

Chapter One

A Project Overview

Introduction

As water resources scientists, managers and policymakers gain understanding of the range and complexity of issues surrounding the region's needs and demands for high quality fresh water, they are increasingly relying on data, information and technology to answer difficult questions. Decision support systems are becoming crucial tools in the fields of water resources science, planning and management. Such systems, which include both descriptive information and normative, prescriptive optimization approaches, link a combination of decision analysis tools (e.g., maximization, cost-benefit analysis) and information components into a decisionmaking process. The objective is to integrate data, information and knowledge from different sources to facilitate informed decisions. Access to accurate and uniform data to inform research and the decisionmaking process is therefore essential.

The Great Lakes Commission and its project collaborators initiated a project, titled *Toward a Water Resources Management Decision Support System for the Great Lakes*, in August 2000. The project responds to the increasing need for data and information on Great Lakes-St. Lawrence River system water resources and the renewed attention and commitment to water resources management on the part of the governors and premiers. This two-year initiative was planned and designed to ensure that scientifically sound technical information on the status of Great Lakes water resources, current water uses, and ecological impacts of individual and cumulative water withdrawals and uses is available to regional decisionmakers.

Background on Great Lakes Water Resources Management and Decisionmaking

Historical Overview

Formal mechanisms for water quantity management within the binational Great Lakes-St. Lawrence River system date back to the Boundary



The Great Lakes-St. Lawrence River governors and premiers signing the Great Lakes Charter in February 1985

Waters Treaty of 1909 between Great Britain and the United States. The Boundary Waters Treaty established the International Joint Commission (IJC), a binational agency consisting of six commissioners; three each appointed by the president of the United States and the governor-in-council of Canada. The IJC has quasi-judicial, arbitration and advisory powers over U.S./Canada boundary waters. The IJC's judicial powers stem from its authority to approve all new "uses, obstructions and diversions" which affect the levels and flows of boundary waters or those crossing the boundary. The Treaty assigns the IJC the power to arbitrate in all matters of difference arising between the two countries that are referred by both to the Commission. This power has yet to be used. The Treaty also enables the governments to refer any matter to the IJC for investigation and recommendations.

The IJC develops Orders of Approval for the regulation of outflows from Lake Superior (1914, 1978, 1979) and Lake Ontario (1952, 1956). Administration for the distribution of flows in the Niagara River between the United States and Canada dates back to the provisions of the Niagara Treaty of 1950, which explicitly recognizes intrabasin flows through the Welland Canal and the New York Barge Canal. Outflows through the Lake Michigan Diversion at Chicago have been managed under Supreme Court oversight since 1905. During World War II, diplomatic letters between the U.S. and Canada provided for diversion of flows through

Long Lac and the Ogoki River from the Albany River watershed into Lake Superior.

Dating back as far as the mid-1850s, dredging, sand mining and/or encroachments in most of the connecting waterways of the Great Lakes-St. Lawrence River system have occurred episodically (and increasingly), and the impacts have been largely unremediated. This has led to significant modification of channel efficiencies and regime changes upstream. Each of these anthropogenic changes to the water balance of the Great Lakes has had profound effects on the storage and retention of water supplies in one part of the system or another, outweighing cumulative impacts of diversions, withdrawals or consumptive uses within the region. The term “water-balance” is a measure of the amount of water entering and leaving a system and any associated changes in storage of waters in a lake system. Frequently, decades of quality controlled water level data distributed across the lakes are required to infer the effects of these altered regime changes in the magnitude of a few centimeters. These facts illustrate that accurate decisionmaking requires a long-term and thorough commitment to data collection, information management and retrieval.

