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The Canada Water Act Annual Report

1988-1989

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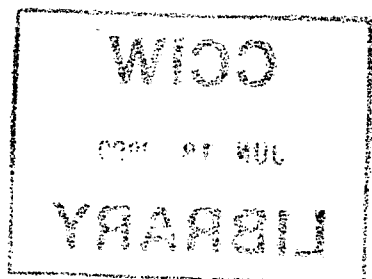
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The Canada Water Act Annual Report

1988-1989



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Ministre de l'Environnement



Minister of the Environment

Her Excellency
The Right Honourable Jeanne Sauvé, C.C., C.M.M., C.D.
Governor General of Canada
Rideau Hall
Ottawa, Ontario
K1A 0A1

Madam:

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 1988/89.

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

A handwritten signature in dark ink, appearing to read "Lucien Bouchard".

Lucien Bouchard



Sous-ministre
Environnement Canada

Deputy Minister
Environment Canada

Ottawa, Ontario
K1A 0H3

The Honourable Lucien Bouchard, P.C., M.P.
Minister of the Environment
Ottawa, Ontario
K1A 0A6

Dear Mr. Bouchard:

I have the honour to submit the Annual Report on
operations under the Canada Water Act for the fiscal year
1988/89.

Yours truly,

Len Good

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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 seventeenth annual report, covers operations to March 31, 1989.

On November 5, 1987, the Federal Water Policy was tabled in Parliament. Later in 1989, 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 and 1987-88. In 1988-89, a budget of \$9.125 million was established.

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 is an underlying principle of the Federal Water Policy, i.e., the use of the water resource today should not damage prospects for future use. 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. Most provinces plus the Northwest Territories participate in the Program. Alberta is about to sign an agreement and the Yukon has an agreement pending. Prince Edward Island is not involved, as it does not experience riverine flooding. For more information on the Flood Damage Reduction Program, see page 13.

Among all the issues addressed in the Federal Water Policy of 1987, two dominated inter-governmental discussions and public debate in the following year: funding municipal water and sewer infrastructure, and regulating water export.

Municipal Water Pricing

Provinces have tended to support requests by their municipalities for the federal government to restore its grants program for water and sewer infrastructure repair. These requests run into several billions of dollars. The need to improve municipal systems is pressing, and environmental quality would benefit greatly from it. Federal policy, however, is opposed to subsidizing municipal infrastructure, partly on constitutional grounds, partly on grounds of financial restraint (federal debt is greater than provincial or municipal debt), and particularly on grounds of water and environmental conservation. If municipalities were to charge users realistic rates for water supply and sewage treatment, that is, sufficient to cover infrastructure replacement, pressure on the environment would be reduced due to the subsequent lower water demands. The Minister

and his senior officials continue to hold firm in delivering this message to their colleagues in other governments and to national water organizations like the Federation of Canadian Municipalities.

Water Export

Water export re-emerged as a major issue during the summer of 1988. The Government of Canada moved to reinforce its position opposing major water exports through legislation, as promised in the Federal Water Policy. On August 25, 1988, the Minister of the Environment tabled Bill C-156, the Canada Water Preservation Act, for first reading in the House of Commons. The Bill would prohibit, without exception, any export, or diversion into boundary or transboundary waters for the purpose of export, of water above an average daily rate of one cubic metre per second or annual volume of 20 000 cubic decametres. The Bill would permit the Minister to consider licensing smaller exports, after undertaking environmental impact assessments and setting terms and conditions; his duties in this respect could be delegated to provincial authorities to carry out. The Bill was not intended to apply to bottled or packaged water.

Within weeks of introducing this water export bill, and before its terms could be considered by a Parliamentary committee, the Government called a general election. Consideration is currently being given to reintroducing the Bill.

Action

The Interdepartmental Committee on Water, itself restructured to serve as the focal point for coordinating the Federal Water Policy among federal departments and agencies, will report to the Minister of the Environment later in 1989 on the action under way to implement the provisions of the Policy.

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:

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

Specific policy statements to which the strategies will be applied:

1. Management of Toxic Substances
2. Water Quality Management
3. Ground Water Contamination
4. Fish Habitat Management
5. Provision of Municipal Water and Sewer Infrastructure
6. Safe Drinking Water
7. Water Use Conflicts
8. Interbasin Transfers
9. Water Use in Irrigation
10. Wetlands Preservation
11. Hydroelectric Energy Development
12. Navigation
13. Heritage River Preservation
14. Management of Northern Water Resources
15. Native Water Rights
16. Canada-U.S. Boundary and Transboundary Water Management
17. Potential Interjurisdictional Water Conflicts within Canada
18. International Water Relations
19. Drought
20. Flooding
21. Shoreline Erosion
22. Climate Change
23. Water Data and Information Needs
24. Research Leadership
25. Technological Needs

Great Lakes Water Level Communications Centre

To meet the problem of record high Great Lakes water levels, in March of 1986 the Environment Minister established the Great Lakes Water Level Communications Centre, which is located at the Canada Centre for Inland Waters in Burlington, Ontario.

In 1988-89, the Centre continued to coordinate federal activities related to fluctuating Great Lakes levels. Centre personnel responded to 300 telephone enquiries from the general public, businesses, and the media. Publications were distributed to interested individuals and groups.

The Centre also developed a series of display panels and a slide/tape show on the subject of fluctuating water levels.

In the past year, the combination of reduced precipitation and high evaporation led to a rapid decline in the lake levels. By March 1989, all of the lakes were at near-average levels, and most of them were at the lowest levels in two decades. As a result of this decline, the nature of the calls received by the Centre changed dramatically. Many of the calls during 1988-89 focused on the causes of the decline and the negative impacts on recreational boating.

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; External Affairs; Agriculture Canada; Health and Welfare Canada; Indian Affairs and Northern Development; Industry, Science and Technology; Energy, Mines and Resources; and

Transport Canada. Environment Canada chairs 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 such as:

- an Environment Canada review of its water resource legislation, with emphasis on the Canada Water Act
- the proposed Health and Welfare Safe Drinking Water Act
- proposed amendments to the Northern Inland Waters Act and the Navigable Waters Protection Act
- a proposed Environment Canada Wetlands policy
- the Canadian Environmental Protection Act.

The Interdepartmental Committee on Water has been designated in the Federal Water Policy as having the responsibility to monitor and advise on the policy's delivery and its evolution with changing national and public perceptions of freshwater priorities. The ICW is required, therefore, to report on relevant activities of federal departments to the Minister of Environment Canada.

The committee has established a Working Group on Policy Implementation and Reporting to report on federal activities undertaken in support of the Federal Water Policy. The first report by the ICW is expected to be delivered to the Minister of the Environment in the fall of 1989.

Following the adoption of its new mandate, the committee found it necessary to reconsider its requirement for subgroups. Consequently, the ICW Subcommittees on Flooding and Water Quality were disbanded. Four subgroups continue to report to the ICW: the Great Lakes Working Group; the Working Group on Responses to International Joint Commission reports; the Mackenzie River Basin Subcommittee; and the new Working Group on Policy Implementation and Reporting.

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

Regulation, Apportionment, Monitoring and Survey Programs

<u>Under Negotiation</u>	<u>New During 1988-89</u>	<u>Ongoing During 1988-89</u>
Water quality monitoring agreements with Saskatchewan, Prince Edward Island, Nova Scotia, Ontario, and Alberta	Water Quality Monitoring Agreement with New Brunswick and Manitoba Agreement 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 and Newfoundland 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 1988-89</u>	<u>Ongoing During 1988-89</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		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 1988-89</u>	<u>Ongoing During 1988-89</u>
Initial agreements with Alberta and Yukon Territory Amending General, Mapping/Studies agreements with Manitoba, Nova Scotia, and Ontario Amending Agreement for Manitoba Flood Protection Projects	Extension of Mille Iles Flood Control Agreement	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.

‡ 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.

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 the Department of Indian Affairs and Northern Development 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 2887 gauging stations, including 140 for sediment observations, were operated under the agreements in Canada, 2598 by the federal government and 289 by the province of Quebec. Data from these stations as well as from 558 stations operated mainly by other provincial agencies are contained in the national water data bank - HYDAT; the data bank also contains data for another 4187 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 cost savings and more efficient service to interests such as 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

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

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

Atmospheric Environment Service and other agencies. As of March 31, 1989, approximately 400 active DCPs were in operation; by the end of 1989, the active total is expected to increase to about 425.

A proposal was developed for a major modernization of the data service involving digital electronic data loggers instead of analogue recorders as well as gradual increases of telemetry. Preliminary planning is under way.

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 providing summary statistics.

