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The Canada Water Act Annual Report

1990-1991

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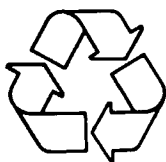
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The Canada Water Act Annual Report

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Minister of the Environment



Ministre de l'Environnement

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

Your Excellency:

I respectfully submit to Your Excellency and to the
Parliament of Canada the annual report on operations under
the Canada Water Act for the fiscal year 1990-1991.

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

A handwritten signature in black ink, reading "Jean J. Charest".

Jean J. Charest



Environment
Canada
Deputy Minister

Environnement
Canada
Sous-ministre

Ottawa, Ontario
K1A 0H3

The Honourable Jean J. Charest, P.C., M.P.
Minister of the Environment
Ottawa, Ontario
K1A 0A6

Dear Mr. Charest:

I have the honour to submit the Annual Report on
operations under the Canada Water Act for the fiscal year
1990-1991.

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 nineteenth annual report, covers operations to March 31, 1991.

On November 5, 1987, the Federal Water Policy was tabled in Parliament, the culmination of a three-year process which began under the authority of the Canada Water Act. In 1990, the Interdepartmental Committee on Water, itself restructured to serve as the focal point for coordinating the Federal Water Policy, reported to the Minister of the Environment on action under way to implement the provisions of the Policy.

Up to and including fiscal year 1975-76, the Canada Water Act funding for federal-provincial

projects was provided on the basis of individual projects. In fiscal year 1976-77, Treasury Board established a ceiling on expenditures cost-shared with the provinces (for river basin planning and implementation, and flood damage reduction) at about an \$18 million per year level. Subsequent budget reductions and consequent adjustments to the program lowered the ceiling in 1984-85 to \$11 million per year. This total fell to \$9.2 million for 1985-86 and stayed near this level in fiscal years 1986-87, 1987-88, 1988-89 and 1989-90. In 1990-91, a budget of \$9.190 million was established. This budget does not include the federal cost of federal-provincial cost-shared monitoring and survey agreements (i.e., water quantity and water quality).

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

Provisions of the Canada Water Act

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

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

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

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

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

Part IV of the Canada Water Act contains provisions for its general administration. In addition, Part IV provides for inspection and enforcement, allows the Minister to establish Advisory Committees and permits the Minister, either directly or in cooperation with any government, institution, or person, to undertake public information programs.

Highlights 1990-1991

THE FEDERAL WATER POLICY

The first progress report on the Federal Water Policy was released by the Interdepartmental Committee on Water in March 1990. The Committee's report noted that the departments are sufficiently committed to implementation of the Policy and that significant progress has been achieved. The report also identifies certain areas which require special attention and recommends appropriate courses of action. The next report of the Interdepartmental Committee on Water concerning progress of the Federal Water Policy is scheduled for publication in 1992.

CANADA'S GREEN PLAN AND THE FEDERAL WATER POLICY

On December 11, 1990, the Government of Canada tabled the Green Plan - a national agenda for environmental action. The Plan introduces new policies, programs and standards for Canada's land, air and water resources and complements the strategies of the Federal Water Policy in charting ways to protect and enhance freshwater resources. Water Commitments of the Plan include programs to:

- Secure safe and dependable supplies of drinking water
- Clean up past mistakes
- Promote pollution prevention
- Encourage wise water use
- Improve water science and technology.

Among the numerous Green Plan initiatives are watershed studies involving provincial participation. These include the proposed Fraser River Action Plan, the Peace-Athabasca-Slave River cumulative environmental impact study, and the Red-Assiniboine Basin water use and pollution study. These interjurisdictional studies complement the Federal Water Policy strategy of integrated planning where all water uses and water-related activities within whatever

political, administrative, economic or functional boundaries are taken into account.

ATLANTIC COASTAL ACTION PLAN

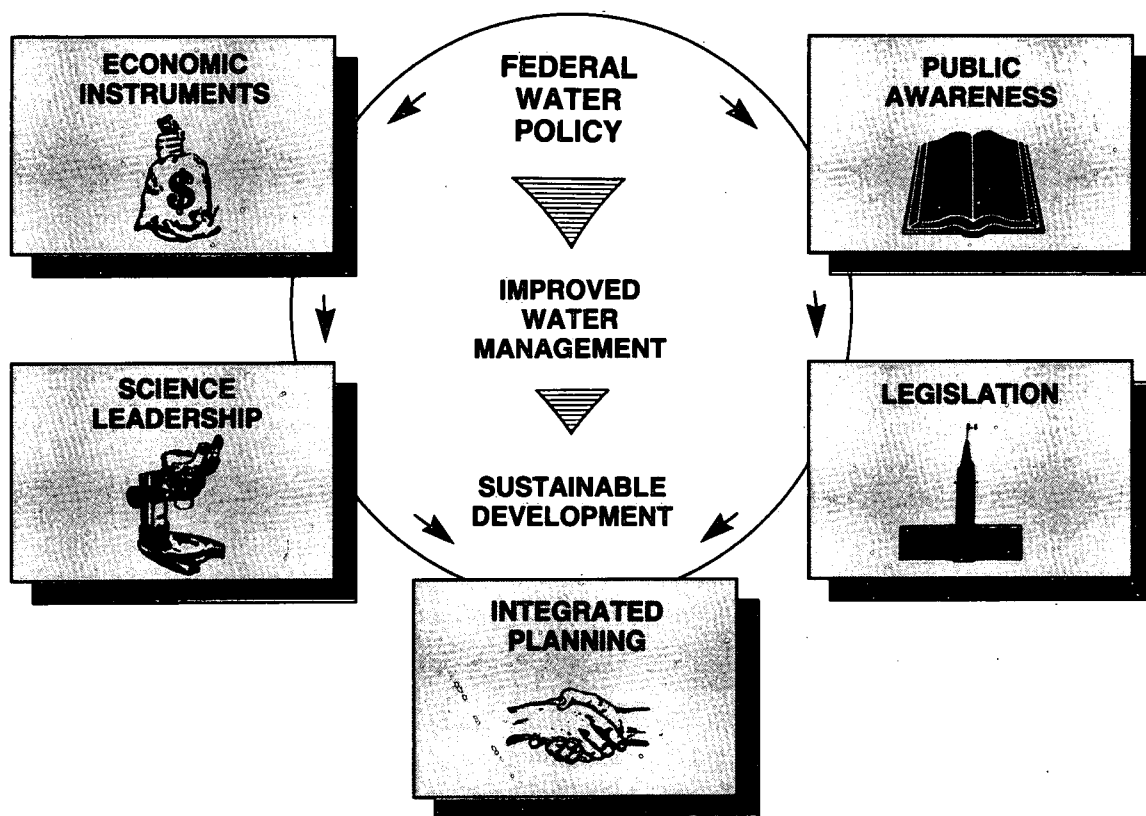
On March 7, 1991, the Atlantic Harbours and Coasts Program was announced in Saint John, New Brunswick. This \$10 million program, funded under the Green Plan, will support comprehensive environmental management in at least 11 Atlantic Canada harbours and estuaries over the next six years. The approach to management is community-based, involving community interests; industries; and municipal, provincial and federal government representatives. Based on environmental use objectives the environmental health of areas will be evaluated, remediation or conservation measures identified and judged suitable by the community, and an implementation strategy developed.

PACIFIC COAST WATER EXPORT PROPOSALS

On separate occasions during 1990-91, two California communities invited bids from British Columbia firms which proposed to export small volumes of freshwater by marine transport. In the first case, Santa Barbara chose instead what it judged to be the lower cost and more politically secure option of desalinization. In the second case, the Goleta Water District's contract with one British Columbia firm, Snowcap, was blocked in March 1991, when the Province intervened and declared a moratorium on all applications for tanker water export until it could complete an overall review of its policy on this controversial issue. Four federal agencies had by this time begun screening Snowcap's proposal under the Environmental Assessment and Review Process.

Federal water policy prohibits large-scale water export, as by the interbasin diversion of lakes or rivers, but allows for consideration of

THE FEDERAL WATER POLICY STRATEGIES AND POLICY STATEMENTS



POLICY STATEMENTS TO WHICH THE 5 STRATEGIES ARE BEING APPLIED:

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

small-scale exports under strict regulation and in cooperation with provincial governments.

SOUTH SASKATCHEWAN RIVER BASIN STUDY

The federal-provincial study of the South Saskatchewan River basin has been completed. Apart from the irrigation, industrial, hydroelectric power and recreation uses, 30 communities, with 40% of all the province's population, draw all, or part, of their municipal water needs from the river. The study predicts that "there is sufficient water in the South Saskatchewan River to meet the needs of existing uses as forecast to the year 2020 without difficulty." For additional information on the study, see page 63.

WATER: NO TIME TO WASTE

Water conservation is on the minds of many Canadians who are concerned about the environment and want to learn how they can preserve it. "Water: No Time to Waste, A Consumer's Guide to Water Conservation" fills this need. This handy guide gives advice on how to conserve water in the home by the following the three golden rules - reduce, repair and retrofit. For more information on this and other products produced as part of the Public Awareness strategy of the Federal Water Policy, please turn to page 45.

GROUNDWATER STRATEGY

A major event during 1990-91 was the issuance, by Environment Canada, of a departmental Groundwater Strategy. It will serve to guide the federal government's activities in implementing the Federal Water Policy, as well as its commitments made to groundwater under the Green Plan. The strategy does the following:

- Stresses a management approach to groundwater in Canada, acknowledging that any single groundwater issue, e.g., groundwater contamination, cannot be dealt with in isolation but must be considered within the context of groundwater management as a whole
- Recognizes that, within a sustainable development framework, although groundwater contamination is a major preoccupation of governments today, all aspects of groundwater must receive due consideration
- Places great emphasis on the partnership approach wherein other departments, the provinces, municipalities, industry and the academic community all have significant roles to play.

To facilitate information exchange between the many individuals working on groundwater-related problems in Canada, Environment Canada publishes The Canadian Groundwater Directory. In early 1991, a revised second edition was issued and circulated.

FLOOD DAMAGE REDUCTION PROGRAM WORKSHOP

On October 3-5, 1990, a national workshop on the Flood Damage Reduction (FDR) Program was held in Burlington, Ontario. The purpose of the workshop was to discuss the objectives and opportunities within the upcoming maintenance phase of the FDR Program as well as to identify topics that need updating within the FDR guidelines. Workshop delegates concluded that the focus under the maintenance phase should be on intensifying public awareness activities and marketing the program to new target audiences. For more information on the FDR Program, see page 15.

Part I: Comprehensive Water Resource Management

FEDERAL-PROVINCIAL COOPERATION

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

Agreements for specific water programs provide for the participating governments to contribute funding, information, and expertise in agreed ratios. For ongoing activities such as the water quantity survey agreements with each province, cost-sharing is in accordance with each party's need for the data. For study and planning agreements, it is usual for the federal government to meet half the costs and the provincial government(s) the other half. The planning studies encompass interprovincial, international or other basins where federal interests are important. Implementation of planning recommendations occurs on a federal, provincial, and federal-provincial basis. Cost-sharing of the construction of works often includes a contribution from local governments.

INTERDEPARTMENTAL COMMITTEE ON WATER

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

Committee membership consists of the nine departments which have a significant interest in freshwater: Environment Canada, Fisheries and Oceans Canada; External Affairs Canada; Agriculture Canada; Health and Welfare Canada; Indian and

Northern Affairs Canada; Industry, Science and Technology Canada; Energy, Mines and Resources Canada; and Transport Canada. Environment Canada chairs and provides the Secretariat of the Committee.

In keeping with its advisory role in the development, coordination and implementation of federal policies on freshwater, much of the Committee's activity involves proposed legislative and policy initiatives. In early 1991, the Committee took on the responsibility of overseeing the implementation of the Federal Water Policy on Wetland Conservation. Consideration is being given to Committee participation in water policy areas such as water export, a groundwater strategy, and review of Great Lakes Remedial Action Plans.

The Committee has been designated in the Federal Water Policy as having the responsibility to monitor and advise the Minister of the Environment on the Policy's delivery. The Committee's first progress report, released in March 1990, recommended that the federal government:

- Increase federal research in support of the development of economic instruments in consultation with the provinces
- Strengthen federal research programs with better integration of natural and social sciences and linkages with external research partners
- Develop alternatives for the Supply and Services Canada Unsolicited Proposal program and Environment Canada's Water Resources Research Support program
- Improve data integration and monitoring, particularly in the North
- Develop a coordinated groundwater strategy
- Implement a federal program to address persistent aquatic debris
- Increase use of the Interdepartmental Committee on Water to enhance integrated

federal decision-making with respect to water-related policies and programs

- Encourage national and provincial round tables
- Proceed with legislative initiatives in support of the Federal Water Policy (integration of the principles of sustainable development, ecosystem water management, fair value for water)
- Implement a federally coordinated water awareness program
- Amend the Interdepartmental Committee on Water reporting time frame for Federal Water Policy implementation to every two years.

