

AN ANALYSIS OF CANADIAN AND OTHER WATER CONSERVATION PRACTICES AND INITIATIVES

ISSUES, OPPORTUNITIES AND SUGGESTED DIRECTIONS

Prepared for the
Water Conservation and Economics Task Group
Canadian Council of Ministers of the Environment

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EXECUTIVE SUMMARY

Background and Objectives

This report has been prepared for the Canadian Council of Ministers of the Environment (CCME) Water Conservation and Economics Task Group (WCETG). It is intended to document relevant strategies and actions that Canadian governments, communities, businesses and households can pursue to ensure that water is used in an efficient, productive and sustainable manner.

Advancement of water conservation goals and initiatives across the country continues to be identified as a priority by the Council's member governments. Ten years have passed since CCME released its 'National Action Plan for Encouraging Municipal Water-Use Efficiency' and progress has been made on a number of fronts. Notwithstanding this progress, there is mounting evidence that a more coordinated, comprehensive and multi-sectoral approach to managing water use and demand is needed to ensure the long-term sustainability of Canadian communities, businesses and individual livelihoods and the protection of aquatic ecosystems. Rapid urbanization, intensification of agricultural operations, growth in the energy-production sector, industrial expansion, and increasing recreational water demands are heightening local and regional concern over the sustainable use of water resources and sparking debate over priorities of use. Adding to these concerns are the increasingly apparent water resource impacts of climate change and variability.

Scope and Methodology

The analysis examines water conservation approaches in use across Canada and in several other countries. It focuses on how freshwater resources are used and managed in the dual contexts of geographic areas and water use sectors. Major sectors include municipal supply, agriculture, thermal power generation, resource extraction, manufacturing, and recreation. These are further subdivided where necessary to get at distinct water-use characteristics and associated conservation aspects.

Jurisdictions selected for study encompassed Canada with all of its provinces and territories, Australia and a couple of its member states, the United States and the states of Arizona, California, Florida and New Mexico, and the European Union including England, Wales and France. Reference is also made to a number of other jurisdictions where certain approaches and practices were felt to be of particular interest and benefit.

Research stressed compilation and analysis of web-based information (covering legislation, policies, reports, manuals, fact sheets and case studies) found within state/provincial, municipal, industry association, individual company, resource and environmental NGO, professional organization and university/college websites. Phone interviews and draft materials circulation helped ensure the currency, accuracy and completeness of the information and analysis. WCETG members assisted in this task.

Conservation Needs and Drivers from a Canadian Perspective

Canada is widely seen as a nation rich in water resources. A comparison of total annual water renewal rates vs. total annual demands puts Canada in the top tier of countries whose renewable supplies far exceed its current water-use demands.

This view of abundance masks other realities regarding the ready availability of these resources for human use. It also discounts the significance of the growing list of situations where resource and investment sustainability concerns exist or are emerging at the local and regional levels.

It also fails to account for the substantial economic costs and foregone opportunities associated with inefficient and less productive uses of water.

- Sixty percent of Canada's water resources flow north while more than 85% of the population and the vast majority of the country's economic activity are located in more southern regions.
- Many agriculturally important areas have semi-arid climates and face growing competition for limited water supplies. Crop and livestock production and many local communities have become dependent on water diversions and constructed storages to meet their needs.
- Many other areas exhibit seasonal and more-prolonged patterns where cumulative demand for water results in competition over supplies and threatens aquatic ecosystems.
- Climate change predictions show that many parts of the country are likely to experience increasing risks from reduced water availability and increased demand.
- Inefficient and non-productive uses of water continue to drive avoidable expenditures and debt accumulation for the construction, expansion, operation and rehabilitation of both municipal and private water and wastewater infrastructure. They also result in excessive energy consumption and contribute to the inefficient use of other resources.

Conservation Benefits

Using water more efficiently and productively has been shown to:

- Prevent or reduce conflicts among water users who share a common resource;
- Contribute to the protection of environmental flows and to the health of aquatic ecosystems;
- Make water resources available for further growth and development;
- Avoid or defer the need to expand the capacity of water and wastewater infrastructure;
- Eliminate the need to augment water supplies through potentially harmful or undesirable diversions from other watersheds;
- Free-up public funding for investment in other priorities including the renewal of outdated water and sewage infrastructure;
- Increase the ability of water users to withstand the impacts of low-water conditions resulting from inherent weather variability and climate change;
- Conserve energy, other resources and raw materials and improve business profitability;
- Enhance wastewater treatment efficiency and reduce environmental emissions; and
- Enhance leverage with other jurisdictions on issues relating to shared waters.

Sectoral Opportunities and Approaches

The review of conservation measures being applied within individual sectors indicates that many globally recognized 'best practices' are already in use within some Canadian communities and businesses. What distinguishes Canada from most other study jurisdictions is the lack of more comprehensive and uniform uptake or application of these measures. The following is a sector by sector overview of more apparent water efficiency opportunities, of the rationale for their broader adoption and of key considerations that need to be addressed in their implementation.

Municipal

Sustainability issues in the municipal water supply sector transcend the question of balancing availability and demand. This is especially so in the case of growth communities where water efficiency improvements can be the key to avoiding or limiting expensive investments in water and wastewater infrastructure.

Strong pressures to implement full cost accounting and cost recovery in the municipal sector favour implementation of universal metering and conservation-oriented rate structures. The first is fundamental in making all users aware of the scope of their demands and in achieving greater equity in the distribution of costs. The latter offers an incentive to use water wisely. The case can also be made for minimizing distribution system losses and for capitalizing on the mutual benefits (to community and consumer) of moving toward the mandatory use of water efficient plumbing fixtures, appliances and other devices in new construction as well as in retrofit and replacement.