Water Quality Monitoring Agreements

Environment Canada has been negotiating water quality monitoring agreements with interested provinces to provide for sharing of work, exchange of data and a Canada-wide analytical quality control program. Agreements have been signed with Quebec, British Columbia, Newfoundland, New Brunswick and Manitoba; negotiations are complete with Nova Scotia, Prince Edward Island and Saskatchewan, and it is expected that these agreements will be signed in the late fall of 1989; negotiations are continuing with Alberta and Ontario. Negotiations with the two territories are complete but must await a resolution of the funding issue.

If all provinces join the program, the new network is expected to incorporate 450 existing stations of federal interest, upwards of 2000

existing stations of provincial interest, and about 180 new stations of joint interest. In addition, some agreements include cost-shared surveys or special studies to best address existing or emerging issues of joint concern. The proposed stations exclude Great Lakes water quality stations which are administered under other agreements. In March 1983, Treasury Board approved the resources required to implement the agreements in all of the provinces. The Yukon and Northwest Territories require separate funding.

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. During the year, the Board's Committee on Hydrology recommended procedures for natural flow determination for apportionment purposes and for evaluating 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 interprovincial matters involving water quality and ground water. A four-year study of historic and current water demands in the three prairie provinces was completed in December 1982 and that information is being updated. The Board also has approved the report on Administration of the Apportionment Agreement and has implemented the recommendations on apportionment of the flow of Battle, Lodge and Middle creeks at the Alberta-Saskatchewan boundary.

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, 1989, authority to conclude the agreement had not been reached.

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 Iles 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 be responsible for reviewing data needs and for coordinating data collection through a joint monitoring program. The Board's first report contained an analysis of monitoring data from the past several years. Its second report, to be released in June 1989, reviews progress made in controlling pollution from the forest industry and municipal sources.

Garrison Diversion Studies

In support of the Department's monitoring of the Garrison Diversion Unit in North Dakota, the Water Planning and Management Branch, Inland Waters Directorate, reviewed three reports to identify Canadian concerns. The reports included the U.S. Bureau of Reclamation's report entitled "Water Supply and Delivery System Study - Southern McClean and Sheridan Counties," and the

North Dakota State Water Commission's reports "Devils Lake Outlet Committees' Final Recommendations" and "Mid Dakota Reservoir Development Plan." This information is being used by External Affairs in its continuing Canada-United States dialogue on the Garrison irrigation project.

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.

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 1988-89, 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.

In 1987, a preplanning study designed to describe the basin water resources of the Yellowknife River basin was initiated. The first draft report of the study was completed in December 1988. A final report should be completed in 1989-90. In March 1989, an interagency working

group, with the participation of Environment Canada, the Department of Indian Affairs and Northern Development, and the Government of the Northwest Territories, submitted a draft study proposal to develop a prototype management plan for the Yellowknife River basin based upon the principles of sustainable development.

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 final report is scheduled for December 1989, although an extension may be requested.

During 1988-89, a number of important baseline studies were completed to document water quality, supply, and use data and catalogue water development proposals. Analytical tools such as water quantity simulation, water use, hydro-electric power, and a dynamic river ice model (the ONE-D model) were also under development during the year. Further refinement and application to the evaluation of water management alternatives for sustainable resource development are planned for 1989-90.

Planning was completed for a Battle River Study that will involve Canada, Saskatchewan and Alberta collaboratively describing longitudinal and seasonal changes in water quality and identifying major inputs of materials to the river. The study will also assess the suitability of media other than water for monitoring selected chemicals.

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 project coordinated by a federal-provincial committee, with each party contributing \$500 000 worth of work. The studies include special surveys and demonstration projects related to ground water resources, inland surface water resources, estuarine water resources, and multi-sectoral and integrated water management. A final report is scheduled for September 1990.

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 1987-88, 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, 1989, 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 the Department of Indian Affairs and Northern Development 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.

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. While these negotiations were under way, work continued under Environment Canada's five-year NFA ecological monitoring program.

During 1988-89, studies were conducted on waterfowl, water quality, hydrology, sediment, mercury, and the ice regime. Results of these and other studies from this program have been published in the Northern Flood Agreement: Ecological Report Series, and given wide distribution. To date, 18 reports have been prepared and five are currently in preparation. All studies undertaken, as well as those planned for the remaining two years of this program, have been developed and submitted to a four-party Program Advisory Board for discussion.

Implementation Programs: Although no new implementation agreements were initiated in 1988-89, several programs continued owing to agreements in earlier years, including a renewed Canada-Ontario Agreement on Great Lakes Water Quality which extends to March 31, 1990. 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 fourth 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 1988-89, construction of the walleye fish nursery to mitigate fisheries impacts was 80% completed and spoil pile leveling/cleanup work continued.

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. Canada and Saskatchewan had not obtained their respective authorities for the extension as of March 31, 1989.

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 \$134 million of a total joint commitment of \$161 million was spent by the end of March 1989.

Flood Damage Reduction Program

During 1988-89, this program was active throughout most of Canada.

Objective: The Flood Damage Reduction (FDR) Program follows the cooperative federal-provincial approach of the Canada Water Act. Its overall aim is to reduce flood damages. The first step is to identify flood risk areas and discourage further flood-vulnerable development in those areas. Where existing development warrants it, a second step may be to provide remedial measures.

When joining the program, the provinces sign a General Agreement and a Mapping Agreement (or a combined 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 disaster assistance will be restricted to structures built before designation and, in some circumstances, new structures which are flood-proofed. Zoning on the basis of the flood risk is encouraged.

The Mapping Agreement provides for the flood risk mapping and designation of the areas to which the policies in the General Agreement will apply. Forming part of this agreement is a list of communities in the province which are to be mapped and specifications to be followed in con-

ducting 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. This agreement also requires 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. As a matter of course all flood risk maps and reports are distributed to key federal departments represented on the Treasury Board Advisory Committee on Federal Land Management and to a number of federal departments whose programs could be affected by FDR Program designations. Designations to March 31, 1989, 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 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. At the conclusion of 1988-89, Alberta was about to sign an agreement.

In 1988-89, the Canada-Quebec Agreement Respecting Flood Damage Reduction on Mille Isles River was amended.

Participants and Funding: Canada and the provinces share the costs (see 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. 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

Canada and Alberta obtained their respective authorities to conclude a \$5.5 million six-year Flood Risk Mapping Agreement. Previous flood risk mapping of 19 communities done by Alberta Environment was reviewed and accepted. Thirty-three other communities requiring new flood risk mapping were identified under the proposed program. All federal reviews and approvals are complete, and the agreement is scheduled for ministerial signatures in early 1989-90.

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.

In 1988-89, nine new designations were made, bringing the total to 44 designations. Also, seven additional floodplains were mapped, and a brochure describing the major features of the agreement was produced and distributed.

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.

During 1988-89, Canada and Manitoba negotiated an extension of the General, Mapping, and Studies agreements until 1996, with additional funding of \$700 000 (federal share: \$350 000), and provision for the development of a low-cost maintenance phase for the program. As of March 31, 1989, federal authority had not been obtained for the extension.

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). As of March 31, 1989, federal authority had not been obtained for the extension.

Under the Flood Protection Projects Agreement, significant progress was made on the mitigation works at Ste. Rose du Lac. This project was delayed for two years because of some local opposition to the land acquisition required for the project.

Other flood protection projects at Brunkild, Letellier, Morris, Rosenort and St. Jean Baptiste have been completed. The emergency communications system has been installed and the storage facility at Morris is complete.

An agreement was reached with Manitoba and the U.S. Army Corps of Engineers for the construction of the international segment of the Emerson-Noyes dyke. Good progress has been made on this project.

New Brunswick

There was little or no flooding along the Saint John River during 1988. An early and gradual release of snowmelt, coupled with a lack of any significant rainfall event, produced water levels which reached near record low proportions. In response to concerns raised following the ice jams of 1987, communications among the various federal, provincial, municipal, private and U.S. participants significantly improved during the year.

Hydrotechnical studies, which focused on documenting historical floods, were successfully completed for the Nashwaak and Kennebecasis River basins under the Mapping and Studies Agreement. Several brochures and posters were completed to more fully inform the public about flooding and the aims of the flood damage reduction program. A comprehensive booklet on floodproofing was completed, and a video on floods in New Brunswick is being produced.

Newfoundland

Hydrotechnical studies have been completed for Stephenville Crossing/Black Duck, Waterford, Cox's Cove, Parson's Pond and Cox's Pond. Studies are under way for Glenwood/Appleton, Glovertown, Cordroy Valley, and Bishop's Falls. Terms of Reference were prepared for the hydrotechnical study of the Trout River area, the last area on Schedule A to be mapped.

Base mapping has been completed for the Cordroy Valley and Trout River. Revisions were made to the Placentia public information map.

Two studies were undertaken during the year regarding remedial measures at Placentia. Negotiations for funding of implementation works are ongoing.