Various large-scale proposals to remove water from the Great Lakes-St. Lawrence River system (or bring water into the system) have been around almost a century. Many of the early proposals did not generate significant attention because they were considered economically and/or environmentally unviable. In the late 1970s, due to apparent heightened interest from regions outside the basin to divert and use Great Lakes water, the Great Lakes governors and premiers began to consider the importance of a regional approach to managing the system’s water resources. In 1983, this interest culminated in the appointment, by the governors and premiers, of a Task Force on Water Diversion and Great Lakes Institutions. This task force was established to address ongoing concerns about future management of the Great Lakes-St. Lawrence River system and the perceived significant economic and environmental consequences to the region from large-scale diversions. The report of the task force, in January 1985, addressed three main areas: the need for regional action in the area of water management; the need to protect the resource; and institutional capabilities and needs. An outcome of this study was the Great Lakes Charter of 1985, a series of principles and procedures for the management of Great Lakes water resources.

One of the central themes of the task force’s 1985 report was that the best defense against outgoing interbasin diversions and intra-regional conflicts over water use is for the region to develop an effective, comprehensive program to manage its water resources. The report states, “developing such a program, of which a common base of data is a first step, will entail a major long-range commitment on the part of the Great Lakes states and provinces.” The task force also concluded “it is important to begin this process now, while public concern is high and political will is strong.”

The Charter calls for the development of a Water Resources Management Program to guide the future development, management and conservation of the water resources of the basin. The following elements are included:

- An inventory of the basin’s surface and groundwater resources;
- An identification and assessment of existing and future demands for diversions (both interbasin and intrabasin), withdrawals and consumptive uses and the ecological considerations of these uses;
- The development of cooperative policies and practices to minimize the consumptive use of the basin’s water resources; and
- Policies to guide the coordinated conservation, development, protection, use and management of the water resources of the basin.



The Great Lakes-St. Lawrence River governors and premiers signing the Great Lakes Charter Annex in June 2001

Since the signing of the Charter, the management framework has been slow to evolve due to changes in regional leadership, public interest that has waxed and waned, and inconsistent financial, programmatic and legislative support of water

management programs, particularly those involving data collection and reporting.

Implementation of Charter principles has also been compromised by numerous other factors:

- The lack of scientifically sound data and information on water withdrawals, diversions and consumptive uses;
- The lack of scientific understanding of, and the limited ability to measure the various components of the Great Lakes hydrologic system that contribute to the development of a water balance;
- The lack of understanding of how individual, collective and cumulative withdrawals, diversions and consumptive uses impact the Great Lakes ecosystem;
- The lack of priority attention given to implementation of the Charter;
- Insufficient legislative and programmatic authority to implement Charter requirements;
- The lack of financial support necessary to carry out Charter requirements;
- The failure to consistently bring different interests and disciplines together to address the complex issues surrounding water resources management; and
- The tendency for the region to be reactive, rather than proactive, when faced with the decisionmaking demands of a water withdrawal or export proposal.

Passage of Water Resources Development Act (WRDA) of 1986 added another dimension to the issue. Section 1109 of WRDA prohibits any new or increased diversion of Great Lakes water without the unanimous approval of the Great Lakes governors. This section, while adding significant legal authority to the governors' ability to protect Great Lakes water resources from outside interests, also affected the process for cooperative water resources management decisionmaking laid out by the Charter. By giving the governors veto power over new diversions of any size, Section 1109 counteracted the Charter trigger level provision that requires prior notice and consultation only for diversions that exceed 5 million gallons per day (mgd) (19 million litres per day) average over a thirty-day period. Section 1109 did not specify any consultation requirements, although a case-by-case consultation process has been used for those few diversion and consumptive use proposals that have been evaluated since 1986. Section 1109 also

created a new dynamic with the Great Lakes-St. Lawrence provinces, which are not subject to U.S. law and, therefore, have no legal standing in the WRDA decisionmaking process.