Higher per-capita servicing costs faced by many small communities (<1000 residents) and northern communities may warrant more direct senior government involvement in helping to fund upfront implementation costs. Government intervention in seeking an appropriate level of water pricing harmonization among municipalities may also be warranted to restrict the destabilizing use of subsidies as a tool in attracting business development.

Agriculture

Irrigated-crop production is recognized as a contributor to water sustainability concerns and user conflicts across Canada and in other countries. Production activities tend to be concentrated within contiguous areas; water demands are intensive, cumulative and overlapping; and these demands typically coincide with periods of lowest water availability. Overall demands are expected to grow as a result of pressures to expand production, to irrigate crop types not currently irrigated, and to make up for a predicted increase in the incidence and severity of drought like conditions.

Solving or preventing serious water management problems will almost certainly involve both demand management and supply management approaches. Demand management opportunities exist to minimize water losses in conveyance systems, to better coordinate the scheduling of irrigation use by individual farmers and groups of producers, to use more efficient application technologies, and to more carefully determine the net economic return in irrigating certain lower-value crops. The substantial investments required pose tough issues for producers and governments in determining appropriate rates of return and in arriving at a workable division of funding responsibilities. The basic issues of mandatory water-use monitoring and reporting, full-cost accounting and cost recovery need to be dealt with in these deliberations.

Thermal Power Generation and Cooling

In Canada more water is withdrawn for cooling, condensing and steam generation purposes than for any other purpose. The majority of these withdrawals are used in thermal power generation but also constitute a key component of water usage within the resource extraction, primary processing and manufacturing sectors.

The dominance of cooling-related withdrawals within Canada's overall water use picture is made even more pronounced by the long-standing practice of once-through cooling. While use of closed-loop systems and air cooling has been growing in popularity, Canada has not as aggressively followed the regulatory lead of many other countries that clearly favour their use in new and retrofit applications. A country-wide examination of environmental and financial arguments for and against continued use of once-through-cooling appears warranted in light of what is happening elsewhere. Such a review is also timely in view of the ongoing restructuring within the industry.

Industrial

The breadth of the industrial or manufacturing sector adds to the complexity and diversity of water quantity management issues and opportunities. The interests and practices of self-supply water

users are also often quite distinct from those who draw from municipal systems, i.e. self-supply users have a less obvious cost-driven incentive to conserve.

Many Canadian companies within all manufacturing sectors have reduced water withdrawals as an adjunct to other objectives such as reducing energy consumption or assisting with the management and reduction of wastewater emissions. Levels of achievement appear to be highly variable perhaps reflecting inconsistencies in pressures and/or incentives for dealing with these multiple objectives.

Beyond taking more obvious steps to reduce waste through repairing leakages and to increase water recycling and reuse, companies within every sector can readily access to documentation involving same-sector companies who have successfully reengineered processes, replaced equipment or implemented other measures to directly or indirectly reduce water demands. It may now or soon be possible to develop 'best practices' guidelines or standards that quantify acceptable industry performance with respect to water-use efficiency and water-use productivity within individual sectors or sub-sectors.

Resource Extraction

With the exception of enhanced oil recovery operations, water quantity management issues in the resource extraction sector generally focus on questions of diversions and impoundments rather than conservation and efficiency.

Process water recycling has been a common practice in mineral mining operations for many years as a means of minimizing wastewater discharge volumes. Evaporative losses from tailings impoundments and from the use of water for dust suppression are generally minor, particularly in the case of hard rock mining. Consumptive losses can be of greater concern in connection with refining of metallic ores (water may be used both as a coolant and as a reagent in byproduct recovery) and processing of non-metallic minerals that requires the creation of intermediate or final-product suspensions or slurries.

Enhanced oil recovery operations (EOR) involving the use of water or steam have raised public concerns over potential impacts on other extractive interests and the environment. Disposal of contaminated water from these operations can also involve the use of permanent deep well injection further adding to the consumptive nature of EOR water usage. These concerns have led governments, particularly in Alberta, to curtail the granting or scope of new freshwater withdrawal approvals and forced the industry to pursue other alternatives including the use of saline water sources along with increased water recycling and reuse. Since EOR and heavy bitumen operations are vital and expanding components in Canadian energy production the use of these and other alternatives for minimizing freshwater use can only grow in importance.

Recreation

Public concern over the impact of water usage by the recreational sector continues to grow in many parts of the country. The focus of much of this attention is golf course operations that, like agricultural and landscape irrigation, exert high seasonal water demands. Ongoing expansion in the number of courses in close proximity to major cities and within city regions will increase pressure on governments and the industry to find management solutions that stress water efficiency improvements over increases in withdrawals. Newer courses can be sited, designed, constructed and operated to make more efficient and sustainable use of water than what is the norm for most existing courses.

Building Support and Overcoming Challenges

Understanding the interests and perspectives of key stakeholders is critical to overcoming challenges in moving forward. The consensus-based views of several well-recognized organizations representing a range of public utility, business, environmental and professional interests appear to support strengthened government initiatives in water conservation. Some of these groups have, however, voiced concerns over how any new initiatives would be structured and want to be part of the process for deciding on the appropriate balance between voluntary and regulatory approaches and for arriving at workable alternatives in the assignment of implementation costs and responsibilities.