The Interdepartmental Committee on Water has scheduled publication of the second Progress Report on the Federal Water Policy for March 1992.

FEDERAL-PROVINCIAL WATER RESOURCE MANAGEMENT PROGRAMS

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

Regulation, Apportionment, Monitoring and Survey Programs

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

Water Quantity Data Collection

The federal government has been involved in the collection of water quantity data since the late 1800s. In earlier years, hydrometric networks were operated under a variety of informal arrangements with the provinces. In 1964, the Quebec government took responsibility for most of

the hydrometric network in that province. Beginning in April 1975, uniform cost-sharing Water Quantity Survey agreements were implemented with all provinces and Memoranda of Agreement with Indian and Northern Affairs Canada for the territories.

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

Data from 3356 active stations were published and are contained in the national data bank HYDAT, which also has data for 4201 discontinued stations. Of the active stations, 2646 are operated by the federal government, 266 are operated and contributed by the Province of Quebec, 108 by other provinces, and 336 by other agencies.

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.

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

Regulation, Apportionment, Monitoring and Survey Programs		
<u>Under Negotiation</u>	<u>New During 1990-91</u>	<u>Ongoing During 1990-91</u>
Water quality monitoring agreements with Saskatchewan, Nova Scotia, Ontario, and Alberta		Water quantity surveys with all provinces Prairie Provinces Water Board Mackenzie River Basin Committee Water quality monitoring agreements with Quebec, British Columbia, Newfoundland, New Brunswick, Manitoba and Prince Edward Island Lake of the Woods Control Board* Ottawa River Regulation Planning Board Water quality monitoring agreements with Northwest Territories and Yukon (no funding)
Water Management Programs		
<u>Under Negotiation</u>	<u>New During 1990-91</u>	<u>Ongoing During 1990-91</u>
Mackenzie River Basin General and Master Agreements Studies on Water Resource Management for Economic Development in New Brunswick Study Agreement on Peace, Athabasca and Slave rivers Renewed Fraser River Estuary Management Program Study Agreement on Red and Assiniboine rivers	Yukon and Alsek River Basins Implementation Agreement Amending Agreement for Qu'Appelle Conveyance Amending Agreement for the South Saskatchewan River Basin Study	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 1990-91</u>	<u>Ongoing During 1990-91</u>
Initial agreement with Yukon Territory Agreement to Implement Flood Control Measures for the Placentia Area in Newfoundland Revised General and Maintenance agreements with Nova Scotia Renewed General/Mapping Agreement with Newfoundland	Amending Flood Risk Mapping Agreement with Ontario	General Agreement with Northwest Territories, Nova Scotia General/mapping agreements with Quebec, Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia General and Combined Mapping/Studies agreements with New Brunswick and Newfoundland Flood Forecasting agreement with New Brunswick Memorandum of Understanding on Indian Lands Manitoba Flood Protection Projects Studies agreements with 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.

Hydrometric Modernization

Project 2000 is an initiative to modernize data collection associated with the hydrometric survey. The aim is to put in place by the year 2000 up-to-date technological infrastructure for more effective monitoring of Canada's water resources. The total investment requirement is approximately equivalent to replacing one third of the combined field and office equipment.

There are seven elements to Project 2000:

- Field instrumentation and equipment
- Telemetry links
- Data-receive sites
- Data communications
- Data integrity/quality control
- Data computation/management
- Data dissemination to clients.

Features include equipping 80% instead of the current 25% of the stations with the potential to collect real-time data and improved quality assurance to ensure that modernization does not affect the integrity of the data. A three-year pilot study involving approximately 100 stations in one region will begin in 1991-92. During 1990-91 development with private industry commenced on COMPUMOD, a software system for use by hydrometric technicians throughout Canada.

Project 2000 will build upon the data collection platforms (DCPs) installed during the 1980s at remote hydrometric sites in order to permit real-time acquisition of hydrometric data via satellites. The DCPs have enabled more efficient service to client interests for real-time data needs such as navigation, reservoir operation, water allocation, and flood forecasting. Some DCPs are equipped with sensors to provide atmospheric and water quality information required by the Atmospheric Environment Service and other agencies. As of March 31, 1991, approximately 490 active DCPs were in operation and 179 telemarks, providing real-time data capability for 25% of the network.

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.

Water Quality Monitoring Agreements

Water quality monitoring provides the basis for identifying contamination in the aquatic environment and for assessing compliance with regulatory requirements. Environment Canada operates a national water quality monitoring program. Federal-provincial agreements provide the basis for data sharing in British Columbia, Manitoba, New Brunswick, Newfoundland, Quebec, and Prince Edward Island. Water quality monitoring agreements have been negotiated with the two territories (no funding). Similar arrangements will be made in Nova Scotia and Saskatchewan. Environment Canada is prepared to negotiate agreements with Alberta and Ontario.

Prairie Provinces Water Board

The Prairie Provinces Water Board, a federal-provincial board that administers the Prairie Provinces Master Agreement on Apportionment, continued to provide recommendations to Canada, Alberta, Saskatchewan, and Manitoba concerning the equitable apportionment of eastward flowing interprovincial prairie rivers. In 1990-91, the Board initiated discussions to amend the Master Agreement on Apportionment to define more clearly its role and responsibilities in interprovincial water quality management.

The Board's Committee on Hydrology has developed procedures for natural flow determination for apportionment purposes. The Committee also evaluates the effect that proposed projects might have on the balance of interprovincial waters. In addition, the Board's Committees on Water Quality and Groundwater provided technical advice on

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
Manitoba Flood Forecasting Agreement	1989
Manitoba Flood Protection Projects	1991
South Saskatchewan River Basin Study	1991

interprovincial matters involving water quality and groundwater. A four-year study of historic and current water demands in the three Prairie provinces was completed in December 1982 and is updated every few years.

The Board publishes an annual report of its activities. It has also published five fact sheets which describe the Board's activities as well as a brochure on water use trends in the Saskatchewan-Nelson Basin. For these publications or other information, please contact:

Prairie Provinces Water Board
201 - 2050 Cornwall Street
Regina, Saskatchewan
S4P 2K5

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, 1991, the agreement was in the process of being signed.

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

Garrison Diversion Studies

In December 1990, the Garrison Joint Technical Committee submitted its report on engineering and biota transfer issues related to the Garrison Diversion project in North Dakota to the Canada/United States Garrison Consultative Group. Inland Waters Directorate of Environment Canada provides two members and a secretary to the Garrison Joint Technical Committee and one member to the Engineering Task Force (a subcommittee). The Engineering Task Force report was submitted in July 1990, and the Biology Task Force report in September 1990.

The Technical Committee will meet annually to review these projects. The introduction of saline water from Devils Lake into the Red River and the proposed future augmentation of Devils Lake with Missouri River water remain a concern to Canada.

Lake of the Woods Control Board

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

Water Management Programs

Depending upon the nature of the work being conducted, water management programs can fall within any of three stages - preplanning studies, planning studies or implementation activities. During 1990-91, several water management programs were continued, including a work-sharing

arrangement for water resource management and development studies in Prince Edward Island, which has been extended to March 31, 1992.

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

Planning Studies: A preplanning study may or may not be followed by a planning study. Planning studies generally are directed toward the development or management of the water resources for the social betterment and economic growth of the basin or area under study. For example, in May 1986, the Canada-Saskatchewan South Saskatchewan River Basin Study Agreement was signed to develop a plan to guide future water development in the basin. The study, which was completed this past year, presents a framework plan for management of the river involving public participation.

In October 1987, a three-year 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 agreement is coordinated by a federal-provincial committee, with each party contributing \$500 000. A two-year extension with additional funding of \$200 000 by each party was signed in 1990.

The extended studies included special investigations and demonstration projects related to groundwater resources, inland surface water resources, estuarine water resources, and multi-sectoral and integrated water management. During this past year fact sheets were produced on surface watershed activities. A teacher's kit, which included a video entitled "Protect

Your Water Resources," and a guide to teachers of secondary school biology were developed. Also, several technical reports were produced.

Under the Green Plan, the federal government announced that it is proposing a joint study with Manitoba and Saskatchewan on water use, sources and effects of pollutants, soil conservation and wildlife habitat in the Red and Assiniboine River basins. Discussions were held with federal agencies and the provinces to identify specific needs and objectives of the proposed study. A survey of water quality is under way in the United States portion of the Red River basin, which offers opportunities to develop a basin-wide perspective on water issues.

A work sharing arrangement with the Province of New Brunswick Respecting the Conduct of Studies on Water Resource Management for Economic Development was in the final stages of negotiation at year-end. This is a five-year agreement coordinated by a federal-provincial committee, with each party contributing \$1 125 000. The arrangement focuses on the protection of surface and groundwater sources of water supply, the management of estuaries, public education, and economic considerations.

In its final study report, 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. To implement the study recommendations, a Canada - British Columbia - Yukon Agreement Respecting Water Resource Management and Information Exchange in the Yukon and Alsek River Basins was ratified on March 7, 1991.

Canada, Manitoba, Manitoba Hydro, and the Northern Flood Committee, which comprises the five Indian bands of Cross Lake, Nelson House, Norway House, Split Lake and York Factory, signed the Northern Flood Agreement (NFA) in December 1977. This agreement, which is not under the Canada Water Act, is administered federally by Indian and Northern Affairs Canada to provide compensation for the effects of Nelson River

hydropower developments, specifically Lake Winnipeg regulation and the Churchill River diversion. It also creates an opportunity for renewed economic and social development in the communities. Article 17 of the agreement commits Canada, Manitoba, and Manitoba Hydro (1) to act jointly for the implementation of the recommendations of the Lake Winnipeg, Churchill and Nelson Rivers Study Board Report, which deals with ecological concerns, and (2) to report annually to the Band Councils on progress made. In April 1986, Treasury Board approved \$1.76 million for Environment Canada to design and implement a five-year ecological monitoring program, subsequently called the Federal Ecological Monitoring Program (FEMP).

In 1988-89, the principals of the NFA began a process called "comprehensive global negotiations" to pursue resolutions of all NFA articles, including environmental monitoring requirements. However, late in 1990-91, four of the five signatory bands to the NFA (Cross Lake, Nelson House, Norway House, and York Factory) decided not to proceed with these negotiations; the fifth band, Split Lake, opted to proceed toward a negotiated settlement. As a result, implementation of the NFA is now proceeding through two processes: arbitration as provided for under the NFA and negotiation with the Split Lake Band.

During 1990-91, Environment Canada, along with Fisheries and Oceans Canada, concluded field activities under FEMP. Work is now in progress on analysis of data and preparation of reports. It is expected that the FEMP final report will be completed by the fall of 1991.

Northern Rivers Study

Under the Canada Water Act, Canada, Alberta, and the Northwest Territories have negotiated an agreement to undertake a comprehensive study of the Peace, Athabasca and Slave River basins for the purpose of identifying the potential cumulative water quality impacts of pulp mill and tar sands developments in the province. This initiative will be undertaken by Alberta Environment; Alberta Forestry, Lands and

Wildlife; Environment Canada; Indian and Northern Affairs Canada; and the N.W.T. Department of Renewable Resources. The study, which had not received Treasury Board approval as of March 1991, would be conducted at a cost of \$12 million equally shared by Canada and Alberta over a four-year period. The study could commence by the summer of 1991.

Modelling

To ensure sustainable resource development, improving and updating analytical modelling tools has been the focus of modelling activities during 1990-91. Models such as REGUSE, RIVICE and ONE-D have been applied to more and varied water resource issues.

Implementation Programs: In addition to the Yukon and Alsek implementation agreement initiated in 1990-91, several programs continued owing to agreements in earlier years, including a renewed Canada-Ontario Agreement Respecting Great Lakes Water Quality which expired on March 31, 1991. (An extension has been proposed.) This agreement provided for the cost-sharing of surveillance, research, upgraded sewage treatment, and phosphorus control, reflecting the commitments undertaken by Canada in the 1978 Canada-U.S. Great Lakes Water Quality Agreement. It also re-emphasized the cooperative phosphorus control and Great Lakes surveillance programs and, in accordance with the 1978 Agreement, outlined 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. At an annual cost of \$250 000, the program is based on a study conducted between 1977 and 1982. Well into its sixth year of operation, the program is designed to guide economic development while protecting the environment of the estuary. The agreement expired on December 31, 1990 (work, however, extended to March 31, 1991); a three-year renewal, with funding of \$600 000 annually and including the Greater Vancouver Regional District as an additional party, was contemplated as of March 31, 1991.