Nova Scotia

The focus this year was public information. Public meetings were held regarding the previous Truro and Sackville designations.

Several meetings were held with federal and provincial departments and agencies regarding highway construction across the East River of the Pictou floodplain.

Terms of Reference were prepared for a hydro-technical study of the Kentville area. Upon reconsideration, it was decided not to undertake a study for this area.

In 1988-89, Canada and Nova Scotia commenced negotiations to amend the General, Mapping and Studies agreements to include a maintenance component.

Ontario

During 1988-89, the Canada/Ontario FDR Program funded 43 projects. Of these, 27 were for flood risk mapping of riverine areas, 11 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 five additional flood risk areas. The Steering Committee also recommended designation in 12 other areas on a community and basin-wide basis.

To date, there have been 25 designations, involving 97 communities and 84 public information map sheets. Currently, work is in progress on behalf of 27 Conservation Authorities and 15 municipalities where no Conservation Authorities exist.

Two studies were completed to improve procedures in flood risk mapping and flood forecasting for Ontario's water courses. The first, the Ice Jam Frequency Study, addressed the probabilities

associated with riverine flooding due to ice jams. The second, the Radar Study, will assist Conservation Authorities to estimate more accurately basin snow cover for use in flood forecasting systems.

The program continued funding three regional hydrology studies on the Grand River, Spencer Creek and Niagara Peninsula watersheds. These studies will provide design flows for floodline mapping at various locations in each of the basins, including previously identified flood damage centres.

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. Work continued on acquiring the aerial survey database for topographic mapping of the shoreline. In 1987-88, horizontal control was completed for 800 km of shoreline. This was complemented by vertical control surveys and aerial photography for the same stretch of shoreline. Work has continued to complete ground surveys, aerial photography and aerial triangulation.

Preparation of floodline maps for shoreline areas will proceed on a priority basis. Design water levels to be used on the maps were calculated for various Great Lakes shoreline reaches.

During 1988-89, Canada and Ontario commenced the negotiation of an amended Flood Damage Reduction Agreement in order to complete high priority mapping and provide for the development of a low-cost maintenance program.

Quebec

Construction of the Grand Moulin Dam was completed in 1986 under the Agreement respecting flood damage reduction on the Mille Iles River. The ministers agreed, through an exchange of letters dated August 15, 1985, to reallocate funds provided for in the agreement in order to increase funding for studies from \$30 000 to \$230 000. These funds are being used to finance studies aimed at increasing the operating

capabilities of the control structure by improving the regulation of some reservoirs on the Ottawa River. In May 1988, the initial termination date of the agreement was extended until March 31, 1989, in order to carry out 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 the operating conditions of the Grand Moulin Dam.

The new agreement concerning mapping and floodplain 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. The Bas-Richelieu designation of November 18, 1981, was revised on June 15, 1988.

Saskatchewan

The Steering Committee recommended and the ministers agreed to designate flood risk areas in Melfort and Radville.

The program completed a hydraulic study for Tisdale and a hydrotechnical study for La Ronge/Air Ronge. A floodplain management study for Regina was initiated, with a report to be completed in 1989-90.

Several studies have been completed under the Mapping/Studies Agreement, and designations will

Table 3. Designations to March 31, 1989, under the Flood Damage Reduction Program

Location	Number of Communities Mapped	Number of Public Information Maps	Date of Designation
British Columbia			
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
44 designations			
Manitoba			
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
New Brunswick			
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
Walker Brook*	2	1	March 1986
8 designations	55	8	
Newfoundland			
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
7 designations	13	7	
Nova Scotia			
East River*	5	1	February 1984
Sackville River*	3	1	February 1984
Antigonish*	2	1	November 1984
Little Sackville River*	3	1	May 1987
Truro*	8	1	March 1988
5 designations	21	5	
Ontario			
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
25 designations	97	84	

be recommended when the local official and public information programs are completed.

Northwest Territories

A draft Canada/N.W.T. Flood Forecasting Sub-Agreement, under the General Agreement, was prepared by a Working Group representing the Government of the Northwest Territories, and the federal departments of Environment, and Indian Affairs and Northern Development.

A report on the 1985 Hay River Flood was released by Environment Canada. Conclusions support the need for a flood warning system for the Town of Hay River, and a recommendation is made for redesignation of the floodplain within the Town, under the FDR program.

The Phase I report was completed of a study of ice breakup, ice jamming, and ice jam reduction methods. Entitled "Ice Jams and Flood Forecasting, Hay River, N.W.T.," the report was prepared by the University of Alberta, under contract to Environment Canada, and Indian Affairs and Northern Development. A first generation flood forecasting algorithm was proposed and conclusions drawn on causes for ice jams leading to flooding. Phase II of the study will proceed in 1989-90.

Under a study funded jointly by Environment Canada and Transport Canada, daily forecasts of water levels and flows on the Mackenzie River, mainly for navigational purposes, were prepared and issued to 11 users from June 1, 1988, to October 17, 1988. The information is used by navigational companies as well as river communities.

On-site assistance was provided to Flood Watch Committees for the Town of Hay River and the Village of Fort Simpson during spring breakup.

Yukon

Work toward an initial agreement with Yukon remained suspended, pending its review of issues with respect to proposed designations in the Territory.

Indian Lands

A short Memorandum of Understanding between Environment Canada and Indian Affairs and Northern Development (DIAND) was signed in May 1985, to allow interested Indian bands, with the support of regional offices in DIAND, 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 expires on March 31, 1990. In this instance, designation, which is intended to restrict flood prone development in flood risk areas, is not required.

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 \$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 this past year.

In Ontario, a Flood Risk Assessment for southern Ontario Indian communities was completed as a follow-up to the more detailed study done for northern Ontario, in which extensive field information on historical flooding was collected. For southern Ontario, a total of 21 communities were assessed, ten of which were identified as priority areas for further investigation and possible flood risk mapping. Based on the recommendations of the two studies, floodline mapping projects were initiated for the communities at Lansdowne House and Summer Beaver in northern Ontario, and at Rama in southern Ontario. Several other areas identified are

Table 3. Concluded

Location	Number of Communities Mapped	Number of Public Information Maps	Date of Designation
Quebec			
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
<u>Trois-Rivières-Ouest</u>	<u>1</u>	<u>5</u>	August 1984
12 designations	185	100	
Saskatchewan			
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
<u>Radville</u>	<u>1</u>	<u>1</u>	June 1988
6 designations	6	6	
Northwest Territories			
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
<u>Tuktoyaktuk</u>	<u>1</u>	<u>1</u>	March 1988
9 designations	10	9	
Total			
132 designations	403	233	

Table 4. Federal-Provincial Flood Damage Reduction Agreements to March 31, 1989

	Duration (years)	Total Cost* (dollars)	Expiry Date
British Columbia			
Floodplain Mapping Agreement	(general 10) (mapping 5)	- 5 000 000	1998 1993
Manitoba			
General Agreement	17	-	1994
Flood Risk Mapping Agreement	11	2 350 000	1988
Studies Agreement	12	310 000	1989
Flood Forecasting	8.5	1 000 000	1989
Construction of Flood Protection Projects Agreement	7	6 100 000(b)	1989
New Brunswick			
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
Newfoundland			
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
Nova Scotia			
General Agreement	16	-	1994
Flood Risk Mapping Agreement	11	1 030 000	1989
Studies Agreement	11	670 000	1989
Ontario			
Flood Damage Reduction Agreement	(general 17) (mapping 12) (other 14)	- 15 400 000 2 200 000	1995 1990 1992
Quebec			
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
Saskatchewan			
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
Northwest Territories			
Memorandum of Understanding	2	225 000(c)	1978
Memorandum of Understanding	14	400 000(c)	1993
General Agreement	(mapping 9) 14	-	1988 1993

* 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 the Department of Indian Affairs and Northern Development.

currently being considered for mapping projects next year.

In British Columbia, a historical flood review involving 30 Indian communities was carried out at a total cost of \$40 000.

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; new 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 Support divisions.

The Institute's current research projects address eight general water research issues. Highlights of the 1988-89 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 1988-89.

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, such as degradation, volatilization, adsorption and bioaccumulation of contaminants are studied in relation to physical dynamics and other important limnological factors. The results will be used to assess pollution impacts and the feasibility of remedial plans.

The analysis of suspended sediments entering Lac Saint-François and Lac Saint-Pierre and of bottom sediments in these major riverine lakes of the St. Lawrence River has revealed that more than 90% of the PCBs (polychlorinated biphenyls) associated with the suspended sediments are not retained in the lakes. The sediment deposits are transitory in Lac Saint-François. PCB concentrations in lake sediments averaged 135 nanograms/gram (ppb), representing approximately 80% of the total organochlorine content of these sediments.