Canadian Stakeholder Perspectives on Water Conservation

GROUP	POLICY OR PERSPECTIVE
MUNICIPAL & WATER UTILITIES	
Federation of Canadian Municipalities (FCM)	FCM calls upon senior governments to work together in establishing policies and legislation aimed at water-use efficiency and sustainable infrastructure development. FCM supports: <ul style="list-style-type: none"> • Per capita consumption goals • Universal metering • Public education regarding alternatives • Building code requirements for water-efficient plumbing fixtures and other devices • Full cost accounting and cost recovery • Special support for small communities.
Canadian Water and Wastewater Association (CWWA)	CWWA supports: <ul style="list-style-type: none"> • Adoption of water conservation policies and programs by all municipal utilities • Universal metering • Full cost accounting and cost recovery • Integration of environmental, public health and sustainable development principles in municipal planning, decision-making and day-to-day operations • Watershed management • Coordinated government intervention in funding municipal water and wastewater infrastructure taking into account differences in the financial capacity of smaller and northern communities.
MANUFACTURING	
Forest Products Association of Canada (FPAC)	FPAC has not identified water conservation as a “current issue” facing the industry. It does, however, report that its members continue to seek ways to recycle and use water and other resources more efficiently.
Canadian Chemical Producers Association (CCPA)	CCPA's Responsible Care® program principles support water conservation. Member companies are expected to: <ul style="list-style-type: none"> • Apply options including reducing, reusing, recycling and recovering [resources and materials] to minimize impacts on the environment.
Canadian Steel Producers Association (CSPA)	CSPA's sustainable development principles commit its member companies to: <ul style="list-style-type: none"> • Maximize resource efficiency in the development, production and use of steel products including efforts to use energy and water more efficiently.
Canadian Petroleum Products Institute (CPPI)	CPPI's guiding principles for the environment' commit member companies to “develop management systems that support efficient utilization of natural resources”.

GROUP	POLICY OR PERSPECTIVE
RESOURCE EXTRACTION	
Mining Association of Canada (MAC)	MAC's Environmental Policy commits member companies to: <ul style="list-style-type: none"> • Develop, design and operate facilities based upon the efficient use of energy, resources and materials.
Canadian Association of Petroleum Producers (CAPP)	CAPP policies require or encourage its members to: <ul style="list-style-type: none"> • Measure and annually report on water-use productivity as a stewardship benchmarking parameter • Develop new technologies to monitor, report and reduce water usage • Support research into and adoption of innovative water conservation and materials recovery measures.
AGRICULTURE	
Canadian Federation of Agriculture (CFA)	CFA does not have a specific position on water conservation and water-use efficiency. On the broader issue of environmental protection, CFA requests governments to consider: <ul style="list-style-type: none"> • Long-term and stable funding for environmental farm planning • Capital cost allowances for environmental investments • Funding for stewardship initiatives undertaken for public environmental benefits.
RECREATIONAL INDUSTRIES	
Royal Canadian Golf Association (RCGA)	RCGA's Environmental Principles encourage golf course designers, developers, owners and operators to: <ul style="list-style-type: none"> • Design and operate irrigation systems to use water efficiently and responsibly • Consider alternative and supplemental sources of water including use of reclaimed water and stormwater runoff.
OTHER	
Canadian Water Resources Association (CWRA)	CWRA supports government, business, public and professional collaboration to encourage water conservation through: <ul style="list-style-type: none"> • Recognizing the value of and limits on water resources and the costs of providing water in adequate quantity and quality • Balancing education, market forces and regulatory systems to promote choice and recognition of shared responsibilities to pay for use of the resource. • Restoring and enhancing government commitments to hydrometric and meteorologic monitoring networks.
Organization for Economic Cooperation and Development (OECD)	In its 2004 Key Environmental Indicators Report, OECD observes that: <ul style="list-style-type: none"> • Most OECD countries [including Canada] face seasonal and/or water quantity problems that serve as a constraint to sustainable development and to the sustainability of agriculture • Solving these problems will involve reducing losses, using more efficient technologies, increasing recycling, using a watershed approach, and applying user-pay principles.

Suggested Directions

Successful water conservation programs and initiatives are founded upon informed decision-making with respect to problem identification, goals, objectives, available alternatives and expected benefits. They also incorporate a good understanding of water conservation's important linkages to other sustainable development initiatives.

Potential partners and major stakeholders need to be engaged in the development of objectives and targets and in the identification and resolution of implementation issues. A range of tools and measures should be evaluated with due consideration to the expected contribution of key water-use sectors. The rationale for harmonization at the provincial/territorial and national levels should also be considered. The resulting water conservation strategy and plan will clearly define the purposes, objectives, targets and actions, will prescribe roles and responsibilities and institutional arrangements and will identify how implementation is to be resourced.

Suggested Government Directions in Support of Water Conservation

<p style="text-align: center;">Sustainable Resource Development and Use Policies</p> <ul style="list-style-type: none"> • Promote water conservation and water-use efficiency as components of broader sustainable development goals and commitments. • Set water conservation and water-use efficiency targets to address watershed and service-area sustainability objectives while also ensuring inter-regional and cross-sectoral harmonization. • Integrate water conservation goal-setting, messaging and implementation with initiatives targeting conservation of energy and other resources and the protection of water quality and aquatic systems. • Integrate the use of regulatory and non-regulatory tools for managing water use. Give due recognition to the capacity and responsibility of users and the benefiting public to share in the costs. • Develop business-renewal strategies for the creation of new economic opportunities based on more-productive water uses. • Support urban development standards and practices that encourage attenuation of stormwater runoff and protection of groundwater recharge. • Implement full-cost accounting and cost recovery across all levels of government in the management and delivery of water-related services. Have regard for the limited financial capacity of smaller communities and some business sectors. Factor in the projected costs of renewing and replacing failing and outdated infrastructure.
<p style="text-align: center;">Legislation and Regulation</p> <ul style="list-style-type: none"> • Introduce regulatory measures that i) require self-supply water users to prepare water conservation /efficiency plans, ii) establish water-efficiency standards/guidelines for individual sectors, iii) protect in-stream uses and aquatic systems, and iv) implement cost recovery. • Introduce or amend legislative mechanisms that will enable government agencies to address situations where reprioritization, redistribution and/or reduction in allocations are essential for the protection and advancement of the public good.
<p style="text-align: center;">Monitoring, Reporting and Analysis</p> <ul style="list-style-type: none"> • Implement mandatory requirements for the metering/measurement and reporting of water usage by all self-supply water users. Harmonize data collection and reporting requirements to facilitate information compilation and analysis across sectors and among jurisdictions. • Implement mandatory metering for all customers served by public/municipal water systems. • Expand and intensify surface and ground water level and flow characterization studies and monitoring networks. Assign priority to areas of existing or emerging water-use conflict or concern. • In high growth watersheds, compile information on projected increases (10-50-yr planning horizons) in water demands across all sectors. • Enhance support for the development, refinement and use of watershed and aquifer-based water allocation and conservation planning tools. • Summarize and publicly report on water availability, water usage and conservation information and analysis on a routine and frequent basis.