The need to revisit regional water resources management decisionmaking was rekindled in 1999, following a thwarted proposal by an Ontario company (Nova Group) to secure a permit to withdraw Lake Superior water with the intent of establishing an overseas market for bulk water export. This event triggered passage of Regulation 285/99 of the Ontario Water Resources Act, stipulating that "no person shall use water by transferring it out of one of Ontario's three water basins" (section 3(2)). In addition, the IJC completed a study requested by Canada and the United States and released the corresponding report, Protection of the Waters of the Great Lakes, in February 2000. The report concludes that the ecological integrity of the Great Lakes needs protection, especially in light of the uncertainties, pressures and cumulative impacts from water withdrawals, consumption, population growth, economic growth and climate change. In December 2001, Canada amended its Boundary Waters Treaty Act to prohibit bulk water removals from the Great Lakes and other boundary waters and to set in place a licensing regime for boundary waters projects such as dams and other works.

Addressing the precedent-setting nature of the proposal and the region's response to it, the Council of Great Lakes Governors issued a statement in 1999 outlining a set of principles to guide the development and maintenance of a strengthened water resources management framework for the Great Lakes-St. Lawrence River system. This statement refocused regional discussion on these issues and led to the development of the Great Lakes Charter Annex, signed by the governors and premiers on June 18, 2001. The statement reaffirmed the governors' and premiers' commitment to the 1985 Charter, and outlined the following set of principles for a water management regime:

- "It must protect the resource. Resource protection, restoration and conservation must be the foundation for the legal standard upon which decisions concerning water withdrawals are based.
- It must be durable. The framework for decisions must be able to endure legal challenges based upon, but not limited to, interstate commerce and international trade. It must be constitutionally sound on a bi-

national basis, and the citizens of the Basin must support this framework.

- It must be simple. The process for making decisions and resolving disputes should be straightforward, transparent and based on common sense.
- It must be efficient. Implementation of the decisionmaking process should engage existing authorities and institutions without necessitating the establishment of new and large bureaucracies. The decisionmaking process should be flexible and responsive to the demands it will confront.
- It must retain authority in the basin. Decisionmaking must remain vested in those authorities, the Great Lakes governors and premiers, who manage the resource on a day-to-day basis.”

In signing Annex 2001, the governors and premiers reaffirmed their commitment to the broad principles set forth in the Great Lakes Charter, but also acknowledged the need to re-examine the strength and adequacy of Charter provisions, particularly regarding the legal foundations upon which current regional water management authorities rest.

Annex 2001 is a non-binding agreement that serves as a blueprint for water management programs to be developed over a period of several years. Annex objectives were developed on the basis of state and provincial experience with water management, and were influenced by the Great Lakes Charter and Section 1109 of WRDA 1986. The Annex also reflects the governors’ 1999 statement on water management, findings from the February 2000 International Joint Commission reference study report on water export, and a study commissioned by the governors on Great Lakes and international water law. That study was supported by the Great Lakes Protection Fund and completed in May 1999.

Annex 2001, through a series of six directives, commits the Great Lakes governors and premiers to the following:

- Developing a set of binding agreements;
- Developing a broad-based public participation program;
- Establishing a new decisionmaking standard for reviewing proposed withdrawals;
- Consulting with the premiers of Ontario and Québec on proposed diversions of Great Lakes water under WRDA 1986;

- Developing a Water Resources Management Decision Support System;
- Additional commitments associated with implementing the Annex.

The Resource and its Ecological/Economic Attributes

The eight states and two provinces that constitute the binational Great Lakes-St. Lawrence River region are blessed with an abundance of high quality fresh surface water. The Great Lakes-St. Lawrence River system contains 6.5 quadrillion gallons (24.6 quadrillion litres) of fresh surface water, a full 20 percent of the world’s supply and 95 percent of the supply in the contiguous United States. The magnitude of the resource has fostered the perception of a seemingly inexhaustible supply of fresh water that can accommodate all current and projected uses. In reality, the system’s water resources are finite, intensively used and ecologically fragile.

In recent years, renewed interest and attention has been focused on Great Lakes water resources management and water supply issues. This interest has been generated, at least in part, from proposals for increased in-basin water use and out-of-basin diversions to nearby communities and beyond. These proposals have raised concerns that current management principles may not provide for sustainable use of the basin’s water resources, and have prompted studies and policy discussions at the state, provincial, regional and federal levels.