Large-volume water samples collected at the mouth of the Yamaska and Saint-François rivers were analyzed for important industrial chemicals and pesticides. Preliminary results have revealed that substantial inputs of atrazine and some organophosphate pesticides are discharged into the St. Lawrence River.

A process that may affect the rate of organic contaminant degradation in the water column was investigated in Lake Erie and several small lakes in the Great Lakes basin. This process involves the formation of hydrogen peroxide (H_2O_2) and superoxide (O_2^-) as a result of photochemical interaction with dissolved organic matter and oxygen. These strongly oxidizing compounds could increase the effect of toxic contaminants on microbial and algal metabolism. The distribution of hydrogen peroxide in the water column and the daily pattern of production and disappearance are currently being monitored.

Lake Restoration

Research continued on evaluation of remedial options for restoring the ecological integrity and human use of lakes and embayments after they have been polluted. 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. The relationship between water clarity and algal production and land runoff has been established for several zones in the harbour. These relationships have permitted the establishment of water clarity objectives that will lead to increases in desirable macrophyte habitat. Burial of contaminated sediments by new "clean" sediments was discovered to be very slow, either because of continuous inputs of contaminants or resuspension of sediments in the harbour. This was further demonstrated by the observation that, on an annual basis, less than 30% of the iron input was retained in the harbour sediments. The collective knowledge of the project is being applied to the analysis of remedial options for cleaning up and maintaining a healthy and usable aquatic resource.

More research has been carried out to verify the hypothesis that higher nutrient concentrations in lakes lead to lower contaminant concentrations in biota under similar contaminant loading regimes. An early indication of this effect was reported last year and further investigation has confirmed the inverse correlation between spring total phosphorus and the concentrations of a wide variety of organochlorine compounds in zooplankton collected from lakes exposed to similar atmospheric sources of organic compounds (e.g., PCBs, DDT family, chlordane, lindane, and α -BHC). This knowledge could eventually affect both nutrient control strategies and fisheries enhancement projects that may be proposed as part of the lakewide management plans being prepared for the Great Lakes through the International Joint Commission.

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, and biotoxicity. Ongoing results will be used for evaluating remediation options in specific areas of concern in the Great Lakes and elsewhere.

One of the present practices for the management of contaminated sediments is to dump them into confined disposal facilities (CDFs) near the shoreline. When a CDF is full, vegetation colonizes the site naturally or it is landscaped for some purpose (e.g., a park, an industrial area, etc.). A study completed this year found that the concentrations of heavy metals in foliage collected from several CDFs in the Great Lakes basin exceeded normal urban levels, whereas those of organic contaminants (PCBs and PAHs) were the same. The study identified certain plant species that accumulated the greatest amount of metals. This information will be used to develop recommendations on the selection of landscaping materials to minimize the transfer of contaminants from the soil to the plant cover.

The concentration of lead in surface sediments of Lake Ontario appears to be declining. The results of the analysis of 20 cores from the three main depositional basins show that the levels in sediments started to decline in the strata deposited in the mid-1970s, at about the time when unleaded gasoline was introduced throughout North America.

Ground Water Contamination

Ground water 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 ground water flow in the Niagara area.

During the past year, physical, chemical and biological processes influencing contaminant transport in granular aquifers have been studied. Results will be 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.

Additional studies were completed on contaminant transport in fractured rocks. A study was done on ground water contamination by petroleum products in Sarnia, Ontario, and a technique was developed to differentiate natural petroleum deposits from refinery wastes that were injected in deep wells in the area. Extensive expert advice was also provided to U.S. and Canadian agencies concerning ground water issues.

In collaboration with Inland Waters Directorate/ Atlantic Region, reconnaissance hydrogeological studies were carried out on the Sheffield Farm in Nova Scotia. A description of the studies is given on page 35. In the near future, a protocol should be developed for field testing of pesticides (e.g., aldicarb, atrazine, dichloropropane, dinoseb and carbofuran) suspected of contaminating ground waters.

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.

Previous studies on tributyltin (TBT), an extremely toxic compound used as an antifouling agent in marine paints, continued. Caged freshwater mussels were used to monitor the availability of TBT in Oshawa Harbour and Whitby Harbour. Preliminary results showed that TBT was accumulating in caged mussels from both harbours.

The biodegradation of TBT compounds was studied using a mixed bacterial culture from activated sludge. Biodegradation occurred under both aerobic and anaerobic conditions, and was faster under anaerobic conditions. A limited ban on aquatic use of TBT by Agriculture Canada went into effect as of February 28, 1989.

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. Current priorities are geared toward the upcoming National LRTAP (Long Range Transport of Airborne Pollutants) Assessment. The National Assessment Report is required by the federal/provincial Research and Monitoring Coordinating Committee (RMCC) by March 1990. At NWRI, a working group has been organized, with participants from the Atmospheric Environment Service, Fisheries and Oceans, 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.

Regional models of watershed acidification have been implemented for southern Quebec and the Atlantic provinces using data from federal and provincial monitoring programs. The regionalization method was tested with data from Quebec, New Brunswick and Nova Scotia. Predictions for Quebec and New Brunswick, using the appropriate soil-sensitivity-water chemistry relationship, were confirmed with observed data. For Nova Scotia, however, a correction had to be introduced because of the presence and influence of organic acids. Scenario predictions for a number of emission control strategies were prepared.

Air-Water Interactions

Evidence is mounting that pollutants in the atmosphere are evoking major changes in 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 from, and volatilization to the atmosphere of persistent organic substances and is also evaluating the effects of long-term climate change on the thermal regime and the water quality of the Great Lakes.

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 tests with lindane and nine other organochlorines were completed.

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.

The remains of freshwater ostracodes (small crustaceans) in sediment cores from small lakes in the prairie region have been used to establish historical changes in local climate and water levels. Ostracode sediment profiles will be used to assess the hydrological effects of climate warming episodes over the last 10 000 years as a guide to those effects which could be expected in any future climate warming.

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 1988-89:

- A gas chromatographic method for the determination of 14 chloronitrobenzenes in water and fish samples
- A gas chromatographic method for the analysis of 31 chlorinated phenolics in paper mill effluents
- A gas chromatographic method for the determination of chloroanilines and aniline
- An automated flow injection analysis - colorimetric method for low levels of boron in water
- A robotic system for the automated analysis of large numbers of samples
- The supercritical fluid extraction of 2,3,7,8-tetrachloro dibenzo-p-dioxin from sediment samples.

The Institute was also extensively involved in analyzing the aftereffects of the Saint-Basile-le-Grand PCB fire in Quebec. Water, sediment and swab samples were analyzed for

polychlorinated biphenyls, dioxins and furans to determine the extent of dioxin/furan formation and the associated level of contamination. A special quality assurance study was also undertaken to establish comparability among the various laboratories generating the analytical data that were used to monitor contamination levels as a result of the PCB fire.

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.

At the request of the National Dioxin Task Force, a detailed quality assurance protocol was developed for dioxin analysis in pulp and paper mill effluents.

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 modified oxygen-uptake toxicity assay for lake sediments was also developed, as was a high-performance liquid chromatographic procedure for the adenylate energy charge stress test in microorganisms.

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

Existing models of the hydrodynamics and transport of fine sediment particles were 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. None of the existing models was found to be capable of predicting realistic behaviour of fine sediment transport.

Improvements to wave forecasting and wave climate prediction models were made. The WAVES (Water-Air Vertical Exchange Studies) field project, undertaken jointly with the Woods Hole Oceanographic Institute, was completed successfully. Analysis of mixing processes beneath the water surface, directional wave properties, and statistics of shoaling waves is now under way. An extensive review on "air-sea interaction" was completed.

NATIONAL HYDROLOGY RESEARCH INSTITUTE

The role of the National Hydrology Research Institute (NHRI), located in Saskatoon, Saskatchewan, is to undertake research into aspects of hydrology and aquatic ecology that enable better management and conservation of water resources. The three phases of water - vapour, liquid, and solid (snow and ice) - are addressed. Scientists carry out investigations to understand the various physical processes at work and to determine the laws that govern them. This knowledge is then incorporated into models of various segments of the hydrological 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.

NHRI's research activities are organized into three major programs: hydrological processes and climatic change, sustainable development, and northern water systems. Environment Canada has identified these as priority areas. The organization of activities in this way allows NHRI scientists to examine environmental issues and problems from a multidisciplinary point of

view. Within these programs, specific concerns are addressed as projects and studies.

The management structure of the Institute consists of three scientific divisions: the Hydrology Division, the Aquatic Ecology Division, and the Ground Water Division. Their work is supported by the Staff Services Division, Research Support Division, and the new Scientific Information Division, which is responsible for providing communication and information services to internal and external groups.