<p style="text-align: center;">Outreach and Education</p> <ul style="list-style-type: none"> • Review existing outreach and education initiatives at all levels of government. Ensure they are effective in reaching water users and in providing essential information on conservation benefits, options and implementation strategies. Tailor initiatives according to sector. • Document and disseminate more detailed technical and cost information required by industry, agricultural producers, and other businesses. • Expand and enhance coverage of water conservation and stewardship goals and measures within school curricula at all age levels.
<p style="text-align: center;">Consultation and Involvement</p> <ul style="list-style-type: none"> • Engage municipalities, industry, business and other stakeholders in target setting, identifying preferred efficiency measures, and in finding innovative resourcing approaches. • Enlist the support of water conservation innovators and champions within each sector in spreading the conservation message and knowledge to their colleagues.
<p style="text-align: center;">Economic Instruments</p> <ul style="list-style-type: none"> • Accelerate the use of full-cost accounting and cost recovery approaches in the provision of water management services and activities including those pertaining to water conservation and efficiency. • Phase out the use of flat-rate and declining block-rate pricing and the use of preferential pricing for large-volume water users. Introduce conservation-oriented rate structures while providing appropriate forms of rate relief for low income households. • Make development of and commitment to a water conservation plan a condition of eligibility for funding assistance in connection with all water and wastewater infrastructure expansion and renewal projects. • Develop and implement appropriate strategies for addressing the more limited implementation capacity of smaller and northern communities and of smaller business operators.
<p style="text-align: center;">Research and Development</p> <ul style="list-style-type: none"> • Examine the benefits and drawbacks of encouraging or requiring use of closed-loop cooling systems in thermal power generation, industrial, commercial and institutional water-use applications. • Investigate the feasibility of national or regional water-use efficiency standards or guidelines based on best technologies and/or practices in major water use sectors and sub-sectors. • Expand research into the impacts of global warming and climate change on water resource availability and demand with a focus on improving regional-level quantification of those impacts.
<p style="text-align: center;">Implementation</p> <ul style="list-style-type: none"> • Acknowledge that the attainment of water efficiency and sustainability goals is likely to take longer in some areas and sectors than in others. Require all new growth and development to use best practices and technologies while setting realistic timeframes for attaining targeted improvements within existing development. Seek continuous improvement. • Work toward devolving day-to-day water management decision-making to the lowest practicable level subject to the application of clearly defined policies and principles and the provision of appropriate over-sight. Assist local and regional/watershed authorities in developing capacity to assume these responsibilities. • Integrate and harmonize conservation planning and implementation among all levels of government and between the public and private sectors.

Potential Roles and Responsibilities

The goal of ensuring that Canada and Canadians develop and use the nation's water resources to the sustainable benefit of all interests can only be realized if responsibilities and accountability are broadly shared. The following roles and responsibilities are suggested.

CCME

- Provide a forum for the discussion, analysis and harmonization of current and proposed federal and provincial/territorial water conservation initiatives.
- Facilitate sharing of conservation experiences across all Canadian jurisdictions.
- Conduct periodic reviews of implementation progress and concerns.

Federal Government

- Facilitate cooperation among the provinces and territories and with federal departments.
- Continue and expand support for shared federal-provincial/territorial networks and programs designed to characterize and monitor streamflows, water-levels and groundwater-elevations.
- Continue to survey, analyze and report information on water use across all major use sectors and on a country-wide basis.
- Implement conservation measures at all federal facilities and properties.
- Seek US support and commitment to conservation initiatives impacting on boundary waters.
- Monitor conservation initiatives and practices in other countries.
- Provide coordination and support for the evaluation, development, adaptation and demonstration of new or improved water-use technologies and practices, e.g. closed-circuit cooling.
- Provide coordination and support toward development of sectoral best practices standards and guidelines for water-use efficiency.
- Examine the feasibility of introducing a national water-efficiency labeling program for plumbing fixtures, household and commercial appliances, and other water-use related devices.
- Adopt taxation policies and cost-share infrastructure eligibility criteria that encourage and facilitate adoption of water-efficiency measures by municipalities and businesses and discourage new or ongoing investment in the use of inefficient practices and technologies.

Provincial and Territorial Governments

- Use provincial building codes to require the mandatory use of water-efficient plumbing fixtures in all new residential, commercial and institutional construction and retrofits.
- Require self-supply water-use licence and permit holders (as a condition of approval) to:
 - Prepare water conservation plans and implement water efficiency measures
 - Accurately meter/monitor and routinely report daily water usage
- Adopt criteria that make municipal and private sector eligibility for water-related infrastructure grants and other government funding conditional upon the preparation and adoption of an acceptable water conservation plan and practices.
- Support development of sectoral best practices water-efficiency standards and guidelines.
- Restrict new water takings and prioritize uses in areas subject to existing or impending conflicts between demand and supply.
- Require and facilitate the preparation of drought-response plans for areas subject to recurring water shortages.
- Implement conservation measures at all provincially-owned facilities and properties.