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.

The termination date for the \$4.75 million agreement, cost-shared equally by the two governments, was March 31, 1989. In 1990-91, an extension of the agreement to March 31, 1992, was concluded with additional funding of \$550 000 to be shared equally.

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. A delta vegetation study was commissioned in 1990. 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 \$142.5 million of a total joint commitment of \$161 million was spent by the end of March 1991.

Flood Damage Reduction Program

During 1990-91, the Flood Damage Reduction (FDR) Program was active throughout most of Canada.

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

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

Mapping agreements provide for the flood risk mapping and designation of the areas to which the policies in the General Agreement will apply. Forming part of these agreements is a list of communities in the province which are to be mapped and specifications to be followed in conducting the hydrotechnical and mapping work. When maps not meeting these specifications are available, interim designation may be applied until such time as new maps are prepared. These

agreements also require that information pertaining to the designated area be made available to governments, zoning authorities, the public, and anyone contemplating development in or near these areas. Under the agreements, pertinent information is provided to government agencies and local authorities for land use planning and zoning purposes. Designations to March 31, 1991, 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, floodproofing, works to control flows and levels, acquisition of property, easements or land use planning. It should be noted that in examining alternatives, the best choice will be made on the basis of effectiveness, cost, and environmental impact. This could mean allowing some flooding to occur.

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

1987-88, a Floodplain Mapping Agreement was concluded with British Columbia, and amendments to the programs in New Brunswick (General, Mapping, Studies, Forecasting), Newfoundland (General, Mapping, Studies), Quebec (General, Mapping), and Manitoba (Forecasting) were undertaken. In April 1989, a Floodplain Mapping Agreement was concluded with Alberta. During 1989-90, two agreements were extended in Manitoba: the General, Mapping and Studies Agreement and the Agreement Respecting the Construction of Flood Protection Projects. In 1990-91, the mapping component of the Canada-Ontario Agreement Respecting Flood Risk Mapping and Other Flood Damage Reduction Measures was extended by two years.

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

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

Report on Progress

Alberta

The Canada-Alberta Flood Risk Mapping Agreement was signed on April 3, 1989. The \$5.5 million in funding of the agreement is to be shared over nine years, with most of it to be spent within the first five years. Work continued on the mapping of several communities. The communities of Cochrane, Medicine Hat and St. Albert were designated.

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. During 1990-91, three newly mapped floodplains were designated, bringing the total number of designations to 53.

Nine mapping studies were prepared for designation recommendation to the Ministers. Key plans for all of the designated floodplains were prepared for distribution to federal, provincial and municipal authorities. Also, a video depicting the major features of this program was finalized and distributed.

Manitoba

During 1988-89, Canada and Manitoba negotiated an extension of the General, Mapping, and Studies agreements, with additional funding of \$700 000 (federal share: \$350 000), and provision for the development of a low-cost maintenance phase for the Program. The extension was signed on January 29, 1990. The termination date for the General Agreement is 1999 and for the Mapping and Studies agreements, 1996. There were no expenditures under these agreements in 1990-91.

Under the Flood Protection Projects Agreement, the north segment of the new dyke at St. Adolphe and the upgrading of the existing dyke at Emerson were completed. Other flood protection projects at Brunkild, Letellier, Morris, Rosenort, St. Baptiste and Ste. Rose du Lac have been completed. The agreement expired on March 31, 1991.

New Brunswick

Although there were ice jams in the Saint John River, there was little or no flooding during 1990. In response to concerns raised following the ice jams of 1987, communications continued to be effective among the various federal, provincial, municipal, private and U.S. participants. The Flood Forecasting Technology Task Force produced a report this year. As well, flood documentation studies, which focused on delineating flood lines from historical floods, were completed for the upper Saint John River and

southwest Miramichi areas under the Mapping and Studies Agreement.

Efforts to inform the public about flooding and the aims of the Flood Damage Reduction Program continued. Public information maps were produced for the Nashwaak and Magaguadavic rivers and are under way for Newcastle and Sackville, which are under interim designation.

Newfoundland

During 1990-91, designations took place for Cox's Cove, Bishop's Falls, Trout River, Codroy Valley, Glenwood/Appleton, and Glovertown. Public information maps are now available for these areas.

Hydrotechnical studies and flood risk maps were completed for Bishop's Falls, Codroy Valley and Trout River. Further hydrotechnical work is pending the signing of the extension agreements. Negotiations are taking place with respect to extending the existing agreements to enable the mapping and designation of other areas.

Federal authority to sign an agreement for funding of implementation works in Placentia was granted in early 1990. As of March 31, 1991, the Province had not obtained its authority.

Nova Scotia

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

Treasury Board approval was received for renewing the General Agreement and entering into a maintenance agreement - the first one under the Program.

Ontario

During 1990-91, the Canada/Ontario FDR Program funded 51 projects. Of these, 27 were for flood risk mapping of riverine areas, 21 were for flood risk mapping of the Great Lakes shoreline, and the rest involved other FDR measures studies.

Table 3. Designations to March 31, 1991, under the Flood Damage Reduction Program

Location	Number of Communities Mapped	Number of Public Information Maps	Date of Designation
Alberta			
St. Albert	1	1	January 1991
Cochrane	1	1	January 1991
Medicine Hat	1	1	February 1991
3 designations	3	3	
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
Elk River near Elkford			September 1989
Bella Coola River			September 1989
Nicola River			September 1989
Campbell and Quinsam rivers			March 1990
Beaver Creek			March 1990
Slocan Creek			March 1990
Lillooet River			September 1990
Lakelse River and Lake			September 1990
Williams Lake			September 1990
53 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

*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
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	
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
Nashwaak River	9	1	February 1991
Magaguadavic River	3	1	February 1991
10 designations	67	10	
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
Parson's Pond	1	1	May 1989
Waterford River	4	1	May 1989
Stephenville Crossing/Black Duck	2	1	May 1989
Cox's Cove	1	1	April 1990
Glenwood/Appleton	1	1	May 1990
Glovertown	1	1	May 1990
Codroy Valley	1	1	May 1990
Bishop's Falls	1	1	November 1990
15 designations	25	15	
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
Coulais River	4	1	March 1987
Espanola	1	1	August 1987

Table 3. Continued

Location	Number of Communities Mapped	Number of Public Information Maps	Date of Designation
Thessalon	1	1	August 1987
Little Cataraqui Creek (Kingston)	1	1	March 1988
Moirra 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
Moirra River (Hwy 401 - Bay of Quinte)	1	1	March 1989
Lake Simcoe	3	5	March 1989
Cooks Creek, Schreiber	1	1	May 1989
Agimak River and Lake, Ignace	1	1	May 1989
Wabigoon River and Lake, Swanson Creek, Dryden	1	1	May 1989
Mississagi River, Iron Bridge	1	1	May 1989
Kettle Creek, Port Stanley	1	1	May 1989
Otonabee River	1	1	May 1989
Indian River	1	1	May 1989
Ottawa River, Ottawa-Carleton	7	5	May 1989
Gull River	4	1	July 1989
Gananoque River	5	3	May 1989
Mississippi River	-	5	May 1989
Raisin Region Conservation Authority streams	12	10	May 1989
Muskoka River, Bracebridge	1	1	August 1989
Lake Ontario shoreline, Toronto	3	3	August 1989
Kebsquasheshing and Nebskwashi rivers, Bucciarelli Creek, Chapleau	1	1	January 1990
Lake Huron Shoreline No. 3, Maitland Valley	1	1	January 1990
Mattawishkwia River, Hearst	1	1	January 1990
Root River, Sault Ste. Marie	1	1	January 1990
Welland River, Forks, Black and Beaver creeks	4	4	January 1990
Ottawa River/Hawkesbury Creek	3	1	November 1990
Mattawa River	1	1	November 1990
Thedforde/Klondyke	1		March 1991
Lucan, Crediton and Grand Bend	3		March 1991
Credit River*	8	8	March 1991
Ancaster/Sulphur creeks	2	1	March 1991
Upper Bell Creek	1	1	March 1991
Silver Creek at Collingwood	1	1	March 1991
Willow Creek/Nottawasaga River at Angus	1	1	March 1991
Spring Creek at Alliston	1	1	March 1991
Mad River at Creemore	1	1	March 1991
Rideau River	3	1	March 1991
Elk Lake at James	1	1	March 1991
Big East River at Huntsville	2	1	March 1991
York River at Bancroft	2	1	March 1991
59 designations	175	147	
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
Trois-Rivières Ouest	1	5	August 1984
Jacques-Cartier	1	3	March 1990
Batiscan	1	4	March 1990
Malbaie	2	4	March 1990
Linlère	2	2	October 1990
Beaurivage	1	6	October 1990
17 designations	192	119	

Table 3. Concluded

Location	Number of Communities Mapped	Number of Public Information Maps	Date of Designation
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
Radville	1	1	June 1988
La Ronge/Air Ronge	2	1	October 1989
Tisdale	1	1	November 1989
Buffalo Narrows	1	1	December 1990
Isle à la Crosse	1	1	December 1990
Battleford	1	1	December 1990
North Battleford	—	—	December 1990
12 designations	12	11	
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
Tuktoyaktuk	1	1	March 1988
9 designations	10	9	
Total	521	333	
199 designations			

The Ministers agreed to extend the duration of the mapping component of the Agreement by two years without increasing the funds in the Agreement. The funds in the Other Measures Component were made available for the flood risk mapping of the Great Lakes shoreline. As required in the Amending Agreement, the Steering Committee prepared an Evaluation Report of the Agreement and submitted it to the Ministers. The evaluation reflected the achievements, direction and feedback received from the user agencies.

The Steering Committee recommended and the Ministers agreed to designate 15 additional flood risk areas. The Steering Committee also conducted open-houses at 21 centres in preparation for the designation. As all the remaining funds of the Agreement are committed, the Steering Committee agreed to recommend designation of the remaining flood risk areas based on the engineering scale maps.

To date, there have been 59 designations, involving 175 communities and 147 public information map sheets. Currently, work is in progress on behalf of 30 Conservation Authorities and 12 municipalities where no Conservation Authorities exist.

Two studies were completed, one to determine and improve procedures in flood risk mapping and the other, to summarize the achievements of the Program and determine what is left to be done under the current agreement. A pilot project on the Regional Hydrograph Parameter study was completed. Work was nearly completed to document the history of flooding in Ontario. The Program revised and finished projects on three regional hydrology studies on the Grand River, Spencer Creek, and Niagara Peninsula watersheds. These studies provide design flows for flood line mapping at various locations in each of the damage centres. The Steering Committee commissioned

and completed a project to develop regional flows for the headwaters basins in the Toronto area.

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. From 1987 to 1989, horizontal control was completed for 1200 kilometres of shoreline. This was complemented by vertical control surveys and aerial photography for the same stretch of shoreline. Work has continued to finish ground surveys, aerial photography and aerial triangulation. All but 125 kilometres of Lake Ontario shoreline is documented in the database. Eight projects, costing in excess of \$500 000, were initiated to develop digitally based topographic maps in southern Ontario. Work was completed on the digital mapping of the Saugeen shoreline. Progress was made on the shoreline mapping for the Lake Huron and Lake Erie projects. As well, work was initiated on digital mapping in nine Conservation Authorities along Lakes Huron and Ontario for about \$300 000. All of the projects are scheduled for completion by October 1991.

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

Quebec

The current agreement concerning mapping and floodplain protection was signed on June 25, 1987. The termination date for the mapping component 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. 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).

Up to now there are 17 designations for flood risk areas of 192 municipalities. The number of

municipalities listed in Schedule A of the agreement has increased to more than 500, with some including more than one basin. Hydraulic and hydrologic studies continued in 1990-91.

Flood risk maps for five municipalities were submitted to the Ministers for signature. The maps were prepared for the Urban Community of Quebec and communities along the Noire, Yamaska, North Yamaska, and Saint-François rivers.

Saskatchewan

The communities of Buffalo Narrows, Isle à la Crosse, and Battleford and North Battleford were designated. Hydrotechnical studies were completed for Fort Qu'Appelle, Carrot River, Lebreton, and Craven. Base maps were completed for Maple Creek.

Northwest Territories

Under a program jointly funded by Environment Canada and Transport Canada, daily forecasts of water levels on the Mackenzie River, mainly for low flow navigational purposes, were provided to 11 users from June 1, 1990, to October 23, 1990. A "Users Guide, 1990 Mackenzie River Stage Forecast" was prepared and distributed. Because of user requests for more exact high flow forecasts, work was initiated to upgrade the field observation network and automate forecasting procedures to meet this requirement in 1991-92.

