

**Prior Action:** Between 1967 and 1971 Canada and Manitoba cooperated in the construction of dykes around seven Red River basin towns that had suffered damages during the 1950 flood and again in 1966. Subsequent experience demonstrated, most recently in 1979, that the dykes constructed under the 1967 Agreement did not provide a sufficient margin of safety nor did they meet the standards of the Canada-Manitoba Flood Damage Reduction Agreement signed in 1976. Thus, a new agreement was signed to upgrade the seven ring dykes that had been jointly built earlier, as well as an eighth dyke, around Brunkild, which had been built and fully paid for by Manitoba.



**Status:** The agreement was signed on March 10, 1983, and a committee was formed to administer it. The agreement was amended in May 1985 to include the construction of a dyke at Ste. Rose du Lac and the upgrading of the dyke at the water treatment plant at Souris with additional funding of \$1 600 000.

With the delays in the Ste. Rose du Lac project and the international section of dyke at Emerson, a two-year extension was negotiated at an additional cost of \$800 000 (federal share: \$360 000) in order to complete the projects. The extension was signed on October 16, 1989. The earthwork and permanent pumping facilities have been completed at Brunkild, Rosenort, Letellier, St. Jean Baptiste, Morris and Ste. Rose du Lac. Upgrading has been completed at Emerson and St. Adolphe. The international segment of the dyke between Emerson, Manitoba, and Noyes, Minnesota, is now finished. The upgrading of the dyke around the water treatment plant at Souris is complete. The communication/storage facility at Morris has been finished and the emergency pumps have been purchased. The communication towers for all the communities have been constructed and the radio communication facilities are operational.

The major outstanding projects are the construction of the new segment of the dyke at St. Adolphe, the north segment of the West Lynne dyke at Emerson, and some minor upgrading at Dominion City.

## **2. MILLE ILES FLOOD CONTROL STRUCTURE**

**Objective:** To reduce the level of flood damage along the Rivière des Mille Iles in the Montreal Region.

**Duration:** December 1983 to March 1989.

**Participants and Funding:**

CANADA.....	\$5.9 000 000
QUEBEC.....	\$7.2 000 000

**Prior Action:** Studies to determine the feasibility of a flood control structure on the Rivière des Mille Iles were conducted under the Agreement Respecting Dykes and Flow Regulation Works - Montreal Region.

**Status:** The Canada-Quebec Agreement was signed on December 10, 1983. The regulation dam was operational by December 1985 and completed in 1986.

In August 1985, the ministers agreed to reallocate funds already in the agreement in order to increase funding for studies from \$30 000 to \$230 000; these studies are directed toward improving the conditions favourable to the operation of the Grand Moulin Dam. In September 1987, the federal government was authorized to extend the agreement until March 31, 1989, and in March 1988, the Quebec government obtained the same authorization. In May 1988, an exchange of letters was completed between Canada and Quebec. The extension of the agreement permitted additional work related to the operation of the Mille Iles structure, i.e., the raising of streets in Fabreville and Laval-Ouest and the continuation of studies aimed at improving operating conditions of the Grand Moulin Dam. Eligible costs under the agreement amounted to \$9.5 million of which Canada paid 45%; Quebec, 45%; and the City of Laval, 10%.