- Use sectorally targeted outreach and education to promote and encourage conservation.
- Provide support for the evaluation, development, adaptation and demonstration of new or improved water-use technologies and practices.
- Establish economic incentives to encourage water users to adopt water-efficient practices and technologies and/or disincentives to discourage new and continued use of inefficient practices and technologies.
- Adopt permit fees and other water charges to cover the costs of water management programs and activities and to support conservation behaviours.
- Continue and expand support for cost-shared monitoring networks and programs used to characterize and measure streamflows, water-levels and groundwater-elevations.
- Require and support the use of supply and demand forecasting and water budgets/balance analyses in all critical-use watersheds/aquifers.
- Monitor conservation initiatives and best practices in other jurisdictions for potential adoption or adaptation.
- Support interprovincial and national harmonization of conservation and sustainable use initiatives.
- Support coordinated conservation and sustainable use initiatives in Canada-US transboundary watersheds.

Municipalities

- Make conservation and water-use efficiency programs a municipal priority.
- Approach conservation planning and implementation in a comprehensive and systematic manner; seek continuous improvement.
- Set water savings targets and implementation timelines.
- Implement universal metering for all customer sectors; commit to regular meter inspection and calibration.
- Minimize distribution system losses through:
 - Leak detection and correction
 - Pressure modulation
 - Scheduled watermain replacement
- Enact bylaws that do some or all of the following:
 - Require use of water-efficient plumbing fixtures and appliances
 - Appropriately restrict lawn watering and other outdoor uses as needed
 - Require the use of rainfall sensors and automated controls for regulating rates of flow and on-off cycles of landscape irrigation systems
 - Limit the impervious area portion of a building lot
- Implement water pricing based on full-cost accounting and recovery.
- Use increasing block, seasonal use and other conservation-oriented rate structures.
- Encourage and subsidize residential, commercial and institutional plumbing-fixture retrofits.
- Promote xeriscaping and use of drought tolerant plants.
- Require or encourage (and subsidize) water-use audits and conservation planning among large-volume users.
- Use outreach and education to encourage good conservation practices.
- Implement conservation measures at all municipally-owned facilities and properties.
- Monitor progress and report on accomplishments.
- Monitor practices in other municipalities for potential adoption or adaptation.

Business and Professional Organizations

- Adopt a water conservation and efficiency code of ethics and require member adherence to it.
- Stay current with advances in sectoral Best Management Practices (BMPs) and disseminate this information to members through seminars, fact sheets, case study reviews, etc.
- Support and participate in pilot and full-scale BMP demonstrations.
- Support and participate with governments in the development of sectoral water efficiency standards and guidelines.
- Routinely monitor and report on sector performance.
- Represent member interests in provincial/territorial and national consultations on water management.

1.0 INTRODUCTION

1.1 BACKGROUND

This report has been prepared for the CCME Water Conservation and Economics Task Group. Its purpose is to highlight strategies and actions that could assist Canadian governments, businesses and households in meeting the challenges and capitalizing on the opportunities associated with the productive, efficient and sustainable use of water. It is intended to provide water managers with a “single recognized and respected source of information on water conservation relevant to Canadian conditions”¹.

Advancement of water conservation initiatives and achievements across the country continues to be identified as a priority by the Council’s member governments. Ten years have passed since CCME released its ‘National Action Plan for Encouraging Municipal Water-Use Efficiency’ and progress has been made on a number of fronts. Notwithstanding this progress, there is mounting evidence that a more coordinated, comprehensive and multi-sectoral approach to managing water use and demand is needed to ensure the long-term sustainability of Canadian communities, businesses and individual livelihoods and the protection of aquatic ecosystems. Rapid urbanization, intensification of agricultural operations, growth in the energy-production sector, industrial expansion, and increasing recreational water demands are heightening local and regional concerns over the sustainable use of water resources and sparking debate over priorities of use. Adding to these concerns are the increasingly apparent water resource impacts of climate change.

1.2 WATER CONSERVATION DEFINED

In the broadest context, water conservation includes any and all efforts and actions taken to ensure the wise development, efficient use, productive use, and careful management of surface and ground water resources. Such actions are taken to ensure the sustainability of aquifer and watercourse yields in the face of cumulative water withdrawals by individuals, communities and businesses. They are also taken to protect in-stream uses and the health of both local and downstream aquatic ecosystems and the biota they support. The connectedness of hydrologic systems dictates that conservation needs and objectives be considered not just at the local level but also at the watershed and basin scales.

In order to arrive at a common understanding among its members and with its consultants, the Task Group took on the task of more specifically defining what they wished to see reflected in the analysis and discussion of water-use practices and conservation in Canadian and other jurisdictions. The following observations and definitions came out of their deliberations.

The terms ‘water conservation’ and ‘water efficiency’ are often used interchangeably in discussions of water conservation. One definition that combines the intent of both terms is proposed. It has been adapted from A Handbook of Water Conservation by Amy Vickers, 2001 and Principles of Water Use Efficiency by Donald Tate.

Water conservation / water efficiency refers to the desired outcome of actions taken to bring about a beneficial reduction in water loss or water waste or to minimize the amount of water used in accomplishing a task or producing a product (*adapted from Vickers and Tate*).

Water conservation measure refers to specific tools (technologies) and practices (behaviour changes) that result in more conservative and efficient water use. (*per Vickers*).

Water use productivity refers to amount of water used to produce one unit of any good or service, e.g. m³/tonne or m³/\$1,000 of shipment value. The lower the water input required, the higher the productivity. (*adapted from Tate*).

1.3 CONSERVATION BENEFITS

Using water more efficiently and productively has been shown to:

- Prevent or reduce conflicts among water users who share a common resource;
- Contribute to the protection of environmental flows and to the health of aquatic ecosystems;
- Make water resources available for new growth and development;
- Avoid or defer the need to expand the capacity of water and wastewater infrastructure;
- Eliminate the need to augment water supplies through potentially harmful or undesirable diversions from other watersheds;
- Free-up public funding for investment in other priorities including the renewal of outdated water and sewage infrastructure;
- Increase the ability of water users to withstand the impacts of low-water conditions resulting from inherent weather variability and climate change;
- Conserve energy, other resources and raw materials and improve business profitability;
- Enhance wastewater treatment efficiency and reduce environmental emissions; and
- Enhance leverage with other jurisdictions on issues relating to shared waters.