Information and advice during spring breakup on real-time river flows and levels was provided to Hay River, Nahanni Butte, Fort Liard, Fort Simpson as well as to communities in the Mackenzie Delta and Esso Resources Ltd. at Norman Wells. Public announcements were made concerning the Peace and Slave rivers during periods of high summer runoff.

Yukon

A proposal for an agreement with the Yukon Territory is under review.

Table 4. Flood Damage Reduction Agreements to March 31, 1991

Government/Agency	Duration (years)	Total Commitment* (dollars)	Expiry Date
Alberta			
Flood Damage Reduction Agreement	(general 9) (mapping 5)	- 5 500 000	1998 1994
British Columbia			
Floodplain Mapping Agreement	(general 10) (mapping 5)	- 5 000 000	1998 1993
Manitoba			
General Agreement	22	-	1999
Flood Risk Mapping Agreement	19	2 850 000	1996
Studies Agreement	19	510 000	1996
Flood Forecasting	8.5	1 000 000	1989
Construction of Flood Protection Projects Agreement	7	6 900 000(b)	1991
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(e)	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	-	1995
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 19) (mapping 14) (other 14)	- 15 400 000 2 200 000	1997 1992 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
General Agreement	14	-	1993
Memorandum of Understanding	14 (mapping 9)	- 400 000(c)	1993 1988
Indian and Northern Affairs Canada			
Memorandum of Understanding Respecting Flood Risk Mapping of Indian Reserve Lands	10	300 000(d)	1995

* These costs are to be shared equally by the federal and provincial governments except for:
 (a) 33 1/3% federal, 66 2/3% provincial/local; (b) 45% federal, 55% provincial/local;
 (c) costs shared equally by Environment Canada and Indian and Northern Affairs Canada;
 (d) maximum annual amount shared equally by Environment Canada and Indian and Northern Affairs Canada; (e) federal share: \$970 000.

Indian Lands

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

Two Manitoba pilot projects initiated in August 1985 included flood risk mapping of Lizard Point and Sioux Valley Indian reserves. Criteria for selection included the severity of flooding, existing flood-prone development, the need for flood risk information, availability of hydro-metric data, past records, aerial photography, and other maps.

These pilot projects have shown that flood risk mapping of thinly populated, widely scattered reserves is prohibitively expensive. Recently, the focus has been changed to historical flood reviews. A historical flood review of Red Earth Indian Reserve in Saskatchewan was completed in 1988-89. A similar study of the Driftpile Indian Reserve in Alberta was completed in 1989-90.

This past year in Ontario, six projects to obtain topographic mapping for the delineation of flood risk areas of the Reserves in southern Ontario were initiated at a cost of about \$85 000. The hydrologic information from earlier studies will be used. The mapping and hydrologic analysis for

the Rama Indian Reserve has progressed and a new project for mapping the flood risk areas in the vicinity of Fox Lake near Chapleau has been developed.

In British Columbia, four high-priority Indian Reserves were mapped at a cost of \$150 000.

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.

Updating of these guidelines began in 1990-91, with top priority given to the sections on public information, the Environmental Assessment and Review Process, the mapping and surveying specifications as well as the hydrotechnical specifications.

Maintenance Phase of the FDR Program

On October 3-5, 1990, a Flood Damage Reduction Program Workshop was held in Burlington, Ontario. The primary objective was to discuss policy aspects of the maintenance phase of the Program. Policies and guidelines for this phase are now being developed.

WATER RESEARCH UNDER THE CANADA WATER ACT

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

- Federal Water Policy

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

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

NATIONAL WATER RESEARCH INSTITUTE

The National Water Research Institute (NWRI), located at 867 Lakeshore Road in Burlington, Ontario, carries out water research under the Canada Water Act to advance understanding of water issues important to Canada. The knowledge and authoritative expertise developed from the Institute's research program are employed by Environment Canada to influence decisions affecting the wise management of our water resources. The Institute's role in Environment Canada is:

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

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

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

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

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

The Institute's current research projects address eight general water research issues. Highlights of the 1990-91 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 1990-91.

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

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

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

Studies comprise both field and laboratory work. For example, the field sampling and processing of water samples and bottom and suspended sediment samples is balanced with intensive laboratory work to analyze for polychlorinated biphenyls (PCBs), organochlorine compounds, chlorobenzenes, chlorophenols, common biocides, various natural and synthetic tracers and radioisotopes. In addition, methods development is undertaken to improve the speed, efficiency and detection limits of analytical procedures.

Development of the contaminant model TOXFATE continued. This model predicts concentrations of a wide range of contaminants in fish, sediment and water and has been useful in accounting for the fate of toxic contaminant loadings in Lake Ontario. TOXFATE has also been applied to other systems including Lake St. Clair, the Toronto waterfront, and the Niagara and Rhine rivers.

In addition to this modelling work, simple methods are sought to predict organochlorine bioconcentration in fish and other compartments of lakes in Ontario. An analysis of provincial data showed that if forage fish such as alewives, smelt, or ciscos are present, the lake trout are about four times more contaminated than in lakes where such forage fish are absent. Similarly, if the freshwater shrimp Mysis relicta, an efficient planktivore, is present, trout contaminant levels are also higher.

The sampling and analysis of water, and bottom and suspended sediments continued in the Saguenay River and the St. Lawrence River and estuary. Biota samples from the St. Lawrence River watershed were analyzed for PCBs and other organochlorine contaminants, in collaboration with researchers at Laval University and the National Museum of Natural History.

Ultra-clean sampling, processing and analytical methods have been developed using new facilities installed at the Institute and onboard ship. The

resulting protocols were evaluated on open lake samples from Lakes Ontario and Erie. These studies indicate that previously reported levels of trace metals from the surface waters of the Great Lakes have been in error - in some cases by as much as a factor of 100. This has implications not only for our reporting under the Great Lakes Water Quality Agreement but also for our understanding of the cycling of trace metals in the ecosystem.

A study of the Yamaska River, which flows into the St. Lawrence, has revealed the intermittent occurrence of 15 dyes in water, suspended solids and sediment downstream from textile mills. The most contaminated area was downstream from Granby, which has the largest concentration of textile mills in the basin. In addition, 2-bromo-4,6-dinitroaniline (a mutagenic degradation product of Disperse Blue 79) was identified in sediment at one site. Most of the dyes found are expected to be moderately stable in aerobic environments, but they may degrade under anaerobic conditions. This is the first time that dyes have been identified in the Canadian environment.

Lake Restoration

Research continued on the evaluation of remedial options for restoring the ecological integrity and human use of polluted lakes and embayments. This multidisciplinary activity requires the melding together of long-term water quality information with new research results to develop the predictive models needed to select optimal solutions to water quality problems. It is a crucial contribution to the federal-provincial Remedial Action Plan (RAP) development.

Attention continues to be focused on Hamilton Harbour and the Bay of Quinte. Research is also taking place in several other areas, such as Collingwood Harbour, Severn Sound, Spanish River and Toronto Harbour, which have been designated as Areas of Concern by the International Joint Commission.

Water clarity in Hamilton Harbour has improved recently due to reduced phosphorus loadings.

Historical water clarity observations were compared with present-day observations to develop a relationship between water clarity and phosphorus loading. Further loading reductions proposed in the Remedial Action Plan can now be evaluated with respect to their expected effect on water clarity.

Organic chemistry plays a central role in the success of many studies in the Areas of Concern. Samples from Hamilton Harbour were analyzed to determine the spatial, temporal and phase distribution of organochlorines. The results show that the loading of PCBs and polycyclic aromatic hydrocarbons (PAHs) from the harbour to Lake Ontario are 10 to 1000 times lower than the loads from the Niagara River.

Studies in the Bay of Quinte have shown that almost all of the silty-clay bottom sediments of the bay are derived from the Trent and Moira rivers. Research on these suspended sediment loads and the bottom sediments has indicated that they release considerable soluble phosphate. In addition, riverine inputs of biologically available phosphorus in April, May and June are between 1.3 and 8 times the inputs from the sewage treatment plants. This early summer input of available phosphorus gives an unwanted stimulation to summer algal productivity. Non-point source controls may have to be considered if the Bay of Quinte is to be returned to its earlier oligotrophic status.

Recent research on the lake ecosystems led to demonstrations of remedial techniques for small lakes in Alberta and British Columbia. For example, preliminary results on the oxygenation of Amisk Lake, Alberta, showed an enhanced fishery resulting from habitat expansion. The release of phosphate from the sediments may also have been reduced by this remediation technique.

Assessment and Remediation of Contaminated Sediments

Previously contaminated bottom sediments are a major source of toxic substances to the overlying waters and biota of lakes. Research is being conducted on the composition and distribution of

toxic substances in sediments and on the physical and biogeochemical processes controlling lake sediment-water interactions. The focus is on sediment deposition and resuspension, chemical release rates, microbial degradation, bioaccumulation and toxicity. Results from this work will be used to evaluate the need for and plausibility of remedial measures in the Great Lakes and elsewhere. In addition, the effectiveness of specific remedial techniques such as chemical and biological treatments and in situ capping are being studied.

A detailed map of the distribution of toxic contaminants in Hamilton Harbour sediments was prepared. Study results on the toxicity and composition of coal tar in the harbour were used in planning a pilot-scale demonstration to remove and clean up bottom sediments. It was discovered that PAH profiles in the coal tar area differ from the general composition in the harbour, mainly in that they have much higher concentrations of naphthalene. These high concentrations of naphthalene are consistent both with the presence of coal tar and with possible direct input of coke oven waste streams.

Initial investigations on subaqueous capping as a means of isolating contaminated fine-grained sediments from aquatic and terrestrial environments were conducted. Preliminary results, using a new analytical approach, predict greater settlement and substantially faster rates of consolidation than those calculated using standard analysis. This information is important for the field demonstration phase of the study which will be conducted next year.

Assessment of Airborne Toxic Substances and Climate Change Effects on Aquatic Ecosystems

Long range transport and deposition of chemicals to aquatic and terrestrial compartments of the environment is a major cause of environmental pollution. In some parts of Canada, this mechanism represents the most important single source of selected chemicals. The atmosphere is an important sink for some chemicals; it serves as a medium for a continuous cycle of deposition

and volatilization of persistent organic contaminants which may ultimately be deposited in the Canadian high Arctic. A detailed understanding of this cycle is needed to quantify the impact that the atmosphere has and will continue to have on the pollution of Canada's surface waters and elsewhere.

Snow samples were collected from the Agassiz Ice Cap on Ellesmere Island, from a site near Resolute, and from a network of 22 stations across the Yukon and Northwest Territories. Results clearly show that our understanding of the extent of the contaminant problem in the Arctic is very poor. The snow record, while substantial, is only showing a small part of the deposition that is taking place and which is raising the levels of these substances in the tissues of humans and biota.

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 exchange of toxic chemicals and greenhouse gases across the air-water interface. This facility was used to explore the effects of aerodynamic roughness wave properties on transfer rates of chlorobenzene and water vapour. Another experiment explored the effects of the wave fetch and temperature on the transfer rates of carbon dioxide and water vapour. An understanding of the transfer rates of these gases is important in the area of climate change. Related work has continued on the analysis of mixing processes beneath the water surface, the properties of directional waves, and the statistics of shoaling waves.

A major study, headed by the Canadian Institute for Research in Atmospheric Chemistry and coordinated through NWRI, to determine the role of wetlands in the global methane budget and on climate change processes has been completed. Preliminary findings from work on the Hudson Bay Lowland indicate that the contribution to the global budget from these wetlands is not as great as previously thought.

Acid Rain

Research into the effects of acid precipitation on lakes, rivers and wetlands is ongoing and with an increasing focus on the effects of nitric acid. Evaluation of critical processes in the acidification and recovery of aquatic ecosystems is undertaken at a variety of sites in eastern Canada. A major collaborative field program with Forestry Canada and the Department of Fisheries and Oceans continues at the Turkey Lakes, north of Sault Ste. Marie.

The Institute has also provided leadership in the assessment of the acid rain monitoring program and the evaluation of the effectiveness of various emission control strategies. The latter work utilized 17 000 data records on deposition, soil types, water chemistry and biology. The analysis of these data, by an expert system, was the only effective way of evaluating the effects of emission scenarios on all the smaller sub-regions in eastern Canada.

Pesticide Assessment

NWRI pesticide research contributes in 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.

Work this past year on the pyrethroid insecticide deltamethrin and the organophosphorus insecticide fenitrothion sprayed on ponds (simulating spray drift) has indicated that extremely rapid volatilization from the surface of water is the major dissipation process. However, contamination of the surface "microlayer" during this period may pose hazards to organisms that spend part or all of their lives at the air-water interface. The hazard may be acute but short-lived in areas sprayed directly or close to aerial spray operations.