NHRI is located at the National Hydrology Research Centre, which also houses the Hydro-meteorological Research Division, Canadian Climate Centre and 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, joined the Centre in 1988-89, to assist NHRI and other tenant groups with communications activities.

Hydrology Research

Microwave Remote Sensing

Remote sensing techniques are being applied to studies of prairie snow cover and the influence of snow structure on the absorption and reflection characteristics of electromagnetic signals. Researchers have modified a microwave model to simulate emission from up to three layers and from five different surfaces of land, water, ice, and snow. By defining functional relationships between remotely sensed data and other variables (microwave regression), researchers can more readily assess natural conditions.

A method to account for snow structure by incorporating snow cover duration in the algorithm for snowpack water equivalent was developed. This has potential for improving the accuracy of snowpack measurement. It was also shown that spring runoff can be estimated from Nimbus 5 satellite microwave observations for mountains, foothills,

plateaus, and plains in western Canada. The forecast accuracy is shown to rival the conventional snow course method involving ground observations.

Multi-Satellite Monitoring of Hydrologic Processes

Recession of meltwater on the clay plain was monitored by microwave satellite. This recession was compared with ground observations of different water recessions. "Dynamic runoff characteristics" were determined for four target areas in Manitoba. The characteristics are correlations of microwave polarization, sensing wetted area, to the accumulated runoff/precipitation ratio. They are necessary components of any integrated remote-sensing runoff model.

Microwave-satellite correlations were developed for monitoring monthly streamflow from three plains watersheds. The correlations used Nimbus 5 satellite observations for 1973-76, normalized with respect to surface air temperature measurements. The relations detected at least three levels of basin moisture over the period April to October. An automatic surface weather station was established at the Canadian Wildlife Service refuge at St. Denis, near Saskatoon, in cooperation with McMaster University and the Atmospheric Environment Service. The data will be used for establishing surface relationships between hydro-meteorological variables, which will subsequently be used for interpreting satellite observations.

Proxy Climate Data from Ice Cores

An ice core obtained by NHRI from atop Mount Logan in the Yukon contains a record of temperature, precipitation, and the gases and aerosols in the atmosphere for about 300 years. Preliminary studies of the core show a good correlation with well-known precipitation data from Saskatchewan and from stations in the wooded steppe of the Soviet Union.

A new core site has been identified on Mount Logan. The site is known as PR Col and is at about 5300 m a.s.l. Work continued on processing upper air data, obtaining X coefficients between

Mount Logan precipitation time series and instrument data from the Northern Hemisphere, cross correlating data sets, and analyzing meteorological data for Alaska and the Yukon. The manufacture and assembly of the new control system for the Canadian Rufli-Rand ice-core drill is approaching test readiness with the completion of the winch hydraulic drive train.

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 Tiedemann 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.

Irrigation Return Flow

Analysis of 1986-89 results has been completed and a final report has been prepared. A joint research project with Agriculture Canada has been approved for funding by the Saskatchewan Agricultural Development Fund (jointly funded by Canada and Saskatchewan) to study the potential environmental impact when irrigating with low pressure (high rate) sprinkler systems.

Agricultural Land Drainage Processes

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 Prairie Farm Rehabilitation Administration, a site was instrumented to study snowmelt infiltration on a coarse textured soil for the purpose of recharging a shallow aquifer that serves a district

community. Analysis of 1987-88 data is finished and the annual report has been completed.

Interactions in Streamflow

A study on the impact of various flow regimes on growth rates and biological feedback in algae growth was designed to be conducted in the experimental troughs at Chase, British Columbia. Large (order of magnitude) differences were noted in the accumulated algal biomass for various flow regimes. The biomass differences appear to be due solely to differences in the physical flow regimes.

Transport of Suspended Sediment in Rivers

Parametric testing of suspended sediment samplers has been completed at the experimental site on the North Saskatchewan River at Borden. Particle sizing analysis of the samples was completed. Using preliminary scaling parameters, a new sampler has been designed for a one-month integration period in the river.

Snowmelt Runoff in Permafrost Basins

Data collection at Inuvik and Resolute Bay, N.W.T., included snow surface energy balance, snow and soil temperature, snow survey, monitoring snow metamorphism, total soil moisture (frozen plus liquid) using gamma probes, and liquid water in the frozen soil using TDR (time-domain reflectometry). These data provide very 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 the exchange of water between the active layer and the underlying permafrost, snow energy balance, and snowmelt runoff.

River Ice Breakup Advance

A field survey was conducted on the Liard River in April 1988, during the annual spring ice

breakup. Weather conditions did not favour formation of a rapidly moving breakup front. Flow and water-level data, and ice strength data from 1987 were analyzed. Preliminary engineering design has been completed for the *in situ* testing of ice flexural strength under decaying conditions. An experimental methodology has been completed for the *in situ* measurement of far-field global ice sheet forces produced by pre-breakup hydrodynamic processes. Heat balance and radiation (including underwater) balance systems have been assembled and tested for field use in fall of 1989.

The Liard River survey data have been transferred from raw form, analyzed and are now being summarized. Development of field methodology for the lake study (ice strength/radiation driven decay) is progressing well, with the completion of the final design for a field device which measures the flexural properties of ice. A complete field program that included documentation of the energy and radiation balance and changes in the flexural strength of decaying ice was carried out at Floral Pond, Saskatchewan, near Saskatoon.

Mackenzie Delta Hydrology

This year's field work in the Mackenzie Delta, which included measurements of lake flooding and water levels at sites in the northern and southern delta, provides essential data on the sill elevation of lakes. In conjunction with similar data already obtained for the middle delta, these data will allow the quantification of changes in lake regime along the north-south axis of the delta.

Ongoing analysis is concentrating on the effect of changes in sea level on the delta water levels, determining the sediment regime of delta lakes, and five years of lake-regime data. Work on the sediment regime of delta lakes has resulted in a report on lake sedimentation rates. In addition, a report on the statistical analysis of long-term water-level data has determined the frequency, timing, and duration of lake flooding. The information has allowed, for the first time, quantification of a lake classification system.

This is important in determining the environmental impact of water level changes on the delta lakes. The influence of storm surges on water levels in the Mackenzie Delta has implications with respect to understanding the effect of rising sea level on the delta hydrological regime.

Ground Water Research

By-products of industry and urbanization affect surface and ground water quality. NHRI scientists are studying the pathways of contaminants, their decay products and processes. For sustained use of water resources, environmental relationships must be understood so that the effects of pollutants can be mitigated.

Pesticides in Ground Water

To determine whether there is a widespread common problem concerning pesticide/ground water interactions in Canada, NHRI established several field sites across Western Canada at a number of "worst-case" sites, where natural conditions and known pesticide usage together produce the highest chance of ground water contamination. These sites are established at Abbotsford and Osoyoos, British Columbia; Taber, Alberta; and Nokomis and Outlook, Saskatchewan. In 1988-89, the preliminary results indicate no evidence for the existence of a common pesticide/ground water problem in the prairies where precipitation is low, but good evidence that there is a problem in the more moist climatic conditions of British Columbia. Irrigation practices appear to have no effect on the incidence of contamination.

However, practically nothing is known about what is happening to the pesticides between the bottom of the root zone and the water table. Possible processes include adsorption, and decay into other compounds by chemical and microbiological action, among others. The relative effects of these processes will form the focus of future research. Reports documenting these conclusions are being prepared and will be available in 1989-90.

In 1988-89, NHRI used the geographic information system SPANS in a pilot study to produce a series of maps and a report showing the vulnerability of an area of southwest Manitoba and southeast Saskatchewan to ground water contamination by pesticides. The SPANS system compiles the information from these various databases (e.g., LANDSAT, Statistics Canada, Agriculture Canada) into maps showing the relative vulnerability to pesticide contamination of the ground water systems. Initial evaluation indicates the SPANS methodology is both viable and economic for regional assessments of ground water contamination by pesticides.

Organic Contaminants in Ground Water

NHRI took a major step this year toward overcoming the high cost of obtaining reliable, reproducible analyses for the contaminants of concern (and their potential breakdown products) at very low concentration levels, through the acquisition of MICROTOX equipment. Ground water and soil-water samples from the hydrogeological studies at Sheffield Farm in Nova Scotia are being cross-checked with this equipment. A description of the studies is given on page 35.

The MICROTOX 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 is hoped that this will enable the screening out of samples with zero or insignificant levels of contamination and to reduce, by a factor of up to 10, the number of samples that require very costly (and often unreliable) traditional chemical analyses using GC/MS (gas chromatography/mass spectrometry) or equivalent techniques.