1.4 CONSERVATION TOOLKIT

The complex nature of ensuring that the country's water resources are developed wisely, used efficiently and shared appropriately requires governments to draw upon a comprehensive range of regulatory and non-regulatory mechanisms from the following categories.

- Legislation and regulations
- Outreach and education
- Research and demonstration
- Economic instruments
- Implementation partnerships
- Monitoring and enforcement
- Ongoing performance review and reporting

The effectiveness and efficiency of government conservation initiatives depends on selecting an appropriate mix of measures and tools for use in directing and influencing individual, community and business choices and behaviours in the way water is used.

1.5 CHALLENGES

“We never know the worth of water till the well is dry”². This centuries-old saying sums up the significant challenge most governments face in getting people, communities and businesses to conserve and use water more efficiently. The task is made more difficult by gaps in knowledge and information such as:

- An insufficiently shared understanding of the existing impacts and long-term consequences posed by current water use practices on sustainable resource development, the environment and the economy.

- Limited awareness of the broader benefits associated with water conservation and efficiency projects, e.g. energy savings, water quality enhancement, renewed growth and development opportunities.
- Lack of complete and/or reliable data on current and projected levels of water use.
- Limited information on surface and ground water availability and variability in levels and flows, even in critical use watersheds.
- Uncertainty over the potential impacts of climate change and variability on water resources.
- Lack of and sometimes conflicting information concerning the scale of water savings achievable under various demand management scenarios.
- Limited accounting of the true and full costs involved in providing water services and in carrying out other water management activities.
- Uncertainty among governments and water users over the impacts of acting independently on conservation initiatives for fear of jeopardizing economic viability and competitiveness within communities and business sectors.
- Uncertainty within current water allocation rules and processes over what is and isn't possible with respect to reducing and reapportioning water withdrawals in response to changing societal and economic interests within regions and watersheds.
- A shared sense of the priority for enhancing government initiatives in water conservation vs. focusing the attention and resources on other environmental needs.

2.0 STUDY DEVELOPMENT

2.1 SCOPE AND ASSUMPTIONS

The CCME Request for Proposal defined the scope of study and analysis as including “... investigating, analyzing and presenting findings on water conservation measures [within the municipal, industrial, agricultural and power generation sectors] that can be implemented provincially / territorially and/or nationally, including their potential effectiveness, and barriers along with opportunities to implement these measures more broadly across Canada.”

With the agreement of Task Group representatives, the project scope was subsequently refined to focus on freshwater resources and expanded to include examination of individual sub-sectors where they exhibit distinct water-use characteristics and/or conservation opportunities. The recreational services industry was added to the list of intensive water-use sectors. The list of study jurisdictions was also expanded to enhance the overall depth and relevance of inter-jurisdictional analyses.

2.2 SELECTION OF STUDY JURISDICTIONS

Jurisdictions selected for study were as defined in the Request for Proposal with the addition of several others that were thought to warrant consideration and review. The study list encompasses all Canadian federal, provincial and territorial jurisdictions; the U.S. federal government and the states of Arizona, California, Florida and New Mexico; along with Australia and some of its member states, the European Union, England and Wales, and France. Reference was also made to sector-specific approaches and practices found in a number of other jurisdictions where these were considered of particular interest and benefit.

The breadth of coverage ensured a good mix of jurisdictions that possess a cross-section of physiographic, climatic, demographic and/or institutional characteristics comparable to the range of conditions found throughout Canada.

2.3 RESEARCH AND ANALYSIS

To illustrate the full breadth of Canadian demographic and physiographic settings under which water use occurs, the project team undertook an initial scoping of water availability and demand conditions and concerns at the regional level. See Chapter 3.

Extensive internet searches of senior government, municipal, industry association, and individual company websites were used to compile information on:

- Characteristics of water use within major geographic regions and sectors / sub-sectors
- Profiling the contribution of water-use intensive sectors within the Canadian economy
- Water-related legislation, regulations, policies and guidelines within each study jurisdiction
- Scope, objectives, content, implementation status and results of water conservation and water-use efficiency program initiatives within each jurisdiction
- Canadian municipal, industrial and NGO perspectives on water conservation programming needs and directions

- Individual municipal utility and business operator case studies including documentation of conservation program drivers, targets, scope of measures, implementation partnerships, costs and results

Inter-jurisdictional and cross-sectoral comparisons of information pertaining to water usage, water-efficiency requirements and production levels rely heavily on the quality and specificity of the data reporting contained in the source documents. In this regard great care was taken to maintain the integrity of the source data and to ensure clarity in how it was used within this report.

Phone interviews and draft materials circulation were used to confirm the currency, accuracy and completeness of the information being collected where necessary.

Information analysis was undertaken at two levels, i.e. comparing approaches among jurisdictions (Chapter 4) and comparing practices within sectors (Chapters 5-8). While these levels should be more closely connected, it is apparent that most jurisdictions are in the relatively early stages of truly making those connections through the use of integrated water resources planning.

Follow-up analysis focused on a deeper examination of stakeholder views regarding water conservation needs and directions. Government initiatives meet with greater acceptance and participation if they have the broad support of those expected to make further investments in technologies and practices. The informed consensus among individuals and businesses within key sectors can be a useful indicator of that support. Many leading organizations representing interests of municipalities, industries, agriculture, other businesses and ratepayers have thoughtfully studied the issues and have documented what they feel to be the fundamental directions, roles and needs for their sector.