The Great Lakes-St. Lawrence River system represents a complex ecosystem with attributes that are related to and dependent upon one another. The nearshore zone is particularly important from both economic and ecological standpoints and is also where the impacts from water withdrawals are most discernable. Even minor chemical, physical or biological changes that might have no immediate measurable impact from a systemwide standpoint may be important when viewed from a nearshore or sub-watershed perspective. Also, cumulative impacts from single or multiple withdrawals will occur over time and space, and may even be seen on a systemwide scale.

The Management Opportunity

Throughout North America, many aquifers, lakes, rivers and reservoirs are being stressed by withdrawals and diversions to meet the needs of cities, farms, homes and industries. The Great Lakes-St. Lawrence River region has historically been largely immune from serious, prolonged water shortages

and water supply problems. However, as other parts of the continent experience water supply shortages, the Great Lakes are increasingly viewed as a source of high quality freshwater to serve their needs. The needs of communities within Great Lakes jurisdictions that lie just outside Great Lakes basin boundaries have also become a major policy issue. Implications of this interest present a significant challenge for policy officials.

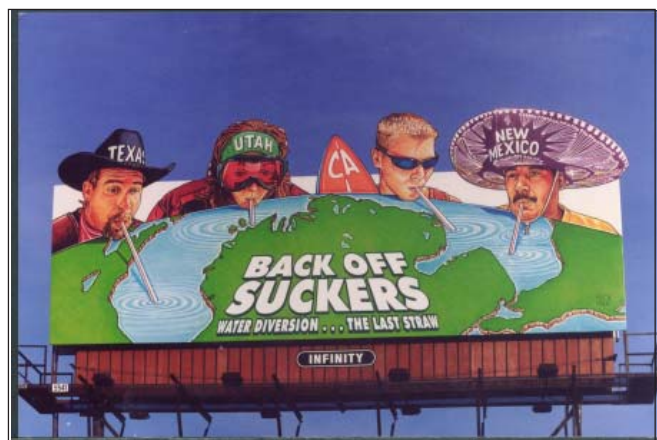
While in-basin demand for Great Lakes water has remained fairly constant over the past decade, uncertainty associated with long-term trends in lake level fluctuations, potential increases in water demand due to population and industrial growth, and regional consequences of global climate change and other factors, has challenged the region to compile and collect the data and information necessary for informed decisionmaking. Policymakers and scientists must also increase their understanding of how small, localized changes to the quality and quantity of Great Lakes water resources impact the larger ecosystem, particularly with regard to long-term and cumulative effects.

One major challenge to scientists and managers is to answer the questions, “how sensitive is the system to impacts associated with cumulative withdrawals?” and “at what level can those impacts be ascertained?” The ability to adequately respond to these questions is complicated by several factors. For example, the system is no longer entirely natural. Changes, primarily for navigation and hydropower production purposes and improvements, have permanently altered the flow regime. Dredging, diversions (both incoming and outgoing) and the construction of locks, dams and controlling works have created changes that are orders of magnitude greater than any changes that might occur from small-scale withdrawal, diversion or export projects. In addition, anthropogenic changes to the natural hydrologic/hydraulic regime have occurred (to a lesser extent) through consumptive uses and related resource demands since settlement began in the region. These issues require scientifically sound data and the formulation of socio-economically viable and environmentally responsible policies. This will be fundamentally important in providing a sustainable future for the region.

Project Background and Scope

In early 2000, in response to the Great Lakes governors’ 1999 statement on water management, the Great Lakes Commission and numerous project collaborators were invited to prepare a proposal to the Great Lakes Protection Fund. The proposed project entailed an inventory and assessment of available water resources information, along with related work, that would yield a framework for a Water Resources Management Decision Support System (WRMDSS) for the Great Lakes. The proposal was approved in June 2000.

The focus of the initiative evolved over time, influenced by Annex deliberations that began in late 2001. Additional tasks were subsequently added to the work plan to address issues that include a review/evaluation of consumptive use coefficients; an examination of water conservation programs and associated elements; and an examination of the “resource improvement standard” concept embodied in Annex 2001 and its prospective application.