Research was carried out to develop methods to determine the impact of pesticides on attached algal communities (periphyton) in streams. A portable incubator was used to determine the effects of atrazine, metolachlor, hexazinone and tebuthiuron on the photosynthetic activity of the periphyton. Using this method, concentrations of the pesticides which caused a significant reduction in primary productivity were determined. The order of toxicity from greatest to least was as follows: hexazinone; atrazine; tebuthiuron; metolachlor. Effects of hexazinone occurred at concentrations as low as 50 µg/L.

For the past three years, the effects of herbicides on the growth of periphyton in streams adjacent to land with a range of tillage practices (conservation versus conventional) have been studied using artificial substrates. The results of these studies suggest that ambient levels of atrazine found in agricultural streams with concentrations less or equal to 25 µg/L have no long-lasting detrimental effects on the growth of attached algae. However, higher concentrations which could occur during storm runoff events may temporarily reduce photosynthesis.

Groundwater Contamination

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

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

During the past year, chemical and biological processes influencing contaminant transport and fate in granular aquifers have been studied near the Gloucester landfill site in Ottawa where laboratory solvents had been dumped. In particular, toxic degradation products of chlorofluorocarbon-113 (CFC-113) were identified, suggesting that it may not be as inert metabolically as previously thought. A laboratory microcosm experiment was conducted to determine rate constants for the metabolism of CFC-113 and the principal metabolites CFC-123a and chlorotrifluoroethene.

Research on the development of expert systems (ES) continued this past year. ES is a special field of artificial intelligence, which is employed in water management for decision-making. It uses a collection of facts, rules of thumb, and other knowledge to help make inferences on how to deal with the water management problem under consideration. One system is being designed to aid regulatory personnel in determining the potential impact of newly introduced pesticides on typical Canadian groundwater environments. In addition, the development of an expert system to rank and classify contaminated sites was initiated.

During 1990-91, a study to investigate the potential impact of natural gas seepage on shallow groundwaters in southern Ontario was initiated. There have been several examples across southern Ontario where the occurrence of natural aromatic organic compounds in groundwater samples has been misidentified as petroleum product contamination. This study will map, on a regional scale, the distribution of these natural compounds in groundwater.

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

Assessment of Industrial Effluent Impacts

The impact assessment of effluents on aquatic ecosystems is complicated by the fact that most of these discharges contain mixtures of organic compounds and metals which have varying degrees of individual and cumulative toxicity. NWRI's research program on pulp and paper mill effluent impacts is tackling this problem. A variety of chemical and ecotoxicological tests have been undertaken to quantify the link between the extent of chlorination and the effluent's immediate and long-term toxicity. This research has been accomplished in partnership with universities, industry and other government departments.

A project on the Athabasca River, which is partially funded by PERD (Panel on Energy Research and Development; Energy, Mines and Resources Canada), is studying the fate, pathways and effects of chemicals released from the exploitation of oil sands. In combination with the PERD project, the Institute has played a major role in the design and initial implementation of studies to address emerging concerns related to the development of pulp and paper mills on the Peace-Athabasca-Slave Basin.

Aquatic Assessment Methods Development

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 studies serve this broad operational need and, at the same time, contribute to the Institute's research on other issues.

For example, the following analytical methods and techniques were developed in 1990-91:

- A new method for organotin compounds at the required level of sensitivity, based on the coupling of atomic emission detection and gas chromatography techniques
- A gas chromatography/mass spectrometry method for non-chlorinated dibenzofuran and

dibenzo-p-dioxin in compounds, used as defoamers in the pulp and paper industry

- A new instrumental technique for heavy metals at ultra-trace levels in environmental samples, which is based on the application of laser-excited atomic fluorescence spectrophotometry
- An improvement of the method to measure low levels of lead in water samples by atomic absorption spectroscopy
- Improvements in terms of sensitivity and selectivity developed for multi-element determinations via cathodic differential pulse stripping voltametry.

Interlaboratory quality assurance studies were completed for 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.

With the assistance of the International Development Research Centre, a combined coliphage/coli-form test was developed. The procedure is simple, inexpensive and designed for testing potable water in developing countries and rural areas without sanitized water supplies. A prototype application at Manitoba's Split Lake Community has been successful and sponsorship of a wider program is being considered.

NATIONAL HYDROLOGY RESEARCH INSTITUTE

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

- To undertake scientific research and provide national leadership on surface and groundwater systems
- To address problems of water and environmental processes related to climate and socio-economic development in western and

northern Canada within the mandate of Environment Canada.

Scientists conduct research to improve our understanding of the physical, chemical and biological processes that influence or that are affected by the hydrologic cycle. This new knowledge is then incorporated into models of various segments of the hydrologic and aquatic environments. Thus, the consequences of changes in the cycle or system through external forces (such as climatic change or the impact of human activity) can be assessed, and measures developed to mitigate undesirable effects.

In the past year, NHRI research activities have been organized into two programs that involve five major projects in the following areas of research:

- Climate and Hydrology
- Land/Atmospheric Processes
- Northern Hydrology
- Nutrient Impacts and Ecosystem Rehabilitation
- Groundwater and Contaminants.

Organizing along project lines facilitates the work of Institute scientists in studying environmental issues and problems from a multidisciplinary point of view. The research projects are carried out within two scientific divisions: the Hydrological Sciences Division and the Environmental Sciences Division, both of which are supported by a Science Liaison Division, which is responsible for providing communication and information services to both internal and external groups.

The Institute is located at 11 Innovation Boulevard in Saskatoon at the National Hydrology Research Centre (NHRC), which also houses the Hydrometeorological Research Division of the Canadian Climate Centre and the Meteorological Inspection Office (both of the Atmospheric Environment Service), and the Water Quality Branch Laboratory of the Inland Waters Directorate, Western & Northern Region. A communications officer with the Communications Branch, Western & Northern Region, is located at

the Centre to assist with communications activities.

Climate and Hydrology

Satellite Snowpack Monitoring

Satellite observations of 17 different watersheds were used to estimate spring runoff in the Rocky Mountains and the Plains regions. Average snowmelt runoff and microwave brightness are correlated. For Rocky Mountain watersheds measuring 5000 to 10 000 square kilometres, the results are almost as good as the conventional snow courses for 1973-1976. Interannual variations in snowpack and brightness are localized and their significance is being tested as a function of watershed area and alpine fractional area. For the Plains, a good multiple correlation was established between microwave brightness, spring runoff, and previous October streamflow. In the Iron Creek (3500 square kilometres) and Antler River (3200 square kilometres) basins, air temperature was measured at four and six climate stations, respectively, and a microwave emissivity index computed as the ratio of monthly mean brightness to surface temperature. This index could be used to monitor monthly basin moisture status. Plans include further digital data analysis, streamflow separation, and airphoto interpretation of the Plains basins. Twenty-three ocean areas were analyzed as potential calibration targets with an ocean-atmosphere model.

Proxy Climate Data from Ice Cores

Analysis of ice cores taken from a field site on Mount Logan in the Yukon has disclosed significantly lower snow accumulation rates from A.D. 1700 to 1860 than from 1860 to 1987, and it has also revealed the existence of "teleconnections" (ultra long-distance correlations) between the Mount Logan net snow-accumulation time-series elsewhere in the Northern Hemisphere. Another important finding is that the main atmospheric pollution of high-altitude snow is by volcanic-eruption gas plumes and possibly forest fires.

Apart from recent contamination by radionuclides from atmospheric nuclear weapons testing, there is no evidence of other acid pollution due to human activity, such as is found in Greenland.

Mountain Hydrology and Glacier Meltwater

Winter and summer mass balance data have been collected at a number of selected glacier basins in Western Canada as part of a continuing study. During 1990, the field program included geodetic surveys of the Peyto and Sentinel glaciers to determine the total ice loss since original maps were prepared at the start of the International Hydrological Decade program in 1965. The research studies include collaborative programs with scientists from the University of Toronto and Wilfrid Laurier University. Reports were prepared on ice mining at the Cline Glacier in Alberta and on a proposed copper mining development of the Windy Craggy property in northern British Columbia.

CRYSYS - Glacier Component

Scientists at NHRI are taking part in a collaborative venture with NASA and the Canada Centre for Remote Sensing called CRYSYS (CRYospheric SYStem to monitor global change in Canada). The study will make use of the Earth Observing System satellites that will be launched later this decade; NHRI will be responsible for inventory studies prior to launch. The first field experiment was conducted in the spring of 1991 in conjunction with a NASA overflight.

The State of Canada's Glaciers

Recent glacier activity and all relevant studies have been documented as part of a global project being sponsored by the U.S. Geological Survey for a satellite image atlas of glaciers of the world. The Canadian report on glaciers in the Rocky Mountains consolidates glaciological information collected over the last century and provides a solid foundation for planning future glaciological work.

Land/Atmospheric Processes

Irrigation Return Flow

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

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

Snow Management and Snowmelt Infiltration

Field measurements of blowing snowstorms, snow accumulation in forests and snowcover development are directed toward developing physically based computer models of snow redistribution processes and their effect on regional and local water budgets. Studies have been started at Resolute Bay, N.W.T., to collect data on blowing snow transport and chemistry; at a sub-alpine area in the Kananaskis Valley, Alberta, to identify accumulation and sublimation processes in the forests and open areas; and at a prairie location to determine the benefits of wind breaks. Studies show that the sheltering effect extends downwind about 30 times the height of the windbreak.

Evapotranspiration

This study is to assess existing techniques to estimate evaporation and to develop new approaches to modelling evapotranspiration. It is a continuation of an evaluation of the Complementary Relationship Areal Evapotranspiration (CRAE) model developed in Canada, to improve the model, particularly with regard to its energy (radiation and soil heat flux)

algorithms and its vapour transfer function. Preliminary field studies have enabled the identification of a vapour transfer relationship on a daily time scale and the development of a new approach to estimating evapotranspiration.

Suspended Sediment Transport

Suspended sediments have been linked to the transport of toxic contaminants in many rivers. Quantification of the potential hazard has been limited by the difficulty and high cost of sampling using continuous-flow centrifuge technology. To overcome some of these difficulties, a sampler has been developed to collect time-integrated samples of the horizontal flux of suspended material in rivers. The samplers are lined with glass and are cleaned to rigid specifications in the laboratory prior to installation in the river. These low-cost samplers can be deployed in sufficiently large numbers to permit identification of sources of toxic contaminants. Field tests are currently under way at sites across Canada in cooperation with the Water Quality Branch of Environment Canada and the Centre Saint-Laurent.

Northern Hydrology

Snowmelt Runoff in Permafrost Basins

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

Analysis of these data will provide an understanding of the annual cycle of the changes in soil moisture. This includes infiltration of snowmelt water into the frozen active layer,

drying of the active layer over the winter, and exchange of water between the active layer and the underlying permafrost, snow energy balance, and snowmelt runoff. Reports on infiltration of meltwater into frozen soils and a comprehensive review paper on snowmelt runoff have been published.

Ice Breakup and Related Environmental Effects

Spring ice breakup is often the most spectacular and energy-intensive event of the annual hydrologic cycle on northern rivers. Flood-related effects of breakup occur in almost all regions of Canada. Institute studies of breakup processes focus on predicting the severity of ice runs and ice jamming for a better understanding of changes in ice cover strength. Meteorological and ice strength measuring equipment has been used to quantify the decrease in ice strength under radiation decay.

Investigations on the Liard River in the N.W.T. and on a small lake near Saskatoon indicate that as little as 10% melt fraction will reduce the strength of columnar ice by some 50% compared to competent ice at 0°C.

Mackenzie Delta Hydrology

Studies on the hydrology of lakes in the Mackenzie Delta focus on the potential environmental impacts of climate change, sea level rise, and/or hydroelectric development. Five years of lake water balance data for a number of lakes have been analyzed and the interactions between hydrologic sources of water and biogeochemical processes within the delta ecosystem evaluated, particularly with respect to flood hydrology, evaporation and nutrient supply.

Freeze-up and Related Environmental Effects

Freeze-up processes on northern rivers are largely controlled by the growth and evolution of dynamic ice types, specifically frazil and anchor ice. Problems related to frazil ice growth are diverse. They range from restrictions on hydropower operation to effects on riverine biota and fish habitats. A study of frazil ice

has been partly funded by Hydro-Québec, Manitoba Hydro, Ontario Hydro, and the New York Power Authority. A circular laboratory flume has been constructed, and video and digital data on anchor ice formation and frazil concentration/distribution have been collected under a range of hydrothermal conditions. Analysis of these results continues.