The following organizations were surveyed for their perspectives on conservation and water-use efficiency:

- American Water Works Association (AWWA)
- Canadian Association of Petroleum Producers (CAPP)
- Canadian Chemical Producers Association (CCPA)
- Canadian Federation(s) of Agriculture (CFA)
- Canadian Petroleum Products Institute (CPPI)
- Canadian Steel Producers Association (CSPA)
- Canadian Water Resources Association (CWRA)
- Irrigation Association (IA)
- Federation of Canadian Municipalities (FCM)
- Forest Products Association of Canada (FPAC)
- Mining Association of Canada (MAC)
- Organization for Economic Cooperation and Development (OECD)
- Royal Canadian Golf Association

2.4 DEVELOPMENT OF CONCLUSIONS AND SUGGESTED DIRECTIONS

The study's conclusions and suggestions for moving forward draw on the consultant team's extensive experience in the evaluation and formulation of public policy and programs for water resources management in Canada and elsewhere. Reference was also made to other independent examinations of conservation needs and directions in the Canadian, North America and global contexts.

3.0 WATER CONSERVATION IN THE CANADIAN CONTEXT

3.1 WATER CONSERVATION: WHY SHOULD CANADIANS CARE?

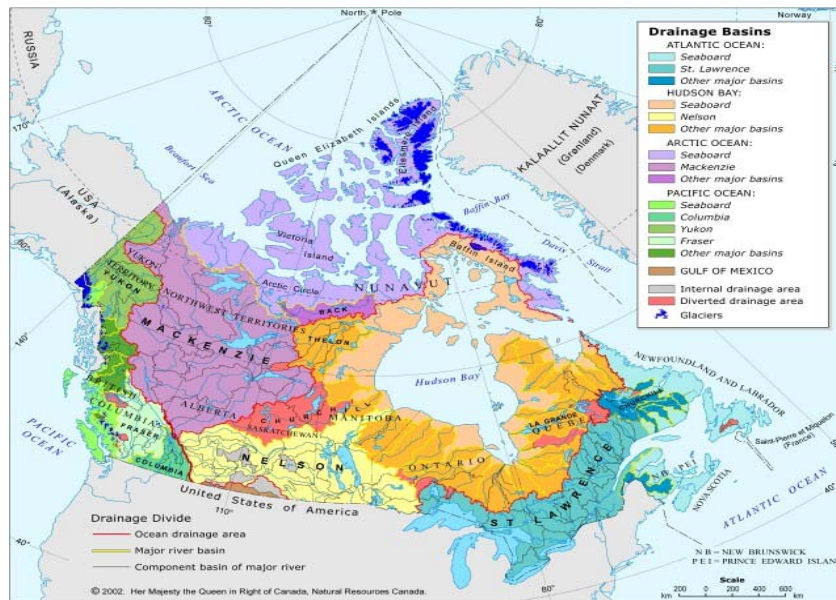
Canada is widely seen as a nation rich in water resources accounting for 8% of the world's renewable freshwater resources. The Great Lakes contain 20% of the global freshwater volume and form one of the largest connected freshwater systems in the world³. A comparison of total annual water renewal rates vs. total annual demand puts Canada in the top tier of countries whose gross renewable supplies far exceed its water-use demands.

This view of abundance masks other realities concerning the availability of these resources and discounts the significance of the mounting list of situations where sustainable-use concerns exist at the local and regional levels. It also ignores the substantial economic costs and foregone opportunities associated with inefficient and less-productive uses of water.

- Much of the country's water wealth is situated in areas far removed from the point of need thereby limiting its availability and potential for development. Sixty percent of Canada's water resources flow north while more than 85% of the population and the vast majority of the country's economic activity are located in more southern regions⁴. This is more than just an issue of cost. Environmental concerns have intensified public opposition to diversions. (See Drainage Basins figure below).
- Agriculturally significant areas of the country including the southern prairies and southwestern Ontario possess semi-arid climates and net water deficits or face growing competition over available supplies. Crop and livestock production and many local communities have come to depend on supply management measures including large-scale diversions, constructed storages and widespread irrigation.
- Many other areas exhibit seasonal or more-prolonged patterns where the cumulative demand for water results in competition for locally available supplies and threatens aquatic ecosystems and environmental health.
- Climate change predictions show that these and other parts of the country are likely to experience increasing risks from reduced water availability and increased water demand.
- Inefficient and non-productive uses of water continue to drive avoidable expenditures and debt accumulation for the construction, expansion, operation and rehabilitation of municipal and private water infrastructure. They also result in excessive energy consumption and contribute to the inefficient use of other resources.

Historically, Canadian cities and towns and water-dependent businesses were drawn to areas with good access to surface or ground water resources. As growth and expansion occurred, they further developed these supplies with little regard for conservation and efficiency of use. Today, this focus on supply-side management is increasingly seen as economically and environmentally unsustainable.

Canada's Major Drainage Basins

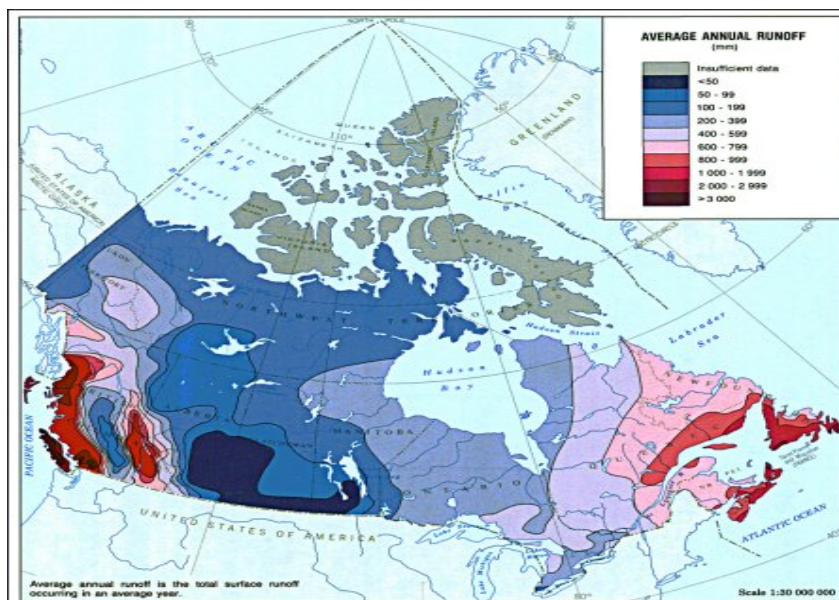


Atlas of Canada. See online at www.atlas.gc.ca/site/english/maps/reference/national/drainbasins