Billboard off an interstate highway in Michigan shows heightened awareness of the need to manage Great Lakes water resources

This final project report addresses the status and availability of data, information, models and other resources required to support the development of a WRMDSS. It includes an assessment of water resources data compiled to support a water balance for the Great Lakes; water withdrawal, diversion and consumptive use information; and a description of models and resources related to the ecological effects of water withdrawals. Further, state and provincial water resource management programs and practices are characterized and, to the extent possible, evaluated with regard to requirements of the Great Lakes Charter. Report products and

information also include an evaluation of data and information gaps and needs, with an eye toward data and information requirements to fully support Annex 2001 implementation.

The project scope addresses the importance of scale (both geographic and temporal) in the assessment of data and information availability, requirements and needs. The ability to discern impacts and the importance of those impacts will vary depending on where a potential withdrawal or diversion is occurring within the system. For example, the data, information requirements and models used to assess the impacts of a water withdrawal from the Great Lakes themselves will vary significantly from the data, information and models required to assess a withdrawal at the sub-watershed level. The way that this issue is presented and addressed varies throughout the report and is a function of the different project element work plans. Some project elements focused on the larger, systemwide data and information requirements, while other elements, such as the ecological impacts component, focus more on the importance of discerning impacts at the sub-watershed level. Any decision support system will likely have to accommodate the different spatial and temporal scales that could be associated with water withdrawal and use.

It is important to note that data and information requirements are just one component of a decision support system. Many other components, such as the legal foundation, decisionmaking process and institutional framework must be addressed as well. Thus, this project represents one very important piece of what is necessary to inform the next step in developing and designing an actual decision support system for Great Lakes-St. Lawrence River water withdrawal projects. It must be augmented by work in other areas as a WRMDSS is designed, tested and implemented.

Project Process and Accomplishments

The Great Lakes Commission and its collaborators are providing the data, information and a needs assessment to assist the governors and premiers in the design and implementation of a WRMDSS. This initiative has also produced several major products, which, singly and collectively, will strengthen water quantity decisionmaking and management processes. Five project elements were pursued as follows:

Detailed Project Design and Infrastructure (Project Element One)

The Great Lakes Commission established a formal project administrative structure, identified management team responsibilities, and defined the role and responsibility of project stakeholders. The administrative structure provided for a Project Management Team (PMT), a Stakeholders Advisory Committee (SAC), a Project Secretariat (Great Lakes Commission staff) and three technical subcommittees (TSCs) (see Figure 1-1). The PMT, with representatives from each of the ten Great Lakes states and provinces and the U.S. and Canadian federal agencies with a major water resources related role or mandate, provided overall leadership and direction in the design and conduct of all project elements. The SAC, comprised of policy and technical experts from other regional and federal agencies as well as citizen, environmental, and industry groups, provided valuable information and