Wetlands in Permafrost Environments

The abundant wetlands of Canada's North represent a valuable ecological resource, the hydrology of which is at present poorly understood. A field study has been initiated on Manner's Creek near Fort Simpson, N.W.T., to improve our understanding of wetland-permafrost processes and to assess potential hydrologic impacts of climate change. Using geochemical and isotopic methods, flow paths within the wetlands have been investigated and an assessment made of their significance to runoff generation. The study has shown that some of the wetland ponding and restriction to lateral flow is dependent on the presence of permafrost-hydrologic divides. Current plans are to assess their overall significance and to model the change in the hydrologic regime that would result from climate-change induced meltout of such divides.

Nutrient Impacts and Ecosystem Rehabilitation

Prairie Lake Ecology

The many small freshwater and saline lakes of the Prairie Region are important recreational areas and wildlife habitats. To manage these systems within the concepts of sustainable development and global warming requires an in-depth understanding of their structure and functioning. It is unclear why neither freshwater nor saline prairie lakes respond to nutrient loads (nitrogen and phosphorus) as predicted by commonly used empirical models. Eutrophication remains a major environmental problem in western and northern Canada.

Studies of phytoplankton (algal), zooplankton, benthic invertebrates and heterotrophic bacterial production have been undertaken in productive and

non-productive saline and freshwater lakes to determine energy transfer through the food web of these different lake types. In particular, studies are under way to ascertain the dependence of bacterial production on phytoplankton production, to assess whether the existence of heterotrophic bacteria leads to summer deoxygenation in productive lakes, to discover the primary limiting nutrients to phytoplankton growth in non-productive saline lakes, and to identify linkages between benthic and open-water communities. Results from these studies are helping NHRI scientists to develop better management strategies for long-term sustainability of prairie water supplies by enabling them to pinpoint the particular factors that cause prairie lakes to respond differently to nutrient loads.

Impacts of Nutrients on Rivers

The Thompson River in British Columbia is a nutrient-limited system in which the food web is primarily dependent on algal production. Research has focused on algal/nutrient/grazer interactions because phosphorus loading from municipal and pulp mill effluents was believed to be the cause of a dramatic increase of algal biomass in the Thompson in the 1970s. After phosphorus loading was cut by 60%, the algal biomass declined. However, recent experiments carried out by NHRI scientists suggest that the reduction in phosphorus loading is not solely responsible for reduced accumulations of river algae. At least one group of algal-grazing invertebrates (Ephemeroptera) has increased by an order of magnitude during the late 1980s, suggesting that grazers are modifying the response of algal biomass to phosphorus in the river. Results of laboratory experiments confirm that under certain conditions mayflies can sharply reduce diatom mass. More laboratory and field experiments are now under way to discover whether invertebrate grazers serve as top-down control agents of algal abundance in the river. Ultimately, these experiments may indicate whether grazer impacts have the potential to modify previously demonstrated nutrient/algal biomass relationships.

Also in the Thompson, a multi-year collaborative study with the National Water Research Institute has been undertaken to investigate the possible bioaccumulation of contaminants along a 100-kilometre stretch of river downstream from the pulp mill effluents.

Aquatic Macrophytes in Prairie Lakes and Watercourses

In the shallow lakes and rivers of the Canadian prairies, submerged aquatic plants grow abundantly, attaining biomasses that are sufficiently large to block water movement, cause water quality problems in domestic and livestock drinking supplies, impair recreational activities, and cause fish kills by depleting oxygen levels. The goal of this research program is to develop innovative management strategies for long-term control of aquatic weed growth in prairie lakes and watercourses. Research has been directed toward the discovery of safe environmental controls: for example, increasing flow rates during critical plant growth stages. Lime is being investigated as an additive that would bind with phosphate and render it unavailable to plants in lakes and dugouts. Results of this investigation show a dramatic decrease in aquatic weed abundance, with submerged plants virtually eliminated two to three weeks after treatment. New studies are now under way to examine the impact of lime additions on aquatic community structure and to determine the mechanism by which lime inhibits plant growth.

Limnology of Great Slave Lake

Great Slave Lake is a large, relatively pristine lake located in the Canadian Arctic. It is important to the local economy which supports commercial and sport fishing. The limnological properties of the lake are strongly affected by the Slave River, which provides water and sediment to the western basin. There are potential adverse effects from developments within the basin. Current research includes collaborative studies of the under-ice ecology and sediment transport.

Groundwater and Contaminants

Hydrology of Fractured Clays and of Shales

Clay tills in the western glaciated plains generally have low permeability, and as flow rates through the tills may be very low, the transport of natural solutes and of contaminants may be largely by diffusion - a very slow process. A long-term study is being carried out to date the porewaters of clay tills at four sites using carbon-14 and carbon-13 analysis on dissolved inorganic carbon and dissolved organic carbon. Porewater samples collected from these sites indicate that they contain porewater over 20 000 years old. More accurate ages will be determined in 1991-92.

Long-term transport through tills of aqueous oxygen-18, chloride and related inorganic ions is being investigated with vertical profiles from several sites. Another study concerns the movement of brine downwards from large salt tailings and brine storage areas near potash mines. It is focusing on the possible movement through fractures and on permeability changes in the clays due to brine.

All of these studies are relevant to the management and protection of groundwater resources in the prairies, particularly with respect to contaminant transport.

The confining nature of slowly permeable shales is difficult to characterize. A study is being made to assess the usefulness of naturally occurring isotopes (oxygen-18, deuterium, chlorine-36 and iodine-129) in shales and groundwater samples to estimate the age, source area(s) and transport mechanisms in the confining shale. The main areas of study are near Milk River, Alberta, and near Saskatoon, Saskatchewan.

Contaminant Transport Studies in Aquifers

In Canada, since groundwaters from aquifers are the main source of water for many domestic, municipal, agricultural and industrial uses, any contamination is a serious concern. Institute

scientists provide information and advice on a number of projects and are making detailed studies of two aquifers. The study areas are the Condie Aquifer in the Regina area where an extensive contamination plume emanates from a sewage lagoon, and the Abbotsford Aquifer in British Columbia where low but persistent levels of pesticides have been measured at selected locations. In 1990-91, detailed studies in the Abbotsford Aquifer were initiated to determine the factors controlling the migration and fate of 1,2-dichloropropane. In 1991-92, regular monthly monitoring will be started at several depths to determine the time dependence of this chemical.

Facility for Indoor Aquifer Testing (FIAT)

The FIAT is a mesoscale model system, which is 4.6 metres high and 2.4 metres in diameter, containing 65 tonnes of soil and aquifer materials. This apparatus is essentially a very large, experimental tank, with the capacity for fine control of water inputs and outputs. It is fitted with numerous water and soil sampling ports. FIAT was conceived as a general purpose test facility for hydrogeological and hydrogeochemical investigations on a variety of aquifer materials under highly controlled conditions.

FIAT has been used successfully in two investigations of groundwater contamination during the past year. The first of these studies examined the effect of water infiltration into an alkaline fly ash disposal site and the impact of the resulting contaminant plume on the microbiota of the model aquifer system. A decline of three orders of magnitude in microbial activity occurred, while toxic effects were reflected also in lower numbers of organisms and reduced diversity. These results indicate that any failure of confinement technology at fly ash disposal sites could have serious impacts on the chemistry and microbiology of the underlying vadose and saturated zones.

In another study the mesoscale model system was used to investigate the transport and degradation of agricultural pesticides, a growing cause of public and regulatory concern. A rain simulation system ensured uniform coverage to the model

aquifer, and sampling of soil sediment, pore waters and gas phase was carried out using a series of in situ collectors and sampling ports. Initial results of tests on the herbicide diclofop-methyl (Hoe Grass) indicate transport of the herbicide through the upper 0.5 of the column with subsequent adsorption to sediment and degradation in the pore waters. These studies will continue through 1991-92.

Acid Mine Drainage

Acid mine drainage is one of the most expensive environmental issues facing the mining industry today. The thrust of NHRI research is to couple geological and mineralogical information with water chemistry to determine the fate and transport of contaminants resulting from mining activities. In 1990-91, detailed studies of an abandoned open pit copper mine on Mount Washington, Vancouver Island, determined the geochemical parameters controlling the acid generation and metal leaching process. The relative reactivity of the sulphide minerals from greatest to the least was as follows: marcasite; pyrohotite, chalcopyrite; pyrite/arsenopyrite. Further studies have begun in the South MacMillan River area of the Yukon.

NHRI Continues to Progress

During 1990-91 the National Hydrology Research Institute held a series of seminars given by invited national and international authorities in a number of disciplines. Scientists at the Institute organized and held two major international meetings in Saskatoon. On July 10 to 12, a Northern Hydrology Symposium was attended by more than 90 participants from Canada, the United States, and circumpolar countries. A 400-page book "Northern Hydrology: Canadian Perspectives" published in the NHRI Science Series formed the basis of the meeting. On August 26 to 30, 1990, in cooperation with the Rawson Academy of Aquatic Sciences, the Institute held a conference on Aquatic Ecology in Semi-Arid Regions. The meeting was attended by more than 95 participants including visitors from India, Australia, and New Zealand. The Institute

anticipates holding or organizing a number of meetings and workshops in the future. These include the Ninth Meeting for the Northern Research Basins (1992), another joint conference with the Rawson Academy (1993), a meeting of the Group for Aquatic Primary Production (1993), and a workshop on irrigation developments.

GROUNDWATER CONTAMINATION STUDIES IN NOVA SCOTIA

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

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

During 1990-91, efforts were focused on the collection and analysis of samples of the unsaturated zone (using lysimeters) and of the saturated zone (using piezometers) in a field of corn. The target herbicide was atrazine. This monitoring will continue next year. Also planned is the monitoring of the fungicide chlorothalonil in a field of potatoes. Monitoring for background chemistry and groundwater levels will continue throughout the farm.

Other activities this past year included:

- Installation and slug testing of a new well
- Installation of a tipping bucket rain gauge
- A major survey of the piezometers and wells
- A surface water balance study
- A groundwater modelling project
- A study of the mineralogy of the area
- Groundwater level monitoring.

Much of this work is being coordinated with the Centre for Water Resources Studies of the Technical University of Nova Scotia in Halifax, the Nova Scotia Department of Environment, the National Hydrology Research Institute, and the National Water Research Institute.

SOCIO-ECONOMIC STUDIES

The role and visibility of socio-economic studies in Canadian water management grew over the 1990-91 fiscal year, in keeping with the intent of the Federal Water Policy. Substantial progress was made in several areas.

Water Resource Economics

Concerted work has commenced to adapt various economic instruments to Canadian water management in the following areas:

- Guidelines for municipal water pricing
- A comprehensive review of economic instruments for the federal Green Plan
- The application of economic instruments to the concept of sustainable development in the Fraser River basin
- The application of water pricing in the industrial sector
- The investigation of the role of realistic water pricing in fostering technological change in the Canadian water industry.

Investigations were also completed on private sector involvement in municipal water facilities in the Halifax-Dartmouth area, and of the application of economic principles to the Remedial Action Plan process in the Great Lakes Basin. In recognition of the increasing importance of economic factors in water management, a Water Resource Economics Section was established within the Inland Waters Directorate of Environment Canada.

Water Use Studies

Reports were completed on water use in municipalities (for 1989) and major industries (1986), and also on municipal water pricing (1989). Preparations were started for a

re-survey, in 1991-92, of both municipal and industrial sectors to obtain updated information on water use and water pricing.

Database Construction

Work was completed on the National Water Use Database, which is a storage and retrieval system for data held by the Directorate on industrial and municipal water uses. The database contains data only for 1986, but plans are under way to include all of the data collected since 1972.

Water Demand Management and Conservation

A comprehensive report was completed on the application of water demand management concepts to future water management in the South Saskatchewan River basin within the Province of Saskatchewan. Also, intensive work was begun on water conservation at federal government facilities. The first product was a report on the potential for water conservation at the Canada Centre for Inland Waters in Burlington, Ontario.

Environmental Indicators

The World Commission on Environment and Development (1987) and the G-7 Paris Economic

WHAT ARE ENVIRONMENTAL INDICATORS?

Environmental indicators are aggregate and/or surrogate measures which summarize the state of environmental quality, natural resource assets and related human activity. The objective behind indicators is to select those key measures which best represent and collectively provide a comprehensive profile of the state of the environment. They focus on measures of environmental change and on measures that convey how the environment is responding to stress and management. Charted over time, these indicators are a tool which help to show trends in our progress toward, or away from, the goals of sustainable development.

INDICATORS AS A TOOL

Currently, decision-makers make use of economic indicators such as inflation, unemployment rates, GNP and Dow Jones. The addition of environmental indicators will provide the necessary balance with economic indicators to improve decision-making for sustainable development.