During the year an intensive program was started to assess the capability of the MICROTOX equipment using hundreds of different chemicals, both separately and in combination. It will continue in 1989-90 using ground water samples from field sites across the country. Conventional gas chromatography and high performance liquid chromatography apparatus was also acquired and

brought on line, and is now being used to identify known contaminants.

Acid Mine Drainage

Initial investigations at the Mount Washington Mine in British Columbia have already led to new insights into the relationship of acid generation and its interaction with the minerals present in the tailings. This offers exciting prospects for the control of acid generation at Mount Washington and elsewhere. The new scanning electron microscope and X-ray diffractometer facilities at NHRI have proved to be invaluable tools for this study.

Permafrost

As the permafrost regions of Canada would likely be impacted strongly by long-term changes in climate, they are therefore one of the more sensitive indicators of climatic change. Initial field investigations were confined to the discontinuous permafrost zone in the area of the Town of High Level, Alberta, where the impact of climatic change would be expected to be more severe.

Initial results tend to confirm the reality of a long-term warming trend in the discontinuous permafrost zone. Soil temperature surveys carried out along the main north-south highway in Alberta showed consistently higher temperatures than those measured by the Geological Survey of Canada 20 years earlier. On the basis of data collected during 1988-89, it appears that the isotherms (and hence the boundary of discontinuous permafrost) may have moved northward as much as 100 km during that period. This result, if confirmed, demonstrates the utility of permafrost/soil temperature as a sensitive indicator of changes in climate.

Facility for Indoor Aquifer Testing (FIAT)

This apparatus is essentially a very large, experimental tank, with the capability for fine control of the 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 m high, 2.44 m in diameter), it avoids most of the edge effects and sampling disturbance problems associated with smaller experimental columns. During 1988-89, FIAT was "officially" commissioned and loaded with local sand to act as the aquifer. Preliminary testing established that all significant design and operating criteria had been met.

These preliminary tests, however, also showed that the concentration of dissolved sulphate varied considerably throughout the depth of the tank and that the water in the base of the tank had become anoxic. This occurrence will be further explored in 1989-90.

The first experiments being conducted in FIAT are directed toward assessing the effects of the disposal of atmospheric fluidized bed combustion wastes on ground water.

Deep Well Disposal

Existing monitoring data for disposal wells have been found to be unsuitable for predicting the effects of wastewater injection either qualitatively or quantitatively using models. Therefore, continuous, bottom-hole, pressure data from the disposal well at the Swan Hills Special Waste Facility were used to test the Alberta Research Council model. The model provided reasonable predictions of the effects of wastewater injection but demonstrated that an adequate database of information on the hydrogeologic parameters for a site must exist and adequate monitoring data must be available to calibrate the model prior to using it in a predictive mode. Future activities on this project will be directed toward improving the quality of the monitoring data to be able to predict confidently the effects of deep well disposal in the oil sands/heavy oil areas of Alberta.

Long-Range Transport of Airborne Pollutants

Significant progress was made in elucidating the

mechanisms involved in decreasing the effect of acid precipitation on the ground water system. Whereas previous studies concentrated on the water phase, in 1988-89, drill-core material was analyzed using the Institute's newly acquired scanning electron microscope and X-ray diffractometer.

The results of the investigations show that the ground water chemistry in the shallow zone is largely determined by precipitation chemistry. Short-term pH depressions occur in response to acid loading events. At the same time as the pH decreases, an increase in the concentration of K⁺ (potassium ions) occurs, which is interpreted as being due to increased weathering of aluminosilicates, especially K-feldspar, during major precipitation events. It appears that the trace carbonates present in the shallow subsurface are insufficient to offset the acid loading events.

Landfill Study

The objective of this study was to examine the transport of contaminants in the vicinity of selected landfills in Western Canada, with emphasis on the special geological and other conditions characteristic of the West. A preliminary drilling program was begun at the City of Regina landfill in January 1989. A complementary drilling program was completed at the Saskatoon landfill. Piezometers, suction lysimeters, and two large-diameter wells were installed and soil samples collected during the drilling programs. Analysis of these samples is continuing.

Specialized double-ring permeameters to determine the hydraulic conductivity of engineered soils using leachate and water under different hydraulic gradients were designed and constructed at NHRI. The concept for a second generation of permeameters which would permit the confining system to incrementally increase the confining stress on the barrier material has been evaluated. Biological reactors-permeameters used to study biomass accumulation in sand cushions were designed and constructed.

Aquatic Ecology Research

Limnological Survey

A limnological survey was conducted of 17 lakes, ranging from freshwater to hypersaline, during the fall of 1988. This study served as a basis for developing a new research program in prairie limnology. Physical and chemical parameters investigated were: temperature, oxygen, chlorophyll and phaeophytin, total particulate carbon, nitrogen, phosphorus, dissolved phosphorus, orthophosphate, nitrate/nitrite. Biological collections were: benthos, periphyton (algae), zooplankton.

Zooplankton samples have been scanned for species composition and abundance and will be re-examined for more detailed quantitative counts. Benthic samples were examined at a limited number of stations. Periphyton samples have been sent to the Center for Great Lakes and Aquatic Sciences, Ann Arbor, Michigan, for taxonomic examination. Sediment cores were collected in Deadmoose, Waldsea, and Redberry lakes. These cores will be sectioned and examined for fossil zooplankton, benthos, and algal remains.

Two central Saskatchewan lakes were selected for detailed limnological study in 1989-90: Humboldt, a weakly saline, hypereutrophic (nutrient-rich) lake, and Redberry Lake, a saline, low-productivity lake. Two other lakes nearby, Lenore (weakly saline and moderately productive) and Basin Lake (saline and moderately productive) will be studied on a less frequent basis. The factors affecting water quality, productivity, and the fat content of zooplankton in these lakes will be investigated. Redberry and Humboldt lakes have been sampled during two winter limnological surveys, while Basin and Lenore lakes have been sampled once.

Riverine Nutrient Impacts

Recent research at the NHRI Experimental Troughs Research Apparatus at Chase, British Columbia, has shown that algal growth in rivers is a function of phosphorus concentrations only up to quite low levels of phosphorus enrichment. Above

these levels, there is no longer any appreciable effect. This finding has major implications both for the establishment of water quality objectives for Canadian rivers and for the regulation of nutrient pollutants.

The study of nutrient impacts on the Thompson River is proceeding. A two- to three-year study is under way to determine the extent of downstream declines in phosphorus and the effects of these changes on algae production. The construction of the control research site in North Kamloops and modifications to the laboratory building are complete. Construction of the prototype for the lower Thompson facility is progressing.

Accumulation of Heavy Metals in Planktons and Sediments

Field work is now complete. All of the samples collected from eight lakes near Flin Flon, Manitoba, have been prepared for study. Sediments have been analyzed for total mercury, methyl mercury, and sulphide. Plankton have been analyzed for copper, cadmium and zinc, and the chemical analysis of individual planktonic organisms and the water is finished.

Biogeochemistry of Heavy Metals

This study is concerned with the different geochemical processes and environmental factors influencing the methylation and demethylation of mercury by sedimentary microbes. Sediments were collected from eight lakes near Flin Flon, Manitoba, and one lake near Southern Indian Lake, Manitoba. Sediments from Flin Flon have been analyzed for total mercury, methyl mercury and sulphide.

Toxic Chemical Effects on Freshwater Ecosystems

More emphasis is now being placed on realistic acute and chronic bioassay techniques to assess the effects of increasingly complex chemical burdens. The study of morphological deformities in midge larvae (Diptera: Chironomidae) is one of the techniques under development for assessing long-term chronic effects of contaminants on such

systems. Operational techniques for assessing deformities in *Chironomus* and *Procladius* larvae are currently well advanced.

NHRI Continues to Progress

The National Hydrology Research Institute continued to recruit new staff in 1988-89. Strong links are being forged with universities, provincial agencies, and other federal agencies that promise to augment efforts to broaden the scale of research and to develop comprehensive, multidisciplinary approaches to major environmental problems related to water.

RECONNAISSANCE GROUND WATER STUDIES IN NOVA SCOTIA

Environment Canada, in cooperation with Agriculture Canada, is developing a pro-active or anticipatory program to determine the environmental behaviour of pesticides and nitrates under Atlantic Canadian 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 ground waters.

Certain pesticides suspected of being soluble and persistent enough to contaminate ground waters will be subjected to controlled field applications.

During 1988-89, reconnaissance hydrogeological studies were carried out on the Sheffield Farm in the Annapolis Valley of Nova Scotia. These included detailed coring of the soil materials and bedrock, split spoon sampling, installation of 19 5-cm diameter piezometers in the completed boreholes, a limited number of hydraulic tests, and some ground and surface water sampling.

Piezometer development is approximately 80% complete.