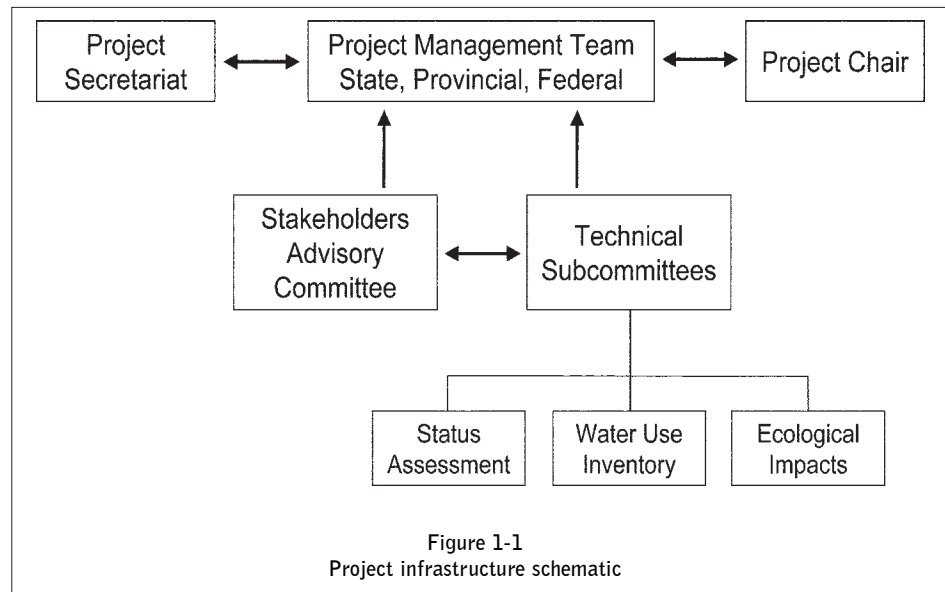


Figure 1-1
Project infrastructure schematic

advice on the project. The TSCs, comprised of experts on topical areas, contributed to work on Project Elements Two through Four: a Status Assessment of Water Resources; an Inventory of Water Withdrawal and Use; and an Inventory of Information on Ecological Impacts.

Status Assessment of Water Resources (Project Element Two)

One of the baseline activities of this effort was the compilation of data and information on the Great Lakes hydrologic system and the completion and update of a water balance. This approach involved assembling data and information associated with both ground and surface water resources based on hydrologic variables such as precipitation, runoff, evaporation, groundwater levels and connecting channel flows. This assessment lays the groundwork for a WRMDSS that is applicable to a broad range of variables and geographic areas ranging from small sub-basins (e.g., a single tributary) to the entire system. An important component of the work for this element included a series of three flows accounting workshops that examined connecting channel flows, diversions and other inputs and outputs to the Great Lakes system. A critical part of the overall characterization and interpretation of the available hydrologic data was to quantitatively and qualitatively identify uncertainties associated with measures or estimates of the various components of the Great Lakes water balance.

Inventory of Water Withdrawal and Use (Project Element Three)

An understanding of the demand for Great Lakes water resources, such as the amount of water withdrawn and used on a daily, monthly or annual basis, is valuable information for scientists working on the water balance. It is also crucial in developing water budgets at the watershed and sub-watershed level, and vital to the understanding of cumulative impacts associated with increases in demand over time.

Every day, nearly one trillion gallons (about 3.75 trillion liters) of water are withdrawn or used instream for industrial, municipal, agricultural, power generation and other purposes, according to data provided by the Great Lakes states and provinces to a Great Lakes Commission-managed regional water use database. While these numbers inform the discussion of water use activities in the Great Lakes basin in a broad sense, there have been long-standing concerns over the quality, quantity and compatibility of water use data provided by the

jurisdictions to the regional database. This lack of high quality, comprehensive and uniform data has contributed to the region's inability to move forward on important activities such as demand forecasting, conducting trend analyses and developing water budgets at the watershed level. Recognizing this area as one of critical need, the project partners have focused significant effort on documenting data gaps and information needs and providing guidance to the states and provinces on ways to improve water use data collection and reporting activities.

With the Great Lakes Regional Water Use Database as a foundation, the Commission staff, with oversight from the Water Withdrawal and Use Technical Subcommittee, assessed the latest available water use data as it relates to withdrawals, in-stream uses, diversions and consumptive use. Beginning in the late 1980s, the states and provinces, through their Water Resources Management Committee and its Technical Work Group, established parameters for data collection and reporting. Data is compiled by each jurisdiction for nine categories of use and presented in aggregate form on an annual basis, broken down by jurisdiction, lake basin and category of use. Technical subcommittee members used the 1998 water use report process as an opportunity to evaluate data and information needs, methodologies for data collection and reporting, and the database's functionality.

Other significant work products include an evaluation of ways to improve the utility of and access to water use data by decisionmakers and other stakeholders; a detailed state/provincial water use programs report; briefing papers on consumptive use and water conservation; and a scenarios process to evaluate water withdrawal and use data and information needs for decisionmaking. Research on water conservation was pursued to support the Annex's directive for a decisionmaking standard that includes water conservation measures. Although this topic was not part of the original project work plan, the PMT agreed that water conservation can inform the decision support process and, consequently, authorized the additional research.