Environmental indicators can:

- Help to convey to decision-makers and the public, in a more succinct and understandable way, information on the state of the environment and progress toward sustainable development which can then be integrated with economic factors to improve decision-making.
 - Act as early warning signals of emerging environmental issues which can assist managers in making pro-active decisions.
 - Measure the success of policy and program responses to environmental concerns, and let us know whether our actions are making a difference.
-

Summit of July 1988 highlighted the need to develop measures of Canada's environmental performance and progress toward sustainable development. Both the Federal Water Policy and the Green Plan commit the federal government to a State of the Environment reporting system which, as elaborated in the Green Plan, includes the development of a national set of regularly reported environmental indicators by 1993.

In 1990-91, under the leadership of Environment Canada, an Environmental Indicators Task Force was created to coordinate the development of a prototype set of national environmental indicators for presentation to the OECD (Organization for Economic Cooperation and Development) Ministerial meeting in Paris in January 1991.

Through consultation with data holders and specialists, a preliminary set of environmental

indicators was developed. Although the constraints of relying upon existing data and monitoring somewhat circumscribed the project, 43 indicators in 18 "issue" areas were developed.

Four indicators of national water use trends were determined. It was not possible to provide comprehensive national trends for water quality because past and current water quality monitoring has not been designed to support environmental reporting but rather to address local and regional needs. Freshwater indicators for eutrophication and pesticide contamination were presented to portray conditions at select sites.

More widely based consultations to refine the preliminary set will take place over the next year. According to the Green Plan, by 1993, the Government of Canada will develop and release, on a regular basis, a comprehensive set of indicators that measure Canada's progress in achieving our environmental goals.

WATER DATA

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

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

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

DATA MANAGEMENT SYSTEMS

Data and information reference systems are essential to water resource planning and management. Federal and provincial governments, universities and the private sector depend on this information. The water-related databases and information systems in operation during 1990-91 are listed in the table on page 40. One of these databases, AQUAREF, is produced by WATDOC, a section of the Inland Waters Directorate (IWD).

WATDOC

Through the AQUAREF database, WATDOC provides the scientific and technical community, as well as the general public, with French and English bibliographic references to Canadian water resources publications and other environment-related documents. For example, AQUAREF includes over 3900 references cited in the Canadian Water Quality Guidelines.

WATDOC has referenced all reports produced to date under the Canada Water Act as well as those related to the Federal Water Policy and the Inquiry on Federal Water Policy. Microfiche copies of all reports pertaining to the Canada Water Act are deposited with Environment Canada's Departmental Library in Hull, Quebec, K1A 0H3, as well as with the Canada Institute for Scientific and Technical Information in Ottawa, Ontario, K1A 0S2. This past year Environment Canada published the Bibliography of Canada Water Act Publications 1970-1990.

WATDOC also produces bibliographies and inventories from subsets of AQUAREF. In 1990-91, WATDOC and the Water Quality Branch of IWD worked together to produce the "Publications 1989" listing. Copies of the Water Quality Branch and Canada Water Act bibliographies may be obtained by writing to:

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

Water-Related Databases and Information Systems

Name	Data Provided
AQUAREF	References to Canadian water resources documents and environment-related articles and reports
NAQUADAT	Water quality data (including chemical, physical, bacteriological, biological, hydrometric) collected for the national water quality monitoring program
STAR	Limnological data on the Great Lakes
MUD and MUP	Data on municipal water and wastewater usage (MUD) and water pricing (MUP) on an individual municipality basis
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
INUDAT	Industrial water use data for four sectors - manufacturing, mineral extraction, thermal power and hydropower - for over 5000 industrial firms across Canada
NAWUDAT	The National Water Use DATabase is a pilot data storage and retrieval system for Environment Canada's (1986) water use data which covers major industries and municipalities
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

As part of the Green Plan initiative dealing with Environmental Citizenship, AQUAREF has been expanded to include references on water education material and general water information. This project is called WACE (Water Awareness, Communications and Education).

During 1990-91, WATDOC was highly visible to the public. WATDOC personnel organized displays at several water-related conferences across Canada. They gave demonstrations on AQUAREF and on the techniques for searching the file. To provide more comprehensive marketing of the IWD databases, WATDOC continued to work with other sections of the Water Planning and Management Branch, the Water Resources Branch, and the Water Quality Branch of IWD in presenting the water use

databases, the HYDAT databank, and the NAQUADAT database.

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

Part II: Water Quality Management

Canadian Water Quality Guidelines

Water Quality Guidelines are scientifically derived tools used in water resource management. In 1987, the Canadian Council of Resource and Environment Ministers (CCREM) (now called the Canadian Council of Ministers of the Environment) published the first edition of the Canadian Water Quality Guidelines. This document, prepared by the CCREM (now CCME) Task Force on Water Quality Guidelines, is a compilation of information on specific water quality parameters that help to determine whether water is suitable for the following major uses: raw water for drinking water supply; recreational water quality and aesthetics; freshwater aquatic life; agricultural uses; and industrial water supplies.

The Guidelines address more than 50 specific substances of concern, including many toxic substances such as heavy metals and pesticides, 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 various water uses and to support the development of site-specific water quality objectives which take local environmental and socio-economic conditions into consideration.

The federal departments of Environment and National Health and Welfare have collaborated to produce a brochure and poster which summarize the Canadian Water Quality Guidelines and the Guidelines for Canadian Drinking Water Quality, entitled "How Safe Is Our Water?" These publications, which were updated in 1990-91 to cover additional water quality parameters, should prove useful in answering requests concerning human health and environmental aspects of water quality. As well, they are convenient reference material for professionals working in the water field. These publications can be obtained from Environment Canada's Water Quality Branch in Ottawa, Ontario, K1A 0H3.

New Guidelines

The Task Force on Water Quality Guidelines continues to recommend water quality guidelines for parameters not covered in the 1987 publication, and to update existing guidelines based on newly available scientific information. Guidelines for the pesticides metolachlor, simazine, trifluralin, triallate, dinoseb and captan were published in 1990-91 by the CCME. Guidelines will be published in 1991-92 for the following pesticides: aldicarb, MCPA, bromoxynil, dicamba, chlorothalonil, linuron, dimethoate and diclofop-methyl.

The Canadian Environmental Protection Act (CEPA) requires that the Minister of the Environment develop environmental quality guidelines and objectives. The Department of the Environment has begun generating guidelines that reflect the needs of the Priority Substance List under CEPA. Freshwater Quality Guidelines for trichloroethylene and 1,2-dichloroethane have been developed and published, while the ones for other selected substances are now in the publishing phase (halogenated methanes and some organotins) or in development (some phthalate esters, tetrachloroethylene, methyl tertiary-butyl ether, styrene and some polycyclic aromatic hydrocarbons). Water, sediment and tissue residue guidelines are also being developed for polychlorinated dibenzodioxins and dibenzofurans.

A protocol for the derivation and use of Canadian Sediment Quality Guidelines is in preparation and a related database on the biological effects of sediment-sorbed contaminants is being established. The document "Water Quality Guidelines for Canadian Coastal and Estuarine Waters: Polychlorinated Biphenyls" has been published and "Canadian Water Quality Guidelines for Organotins" is scheduled for publication in 1991-92. "The Development of Canadian Marine Sediment Guidelines for Polycyclic Aromatic Hydrocarbons" is in preparation. As well, progress has been made in the preparation of a report entitled "The Development of Canadian Marine Environmental Quality Guidelines."

In October of 1989, the CCME initiated the National Contaminated Sites Remediation Program. This program has been established:

- To promote a coordinated and nationally consistent approach for the identification, assessment and remediation (cleanup) of the contaminated sites in Canada which impact on human health or the environment or have the potential to do so
- To provide the necessary government funds to remediate "orphan" sites for which the responsible party cannot be identified or is financially unable to carry out the work
- To cooperate with industry to stimulate the development and demonstration of new and innovative remediation technologies.

During 1990-91, Environment Canada, in collaboration with CCME and Health and Welfare Canada, developed the following tools: a National Classification System for contaminated sites; National Environmental Quality Criteria for Contaminated Sites; and Remediation Criteria.

Under the latest (1987) revisions to the Great Lakes Water Quality Agreement, the development of objectives for the Great Lakes is clearly a responsibility of the Governments of Canada and the United States. To undertake this task, the Governments established the Binational Objectives Development Committee which, in turn, created the Ecosystem Objectives Work Group and the Chemical Objectives Work Group. The initial focus of the former group was on developing Ecosystem Objectives for Lake Ontario, in conjunction with the Lake Ontario Toxics Management Plan. Ecosystem Indicators are now being developed for each of the objectives. The latter group will develop water quality objectives for each lake and, if relevant, tissue levels in fish to protect consumers.

Ecosystem Objectives are developed through public consultation and are basin-wide in scope. They are, in fact, a narrative description of a desirable lake. Ecosystem Indicators consist of scientifically based measurable yardsticks that are publicly reviewed. For Lake Ontario, Ecosystem Objectives were developed in terms of aquatic communities, wildlife, human health, habitat, and stewardship.

Part IV: Public Information Program

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

- Alberta resident

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

A Primer on Water - Questions and Answers

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

Beginning with the question "What is water?", the Primer answers 128 questions which cover different aspects of water: its physical characteristics; its availability both above and below ground; the uses we make of it; and how we share and manage it. The Primer also contains practical advice on what we, as individuals, can do to help conserve water.

Fact Sheets for Everyone

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

industrial, agricultural, domestic and instream uses; and illuminate the role water has played culturally throughout the ages. The most recent fact sheet examines groundwater. (Over six million Canadians rely on groundwater for domestic use.) The fact sheets are well received by students and the general public alike.

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

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

Water: No Time to Waste

The timely booklet "Water: No Time to Waste, A Consumer's Guide to Water Conservation" stresses the need to conserve water now. It explains that conservation does not mean depriving oneself of water, but rather reducing consumption through judicious use. It suggests that we must reassess our attitudes about water because we cannot assume that there will always be a safe and adequate supply.

This illustrated guide offers practical methods for arriving at solutions. By applying the three golden rules of water conservation - reduce, repair, retrofit - in the kitchen, bathroom, utility room, pool and outdoors, water use can be cut by half and consequently household costs will be reduced as well. The underlying theme implies that water can no longer be taken for granted.

Water No Time to Waste is co-published with the Canada Communication Group (formerly Supply and Services Canada) and is available at local bookstores across Canada for \$1.95.

WACE

Educators, librarians, researchers, students and those wanting to learn more about their environment will soon have access to a

bibliography covering materials related to Water Awareness, Communications and Education (WACE). The on-line records are now available through the AQUAREF database described on page 39 and a catalogue which will include bibliographic data, an abstract, and information pertaining to availability of each document, video, etc., is planned for 1992 as part of the Green Plan's Environmental Citizenship initiative.

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,

which has been extended until March 31, 1992, a series of four fact sheets have been prepared about Prince Edward Island on the following: surface water, coastal estuaries, groundwater, and domestic sewage and septic systems. Each fact sheet contains a section on "What You Can Do." These fact sheets may be obtained by writing to:

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

In 1990-91, fact sheets were produced on surface watershed activities. Also developed were a teacher's kit, which includes a video entitled "Protect Your Water Resources," and a guide to teachers of secondary school biology.

**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 provide for the operation of a viable and efficient national water quantity survey network; and to define relevant federal and provincial responsibilities.

Duration of Agreements:

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

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

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

Funding: 1990-91 (provisional costs)

Total Program Costs	\$24 667 000
Total Recovered under Agreements	6 166 677
Total Paid to Quebec under Agreement	747 800

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

The "Total Recovered under Agreements" is the amount paid to Canada by the provinces (Quebec excepted) and by Indian and Northern Affairs Canada. The "Total Paid to Quebec under Agreement" is the amount paid by Canada to the Province of Quebec for operating stations of federal interest in that province.

Status: Coordinating Committees, established for each province, convene at least annually but normally more frequently to review the water quantity survey networks and to determine annual cost sharing. National meetings of all Coordinating Committees are convened periodically to ensure common practices are followed in administering the agreements. The last National Coordinators meeting was held in January 1990.

2. WATER QUALITY MONITORING AGREEMENTS

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

Duration of Agreements:

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

Participants:

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

Arrangements:

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

Funding:

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

Status:

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

3. PRAIRIE PROVINCES WATER BOARD

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

Duration of Agreement:

Continuous since October 30, 1969.

Participants and Funding:

CANADA
ALBERTA
MANITOBA
SASKATCHEWAN

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

Arrangement:

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

Status:

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

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

At the request of the Board, the Water Quality Branch of Environment Canada monitors water quality monthly at 11 interprovincial monitoring sites. These stations are part of the Board's long-term network to monitor water quality in the Prairie provinces. The Board's Committee on Water Quality (COWQ) updated the PPWB water quality contingency plan developed in 1984 and reported spills and unusual water quality conditions on interjurisdictional streams to the Board and its Member Agencies. The COWQ prepared new water quality objectives for use at each of the 11 stations in 1989. A report summarizing water quality monitoring results from all 11 stations for the period from April 1974 to December 1988 was completed in February 1990. The Committee's Task Force on Analytical Methodology provides a means of quality assurance and coordinates water quality laboratory results for the Prairie provinces. The Task Force is preparing a second report on the comparability of water quality data generated by federal (Environment Canada) and provincial laboratories in the Prairies.