Ongoing work plans include the development of a computerized database, spatial analysis of the data, the completion of piezometer development and water sampling and analysis, hydraulic conductivity testing, surface water hydrometrics including tile drain effluent from neighbouring farms, terrain and borehole geophysics, the updating of soils mapping, surficial and bedrock geology, and land use. Much of this work is being coordinated with the Centre for Water Resources Studies of the Technical University of Nova Scotia in Halifax.

WATER RESOURCES RESEARCH SUBVENTION PROGRAM

Upon the cancellation of the Water Resources Research Subvention Program in November 1986, the Rawson Academy of Aquatic Science was awarded a contract in July 1987 to assess the value of the program during its existence from 1967 to 1987. A comprehensive report was completed and issued to 70 individuals and organizations. Comments were solicited and received from federal institutions and universities. Based on the report and comments, an Action Plan to restructure the Inland Waters Directorate (IWD) subventions program was developed.

Following the recommendations of the Rawson Academy report which suggested that ties be strengthened with the Natural Sciences and Engineering Research Council (NSERC), the Inland Waters Directorate has assisted in the redirection of NSERC's strategic grants program to ensure that water resource studies are included in their Environmental program. The Inland Waters Directorate is currently in the process of identifying new sources of funding and potential partners for water resource research.

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

The National Water Use Analysis Program (NWUAP) is a basic component of Inland Waters Directorate (IWD) operations, with the Water Planning and Management Branch having the lead responsibility for program delivery. In 1988-89, activities under NWUAP included the following areas.

Data Collection

Data collection activities focused on two principal areas - industrial and municipal water use and water pricing. The 1986 Industrial Water Use Survey findings were reported and made available for general distribution. Preparations were completed for updating the Municipal Water Use database to 1989. This update will include current water pricing data.

Database Construction

The National Water Use Data System (NAWUDAT) is a key component of the National Water Use Analysis Program and will make water use data available to a wide range of users. Progress in 1988-89 included the completion of the design phase, selection of the principal program (ORACLE), and entry of test data.

Modelling

The Water Supply Constraints to Energy Development project was completed, and the final results presented in a report. The Water Use Analysis Model (WUAM) was the main product of this study. A User's Manual for WUAM has been completed. Other modelling activities included construction of a model of the relationships between municipal water use and price and a model of structural change as it affects industrial water use.

Water Demand Research

Work commenced on developing guidelines for municipal water pricing to serve as background

information, since pricing is a provincial responsibility.

Several research papers on pricing and water demand management have been completed. "Municipal Water Rates in Canada: Prices and Practices" was published as part of IWD's Social Science Research Series. An accompanying brochure, aimed at the general public, has proven to be in high demand. A state of the art review on water demand management will be published in 1989-90.

Acid Rain

In 1988-89, activities related to acid rain or the long range transport of airborne pollutants (LRTAP) continued. Most activities were associated with participation on Environment Canada's Conservation and Protection Service LRTAP Socio-Economic Steering Committee (SESC). The Committee is responsible for the coordination and review of the socio-economic component of the Service LRTAP program.

A number of research studies were contracted for and completed during the year, providing an update of resources-at-risk baseline data. Further work is being undertaken on the potential socio-economic impacts of LRTAP, and, in turn, the impact of emission control plans (pre-1994), as a contribution to the LRTAP National Assessment to be completed by March 1990.

Organizational assistance and partial funding were provided for a workshop concerning the integration of physical and socio-economic models to be held at the University of Toronto in April 1990.

Climate Change

Activities related to long-term climate change, or the greenhouse effect, intensified in 1988-89. 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, IWD contributed project and administrative support to the Conservation and Protection (C&P) Service Science and Operations Committee on Atmospheric Change (SOCAC). In 1988-89, SOCAC completed an inventory of C&P activities related to atmospheric issues, initiated a C&P strategy relating to atmospheric change, and contributed to various other federal initiatives to address this issue.

In cooperation with the Canadian Climate Centre, a national workshop on the impacts of climate change in the water resources sector was organized to be held in Saskatoon in May 1989.

In addition, the Inland Waters Directorate continued to encourage and support research proposals and projects at the national and regional level, which contributed to assessment of climate change and the potential water-related socio-economic impacts. In particular, IWD explored further the application of the Water Use Analysis Model (WUAM) as an analytical tool for examining the implications of the greenhouse effect for water use and management.

CCME Principles for Water Management

In 1988-89, the Water Advisory Committee of the Canadian Council of Ministers of the Environment (CCME, formerly Canadian Council of Resource and Environment Ministers) on which Inland Waters Directorate represents the federal government, initiated a review of federal and provincial water policies and their compatibility of approaches to socio-economic aspects such as water pricing, planning methods and legislation. The Committee also initiated the drafting of a statement of national principles for water management.

Water Communications Activities

During 1988-89, water communications activities broadened in scope. Ensuring the wise use of the water resource requires an educated and informed public. A number of activities were undertaken in

order to reach as many sectors of the public as possible:

- Gathering and collating of various audio-visual materials such as videos, films, slides, prints and overheads was initiated and is ongoing.
- Revision of the Water Fact Sheet series began with the publication of the first two fact sheets in early 1989. Drafts of several fact sheets remain to be finalized in 1989-90. In addition, a reference booklet containing "Questions and Answers on Water" will be published in 1989-90.
- Water education in Canadian schools became a major focus this past year and a survey was undertaken under contract with a non-governmental partner. The study will be completed in June 1989 and will recommend follow-up initiatives for the Inland Waters Directorate.
- Numerous public presentations on various aspects of water planning and management were made by staff. Computer-based displays such as that developed to illustrate water use have proven to be very effective.
- The formation and development of a national communication and education strategy for water was initiated for completion by the fall of 1989.

The need to intensify these communication activities over the next few years is apparent and promises to be an integral part of an overall national water communications strategy.

Regional Highlights

In 1988-89, socio-economic activities in the regions involved:

- Completion of studies of the relationships between water pricing and water demand for Victoria, British Columbia
- Research on socio-economic components of Remedial Action Plans to clean up water pollution

in the Great Lakes basin and on the federal role in municipal infrastructure in Ontario

- A video "Water - Now is the Future" produced in the Atlantic Region
- An assessment of the impact of various climate change scenarios on New Brunswick water resources
- Completion of two reports focusing on the evaluation of several methodologies to assess the socio-economic values of wetlands along the Bay of Fundy
- Integration of socio-economic factors in a major hydrometric network evaluation for New Brunswick.

International Involvement

Chairmanship and general administrative support were provided to the Organization Committee for the International Water Resources Association's Sixth World Congress on Water Resources held in Ottawa, June 1988. Close to 700 participants from 121 countries participated in a very successful conference. Recommendations from the delegates' discussions and workshops were widely distributed.

Representatives from Canada attended the 1988 annual meeting of the Economic Commission for Europe (ECE) and participated on the Committee on Water Problems. The Committee approved a joint proposal by Canada and Norway to undertake in 1990, a one-year study on the "Ecosystem Approach to Water Management," using the Great Lakes as a case example.

Canada also participated in the Natural Resources Management Group of the Organization for Economic Cooperation and Development (OECD) which completed its task on water management with three reports on integrating water and other policy issues, demand management techniques, and cumulative contamination of ground water.

WATER DATA

Programs for the systematic collection and compilation of data on streamflow, water levels, sediment transport, ground water, 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 ground water, 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 1988-89 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. WATDOC also produces bibliographies and inventories from subsets of AQUAREF. In 1988-89, WATDOC produced the 1986-87 edition of a bibliography on hydrology, in collaboration with the

Water-Related Databases and Information Systems

Name	Data Provided
AQUAREF	Inventory of 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

Associate Committee on Hydrology of the National Research Council of Canada. WATDOC and the Water Quality Branch of IWD worked together to produce the "Publications 1987" listing.

During 1988-89, 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 the Water

Resources Branch and the Water Quality Branch of IWD in presenting the HYDAT databank and the NAQUADAT database. The water use databases were added to the integrated display.

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). As well as responding to many specific information requests, WATDOC produces a newsletter highlighting recent developments and sample searches.

Part II: Water Quality Management

No water quality management areas, as defined under Part II of the Canada Water Act, have been set up. However, there are a number of federal-provincial implementation agreements under which water quality management programs have been or are being implemented. These include programs in the Great Lakes basin and in the Okanagan and Qu'Appelle basins. While these agreements do not provide for the establishment of water quality management agencies under Part II of the Act, they nevertheless have the same objectives of maintaining and improving water quality and are managed by joint federal-provincial boards.

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.

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
- 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.

Since publication in May 1987, 4000 copies of the Guidelines have been distributed to federal and provincial agencies, national and international organizations, as well as to domestic and foreign associations and agencies, consultant groups, libraries, and the research community.

The federal departments of Environment and National Health and Welfare have recently 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, K1A 0H3.