Inventory of Information on Ecological Impacts (Project Element Four)

The Great Lakes hydrologic system is dynamic and highly complex. Levels and flows within the system constantly fluctuate in response to both natural and human-induced factors, and alterations to this system have an ecological effect that can be cumulative, occurring over space and time. Experts

generally agree that demands on Great Lakes water resources are likely to increase and impacts on the Great Lakes basin ecosystem likely will intensify. Enhanced understanding of ecological/biological impacts (local and systemwide) associated with increased water withdrawal and use will be key to formulating scientifically sound resource management decisions.

This project element includes three discrete activities. The scientific literature on the ecological impacts of water use and changes in levels and flows provided information on the status of current knowledge. A descriptive inventory of models with prospective relevance to ecological impacts of water withdrawals complemented information gathered through the literature search. The Commission staff also convened an “Experts Workshop” which brought together U.S. and Canadian scientists with policy and management officials to determine how scientific understanding and modeling capabilities can be incorporated into a decision support system. A third discrete project task involved a focus group approach to determining the potential definitions and application of a “resource improvement standard” that might be applied to water withdrawal and use proposals. A briefing paper and one-day workshop helped inform future discussion on this topic as called for in Directive #3 of the Annex.

Project Synthesis and Next Steps (Project Element Five)

The many individual work products associated with the project have been synthesized and presented in a manner that will ensure immediate use and benefit to the Great Lakes states and provinces and other relevant parties. A comprehensive series of findings and recommendations associated with each of the project elements and their products, as developed by the TSCs and agreed to by the PMT in consultation with the SAC, was the primary focus of project element activity. This included identification of gaps and unmet needs associated with the project work.

Many preliminary findings and recommendations were derived from a project-wide “scenarios workshop” that bridged the work of the technical products by visualizing how water use proposals may be reviewed under decisionmaking mechanisms developed through the Annex process. The workshop also provided an improved understanding of the consequences of cumulative effects over time and space and highlighted the need to address this topic in future decisionmaking strategies.

Report Format

This report provides a description of the results of the work done through the WRMDSS project and presents findings and recommendations that have resulted from that work. These findings and recommendations are explicitly addressed within each chapter, and then are brought together cohesively in Chapter eight.

This written report and the many supporting documents that have resulted from this project provide a wealth of information about the water resources and associated policies related to the Great Lakes-St. Lawrence River basin. Along with the various briefing papers and technical reports, the appendices include background information on Great Lakes regional water resources management, annotated bibliographies, a summary project work plan, and a list of project participants. The project technical reports and various appendices are attached in CD-ROM form and are available at www.glc.org/wateruse/wrmdss/.

References

- Council of Great Lakes Governors. 1999. A Statement on Protecting the Great Lakes: Managing Diversions and Bulk Water Exports. 15 October.
- Great Lakes Governors Task Force on Water Diversion and Great Lakes Institutions. 1985. Final Report and Recommendations: A report to the governors and premiers of the Great Lakes states and provinces prepared at the request of the Council of Great Lakes Governors. January.
- The Great Lakes Charter Annex: A Supplementary Agreement to the Great Lakes Charter. 2001.
- The Great Lakes Charter: Principles for the Management of Great Lakes Water Resources. 1985.
- Great Lakes Commission. 2002. Annual Report of the Great Lakes Regional Water Use Database Repository Representing 1998 Water Use Data.
- International Joint Commission. 2000. Protection of the Waters of the Great Lakes: Final Report to the Governments of Canada and the United States.
- Ontario Regulation 285/99. Ontario Water Resources Act.
- Treaty Between the United States and Great Britain Relating to Boundary Waters, and Questions Arising Between the United States and Canada. 11 Jan. 1909.
- 42 US Code Sec. 1962d. Water Resources Development Act (1986, amended 2000).