The Board's "fixed term" Committee on Water Quality Policy recommended a water quality strategy for the Board in 1989, and the Board is currently reviewing its recommendations. As a result of the Committee's report, the PPWB initiated discussions to amend the Master Agreement on Apportionment to define more clearly the Board's role and responsibilities in interprovincial water quality management.

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. A brochure on water use trends in the Saskatchewan-Nelson Basin has also been published by the Board.

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

With respect to maintaining and updating historical streamflow and natural flow data files for selected hydrometric stations in the Saskatchewan-Nelson Basin, the Secretariat has completed updating 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 within Environment Canada acts as the executive arm of the Board.

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

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

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

5. MACKENZIE RIVER BASIN COMMITTEE

Objective:

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

Duration of Agreement:

Continuous since 1973.

Participants:

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

Prior Action:

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

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

Status:

The Mackenzie River Basin Committee continued to meet during 1990-91 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, 1991, authority to conclude this general agreement had been obtained by all the parties and signing was in progress. Implementation of Recommendation 1, an agreement through which transboundary water management issues can be handled, is being addressed through development of a "master" agreement which will establish broad principles, goals and objectives for cooperative water sharing. Under this agreement a water management board will be established for the basin. Seven bilateral sub-agreements between the various jurisdictions are being developed in tandem with the master agreement.

6. 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 maintains an engineering support group in Ottawa within the Inland Waters Directorate of Environment Canada. This group was formally established as the Board's Secretariat with the signing of a Memorandum of Understanding in 1981.

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

7. CANADA - B.C. - YUKON AGREEMENT RESPECTING WATER RESOURCE MANAGEMENT AND INFORMATION EXCHANGE IN THE YUKON AND ELSEK RIVER BASINS

Objective: To coordinate ongoing water and related resource planning and management activities through the exchange of information and recommendation of joint studies and investigations.

Duration: Effective from March 7, 1991. Continuous until terminated by one of the parties upon serving one year's notice to the other parties.

Participants: ENVIRONMENT CANADA
FISHERIES AND OCEANS CANADA
INDIAN AND NORTHERN AFFAIRS CANADA
B.C. MINISTRY OF ENVIRONMENT
YUKON GOVERNMENT

Prior Action: In November 1980, Canada, British Columbia and Yukon entered into An Agreement Respecting Studies and Planning of the Water Resources in the Yukon River Basin. The Yukon River Basin Committee was established and assigned the responsibility for undertaking studies and recommending measures that would lead to the formulation of a planning framework for the Yukon River basin's water resource. In September 1984, the Committee submitted its findings to the participating governments in the Report on the Yukon River Basin Study. In March 1986, the governments agreed to support implementation of the recommendations wherever possible.

Status: The Minister of the Environment for Canada and the Minister of Renewable Resources for Yukon signed the Agreement at a ceremony in Whitehorse on September 7, 1990. All of the remaining signatures were obtained by March 7, 1991. At year end, the parties were in the process of appointing members to the Yukon and Alsek River Basins Committee established to administer the Agreement.

Activities under the Agreement are expected to be guided by the recommendations of the Yukon River Basin Study, although the geographic scope is now expanded to include the Canadian portion of the Alsek River basin. These activities are designed to encourage all agencies involved in managing water and related resources in the basins to accept wise use, or conservation, as a guiding principle for future management decisions. In addition, the parties have agreed to encourage, wherever practical, the coordination of water management and land use planning activities, free exchange of information and public participation in the planning process, and early implementation of a range of tasks such as improvement of the daily flow model, and limnological research into the potential effects of regulation on biological productivity in the headwater lakes.

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;
work extended to March 31, 1991.

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 of the agreement is \$1 250 000; annual costs to be shared equally by the five parties are not to exceed \$250 000. Under a proposed three-year renewal of the agreement, the Greater Vancouver Regional District would become a participating partner and a member of the Management Committee Executive. The annual costs of this agreement would be shared equally by the six parties and not to exceed \$600 000.

The management committee established by the agreement comprises representatives 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 and 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. Work under the agreement, which was scheduled to expire on December 31, 1990, was extended to March 31, 1991.

Over the past five years, the Fraser River Estuary Management Program has provided the framework for achieving sustainable development in the Fraser River estuary. Accomplishments include the following highlights:

- (1) Implementation of a coordinated referral and review process for all development projects proposed in the estuary. Some 500 proposals for developments have been processed over the past five years to ensure screening by all the appropriate regulatory and management agencies.
- (2) Preparation of a Water Quality Plan for the estuary by a seven-member federal-provincial Standing Committee on Water Quality. The Water Quality Plan will include ambient water quality objectives for various reaches of the estuary, a comprehensive monitoring program, and strategies for compliance and enforcement. The Plan is to be reviewed by the public before it is finalized.
- (3) Initiation of a foreshore area designation process involving local governments, federal and provincial agencies and Harbour Commissions.
- (4) Preparation of estuary-wide plans for seven Activity Programs by inter-agency Work Groups. Each work group is chaired by a lead agency and may include representatives from local and senior governments, public interest organizations and industry.

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, 1992 (extended).

Participants and Funding:

CANADA.....\$2 650 000
SASKATCHEWAN.....\$2 650 000

Status:

A total of \$4.44 million (Canada's share \$2.22 million) has been spent to March 31, 1991. Works have been completed to mitigate the loss of walleye and jackfish spawning habitat. A three-year fish population monitoring program, designed to assess the adequacy of the mitigation works, is in its second year of operation. Pending an agreement between Sask Water and local land owners on the question of irrigation facilities to replace the earthfill plugs previously used, channel improvement work in the reach of river between Craven and Highway #6 is yet to be completed. An amending agreement to extend the project until March 31, 1992, and increase funding by \$550 000 was concluded by the parties in February 1991.

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 riverbank protection, and improving internal drainage facilities.

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

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

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

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

Status: Construction has been completed at Kent, Matsqui, Surrey (Serpentine-Nicomekl dams), New Westminster, Coquitlam, Abbotsford, Kamloops (Oak Hills), Surrey-South Westminster, Richmond, Pitt Meadows, Pitt Meadows No. 2, Delta, Chilliwack (Phase I), Vedder River, South Dewdney, Glenn Valley, Chilliwack (Phase II) and Mission. Construction is about two-thirds complete at Coquitlam River. Final design for Harrison Hot Springs and Langley-Salmon River dykes and negotiations for the Delta-Boundary Bay Village dyke right-of-way are under way. Estimated expenditures under the program to March 31, 1991, are \$142 500 000. The current annual funding rate is over \$1.5 million from each government.

4. CANADA-ONTARIO AGREEMENT RESPECTING GREAT LAKES WATER QUALITY

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

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

An initial agreement from August 1971 to December 31, 1975, authorized \$3 million for feasibility studies and joint sewage treatment technology and urban drainage research. Loans totalling \$250 million for sewage treatment facilities from the Canada Mortgage and Housing Corporation (CMHC) and the

Ontario Government were also called for in the initial agreement. (Funding for municipal sewage treatment between 1976 and the signing of the new agreement in 1982 was the subject of a separate agreement with CMHC under the National Housing Act.)

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

Participants and Funding:

CANADA
ONTARIO

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

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

The 1986 agreement, which expired on March 31, 1991, provided \$22.1 million for cost-shared funding on a 50/50 basis for surveillance, research and other activities, and phosphorus control programs. Federal financial assistance for upgraded sewage treatment amounting to \$9.785 million was also provided for in the agreement. Until a new agreement is signed, an extension of the surveillance and phosphorus control programs beyond March 31, 1991, is being negotiated, with each government providing \$1.87 million annually.

Status:

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

Because, as already noted, the Canada-Ontario Agreement is being undertaken to provide a basis for implementing the Canada-U.S. Agreement on Great Lakes Water

Quality, a brief outline of activities under the latter agreement is also provided.

CANADA-U.S. GREAT LAKES WATER QUALITY AGREEMENT

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

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

Participants: CANADA
UNITED STATES

Commitment: The concept of the Great Lakes basin and its human resources as an ecosystem is explicitly recognized in the 1978 agreement. Numerical water quality objectives for some 40 compounds have been specified. Approximately 99% of the sewered population on the Canadian side of the basin is now served by adequate municipal wastewater treatment facilities. Programs to control and prevent pollution from industrial sources entering the Great Lakes System have been designed and are being implemented. A commitment has been made to eliminate the discharge of toxic substances into the Great Lakes. New interim phosphorus loading targets, defined for each lake, are designed to achieve desirable levels of water quality. Binational negotiations to ratify the loading targets and reach agreement on Canadian and U.S. programs to meet these targets were partially completed in 1983. The Protocol signed in 1987 consists of new provisions that strengthen the two governments' attack on toxic substances with new requirements to address contaminated sediments, groundwater, airborne toxic substances, and non-point sources.

Arrangement: The International Joint Commission was given primary responsibility for overseeing implementation of this international water quality agreement. The Commission has established a number of boards and committees to carry out the various provisions of the agreement. Activities are carried out under four programs: Objectives Development, Controls, Assessment, and Special Projects (including toxics, eutrophication, health hazards, etc.). The 1987 Protocol commits the two governments to coordinate implementation and evaluate progress under the agreement through semi-annual meetings.

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

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

The 1978 Canada-U.S. Great Lakes Water Quality Agreement was amended with the signing of the Protocol in November 1987. The Protocol reaffirms the commitment to the cleanup of the Great Lakes and outlines expanded responsibilities for the parties. Canada reports biennially to the Commission on progress made in implementing the Protocol. The first report was completed for December 1988, and the second, scheduled for completion in June 1991. In October 1989, a \$125 million Great Lakes Action Plan was announced by Canada, reconfirming the federal government's commitment to cleaning up the Great Lakes. The Plan consists of three components: Preservation (\$50 million), Cleanup (\$55 million), and Health Effects (\$20 million).

5. SOUTH SASKATCHEWAN RIVER BASIN STUDY

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

Duration of Agreement: May 1986 to March 31, 1991 (extended).

Participants and Funding:

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

Status: In May 1990, an amending agreement was concluded for a 15-month extension of the study to March 31, 1991. The agreement has now expired with the completion of the Canada-Saskatchewan South Saskatchewan River Basin Study Final Report, an 80-page document intended for the general public. Three technical appendices to the report cover Issues Documentation, Resource Assessment, and the Framework Plan.

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

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

Duration: April 1, 1987 to March 31, 1992 (extended).

Participants and Funding:

CANADA.....\$700 000
PRINCE EDWARD ISLAND....\$700 000

Status:

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

An amending agreement to increase the total funding to \$1.4 million (from \$1.0 million) and extend the expiry date by two years to March 31, 1992, was signed by the Ministers in November 1990.

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

The groundwater program addressed several problems and included drilling and testing in areas where groundwater availability is limiting economic growth; an assessment of pesticides in groundwater; and the introduction of techniques to prevent contamination of individual wells. Information from the latter project is being used in the development of well drilling regulations for Prince Edward Island. The economic implications of the establishment of groundwater protection zones are being examined. Pesticide assessment will be expanded, and a study relating nitrate in groundwater to land use will be undertaken as well as remedial techniques to remove hydrocarbons from contaminated soil.

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

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

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

FLOOD DAMAGE REDUCTION PROGRAM

1. CANADA-MANITOBA FLOOD PROTECTION PROJECTS

Objective:

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

Duration:

March 10, 1983 to March 31, 1991 (extended).

Participants and Funding:

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

Prior Action:

Between 1967 and 1971 Canada and Manitoba cooperated in the construction of dykes around seven communities in the Red River basin that had suffered damages during floods in 1950 and 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 as well as the dyke around Brunkild.

Status:

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

With the delays in the Ste. Rose du Lac project and the international section of dyke at Emerson, a two-year extension was negotiated at an additional cost of \$800 000 (federal share: \$360 000) in order to complete the projects. The extension was signed on October 16, 1989, and the agreement expired on March 31, 1991. All projects in the agreement are completed with the exception of the north segment of the West Lynne dyke at Emerson and some minor upgrading at Dominion City. With the expiry of the agreement, these projects will not be finished. The communication/storage facility at Morris has been finished and the emergency pumps have been purchased. The communication towers for all the communities have been constructed and the radio communication facilities are operational.