New Guidelines

The Task Force on Water Quality Guidelines continues to recommend water quality guidelines. Guidelines for the pesticides atrazine, carbofuran, glyphosate and picloram will be published in 1989-90 by the Canadian Council of Ministers of the Environment (CCME, formerly Canadian Council of Resource and Environment Ministers).

The new Canadian Environmental Protection Act requires that the Minister of 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.

Part IV: Public Information Program

Three in four Canadians feel that water quality is one of the most serious environmental issues of our time.

-The Environmental Monitor

Public concern is increasing about drinking water and the state of Canada's water in general. Public awareness and positive action can help to protect this vital resource. The public information program enables Canadians to achieve a perspective on water-related problems, both regional and national, and thus decide how to contribute to their solution.

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.

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 were prepared about Prince Edward Island on the following: surface water, coastal estuaries, ground water, and domestic sewage and septic systems. Each fact sheet contains a section on "What You Can Do."

Environment Displays

Due to their mobility, displays are proving to be an effective means of reaching Canadians across the country. An integrated display of water information and technology produced by the Inland Waters Directorate of the Department of the Environment criss-crossed Canada this past year. The display explained water uses and water quality, and also featured the Flood Damage Reduction (FDR) Program.

FDR Outreach

In 1988-89, a report on flood events in Canada between 1983 and 1987, and the 1987 Status Report on the Flood Damage Reduction Program were released. Two new brochures explaining the FDR Program to realtors and hydrologists were published. The brochure "Learn the Facts about Floods" was reprinted.

Under the New Brunswick/Canada FDR Agreement, two brochures dealing with flood forecasting, a map highlighting flood prone areas in the province, and a publication illustrating techniques on how to protect homes against flooding were published. In addition, a historical summary of flooding in Nova Scotia and an updated brochure explaining the Newfoundland/Canada Flood Damage Reduction Program were produced.

For the rest of Canada, other maps and brochures were made available. In Quebec, the revision of the Bas-Richelieu designation resulted in the publication of 58 new maps and an updated brochure. In Ontario, nine public information maps for five newly designated areas were produced. Two public information maps were published for the two new Saskatchewan designations. In British Columbia, the most recent member of the FDR Program, a brochure explaining the B.C./Canada Floodplain Mapping Program was published.

**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 the Department of the Environment and the Department of Indian Affairs and Northern Development 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....Department of the Environment (DOE), and the Department of Indian Affairs and Northern Development (DIAND) 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. DIAND transfers funds annually to DOE for the territories' share of costs.

Funding: 1988-89 (provisional costs)

Total Program Costs	\$23 500 000
Total Recovered from Provinces	5 600 000
Total Paid to Quebec by Canada	756 000

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. No national meetings of either the coordinators or the administrators were held in 1988-89.

Water quantity surveys now include technologically advanced techniques such as satellite communication telemetry systems and a nationally distributed electronic data processing system. As a follow-up to the national meeting of coordinators held in October 1987, an explanation of plans for the operation of satellite receiving stations installed during the year was provided to coordinators in each region during visits by headquarters staff.

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 and New Brunswick. 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.....Department of the Environment
ALL PROVINCES AND TERRITORIES

Arrangements:

In designing the agreements to meet the needs of both the federal and 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; federal-provincial 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, 1988; and New Brunswick, 1988. Negotiations for agreements with Saskatchewan, Prince Edward Island 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 on an annual basis for the 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 presented Proposed Water Quality Indicators for each of the 11 stations to the Board in the fall of 1986, which are now being reviewed by the Board's agencies prior to any further action. The Committee on Water Quality has prepared draft supporting documentation for the 11 PPWB monitoring sites to assist the agency review. Also this Committee has established a Task Force on Analytical Methodology to provide a means of quality assurance and to coordinate water quality laboratory results for the Prairie provinces. The Task Force has prepared a report for the Board on the compatibility of the initial results from the quality assurance program, which the Board has accepted along with its recommendations. Another comparability report will be produced in 1990.

The Board has established a "fixed term" Committee on Water Quality Policy to review the Board's mandate in water quality matters, and to recommend a water quality strategy for the Board.

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 ground water conditions along the Alberta-Saskatchewan boundary and the Saskatchewan-Manitoba boundary. The Committee has been reviewing the effectiveness of ground water related legislation for the Prairie provinces and coordinating the tabulation of a bibliography of ground water reports and data related to interprovincial ground water 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 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

Prior Action: A Technical Work Group on Water Quality in the Ottawa River was formed in 1980 to study problems related to bacteria and toxic substances in the Ottawa River basin; to identify quantities and sources of nutrients; and to evaluate the importance of agricultural and other diffuse sources of phosphorus. It was hindered from carrying out its mandate by gaps in the data available and, in its report of October 1981, recommended the establishment of a committee to coordinate monitoring, and proposed a monitoring plan to obtain the data needed.

Status: The first report of the Coordinating Committee 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, to be released in June 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.....Department of the Environment, Ministry of Transport, Department of Indian Affairs and Northern Development, 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 1988-89 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, 1989, authority to sign this general agreement had not 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. 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 communications 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.

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 \$687 260 was spent on the project in 1988-89. Some money paid for spoil pile leveling and cleanup work. The largest portion went toward construction of the walleye fish nursery, approximately 80% complete, 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 was negotiated, subject to the approval of parties, which would extend the duration and increase the funding provisions of the agreement.

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 fiscal year 1983-84, the agreement was extended to December 31, 1986, with no increase in funds. In fiscal year 1985-86, the agreement was extended to March 1995 and funding was increased by \$41 million. Total funding committed to the program by both governments increased to \$161 million.

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, Delta, Chilliwack (Phase I), Vedder River, South Dewdney, and Pitt Meadows No. 2. Construction is well advanced for Glen Valley. Final design is well under way for Coquitlam River and Chilliwack (Phase II). Estimated expenditures under the program to March 31, 1989, are

\$134 000 000. The current annual funding rate is \$2 500 000 from each government.

4. CANADA-ONTARIO AGREEMENT ON 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.

Duration of Agreement: April 1971 to March 31, 1990;
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 phosphorous 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. A four-party status report on activities was released in July 1987, and a four-party analysis report, in January 1988.

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. AGREEMENT ON GREAT LAKES WATER QUALITY

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, ground water, 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 IJC'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 and the eight Great Lakes states. 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.

5. SOUTH SASKATCHEWAN RIVER BASIN STUDY

Objective: To develop a framework plan to guide long-term water resources development in the South Saskatchewan River basin.

Duration of Agreement: May 1986 to December 31, 1989.

Participants and Funding: CANADA.....\$800 000
SASKATCHEWAN.....\$800 000

Status: During 1988-89, analytical models for hydrology, water use, water quality, and hydropower simulations were completed. They will be used to evaluate and select the optimum management scenarios for the basin. The final study plan will comprise three components:

- (1) Basin management strategy
- (2) Project evaluation procedures
- (3) Implementation plan.

It has been proposed 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 in Prince Edward Island; and to identify future development potential in the province's water resources bases, i.e., ground water, 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. The same date a Memorandum of Understanding on Conservation and Development between several key federal and provincial government agencies was signed.

The work-shared arrangement, scaled down from an initial \$2.5 million proposal, deals with key water issues on the Island concerning ground water, surface water, and estuaries.

The ground water program addresses several problems and includes a study of areas where ground water availability is limiting economic growth; an assessment of pesticides in ground water; and the demonstration of techniques to prevent contamination of individual wells. The surface water program assesses the impacts of various land use patterns on water quality and on fish habitat. Pilot projects are being implemented to demonstrate techniques to improve water courses for fish habitat. The estuary program addresses 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 deals with the problems and economics of water and wastewater systems, especially the design and operation of on-site sewage disposal.

Ten percent of the budget has been designated for environmental education. A communications plan has been designed to reach a wide audience with information on water resources and environmental management. Several brochures, fact sheets and reports were published in 1988-89.

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, 1989.

Participants and Funding: CANADA.....\$2 745 000
MANITOBA.....\$3 355 000

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. The earthwork and permanent pumping facilities have been completed at Brunkild, Rosenort, Letellier, St. Jean Baptiste and Morris. Some upgrading has been completed at Emerson and St. Adolphe. The communication/storage facility at Morris is complete and the emergency pumps for the communities have been purchased. The communication towers for all communities have been constructed.

The agreement to construct the international segment of the Emerson, Manitoba, and Noyes, Minnesota dyke was negotiated. Significant progress was made in the construction of the dyke as well as some upgrading of the existing dyke. After considerable delay, the Ste. Rose du Lac project was initiated. About 75% of the project was completed during 1988-89. 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. As of March 31, 1989, federal authority for the extension had not been obtained.

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 Îles 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 Îles 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%.