3.2 WATER AVAILABILITY

Canada's east and west coasts are characterized by high precipitation and average annual runoff in the range of 1000-3000 mm and higher (see figure). At the opposite extreme, the southern prairies experience mean annual precipitation levels of less than 400 mm and runoff of less than 50 mm. Climatic conditions in southern Ontario and southwestern Quebec are in between with normal-year precipitation levels in the range of 600-900 mm and runoff levels of 200-400 mm annually. The distribution and scope of groundwater resources is highly variable, however, all provinces have access to significant supplies. These are important as potable supplies for most rural populations, some urban communities and agriculture.

Average Annual Runoff



3.3 WATER WITHDRAWALS AND WATER USAGE

Extractive uses of water are generally separated into two categories – non-consumptive uses and consumptive uses. If the water withdrawn is returned undiminished to the source from which it was taken, the use is commonly referred to as non-consumptive. The returned water becomes available for reuse by downstream users/uses even though its quality may have been altered. Water takings for domestic, commercial and institutional indoor uses, mining, power generation, and some industrial purposes are often considered non-consumptive. Other uses involving significant evaporative losses, e.g. crop and landscape irrigation and steam generation in manufacturing, as well as uses that result in water being incorporated into a product are considered consumptive.

This simplistic characterization of consumptive vs. non-consumptive uses is not particularly helpful when a water manager is faced with having to determine a water budget or balance for an aquifer or watershed. What is the likely impact if most but not all of the water taken is returned? What if all the water is returned but to a different waterbody or to the same waterbody but at a time and/or location well removed from the initial taking?

Answering these questions requires a closer look at actual levels of consumptive usage or loss and at the particulars relating to the location and timing of discharge (return) relative to the intake. In the first instance it is common to use an empirical consumptive-use coefficient determined for the category of use. A commonly used consumptive-loss coefficient for irrigation uses is 0.8 or 80% of intake. Higher or lower values could apply if locally specific data were as available to support their application.

From a conservation perspective, water withdrawals involving high consumptive losses are of greater concern than those where most of the taking is returned to the originating watercourse. Notwithstanding the basic hydrologic-cycle principle that water consumed is not truly lost and ultimately returns to earth at another time and location, consumptive usage is often a critical factor in the creation of imbalances between water availability and demand and user conflicts at the local and regional scale, i.e. at the stream reach, sub-watershed and watershed levels.

The case of groundwater withdrawals is more complicated since that which is not consumed is typically returned to a surface watercourse or to the shallow groundwater system and therefore becomes available to downstream interests. This is not to lessen the environmental significance of those situations where groundwater takings exceed the rate at which the source aquifer is replenished. Such “mining” of an aquifer, can interfere with other extractive uses and diminish the baseflows that sustain local watercourses.

Information is presented later in this report regarding technologies and practices used to reduce the amount or significance of consumptive loss associated with crop irrigation, turf and landscape irrigation, and other activities. More in-depth attention is given to crop irrigation practices since additional considerations surround the need to minimize return flows (runoff and groundwater transport) that can carry nutrients and agricultural chemicals detrimental to surface and groundwater quality.

Knowledge and understanding of where and how water is used and how the balance between water availability and water demand varies from region to region (or more appropriately from watershed to watershed) and over time are essential to the proper planning and successful implementation of conservation initiatives.

While statistics on the magnitude and distribution of water use by business activity exist at the national, provincial and (less uniformly) lower levels, their compilation and reporting lack both rigour and continuity. Most jurisdictions have yet to require water users to accurately meter and routinely report on their water withdrawals making currently available data rough estimates at best. Different forms of water use can also result in different pressures on the resource and other uses, e.g. in relation to the consumptive usage or loss component and/or whether the taking is from a surface or ground water source.

The following table illustrates the distribution of freshwater withdrawals and consumptive use among major sectors at the national level for 1996 (most current reporting year). Environment Canada is in the process of compiling and analyzing more recent data. The more recent figures are expected to show reduced total withdrawals between the primary and manufacturing industries. These anticipated reductions are a product of ongoing company efforts in creating water and energy savings and in improving wastewater emission performance. A sector by sector overview of some of these initiatives, along with case studies, is contained in Chapter 6.

Canadian Freshwater Withdrawals and Consumptive Usage (1996)⁵

Activity Sector	Withdrawal million m ³	% of National Freshwater Use	Consumptive Use million m ³ (% of Withdrawal)
Agriculture	4,100	9.6	3,040 (74)
Mining	475	1.1	
Self-Supply Manufacturing (Total)	5,290	12.4	495 (9.4)
- <i>Pulp & Paper</i>	(2,350)		
- <i>Primary Metals</i>	(1,350)		
- <i>Chemicals & Chemical Products</i>	(1,015)		
- <i>Petroleum Refining</i>	(255)		
- <i>All Other Manufacturing</i>	(320)		
Thermal-Electric Power Generation	26,900	63.3	450 (1.7)
Municipal	4,895	11.5	550 (11)
Rural (domestic, commercial, institutional)	840	2.0	
Totals	42,500	100	4,535

Sectoral water use was further broken out on a regional basis as shown in the accompanying table. Some data had to be interpolated from the 1996 Environment Canada survey results using best judgment assumptions in reconfiguring the municipal and manufacturing categories, i.e. to separate self-supply industrial takings from municipally supplied industrial usage.

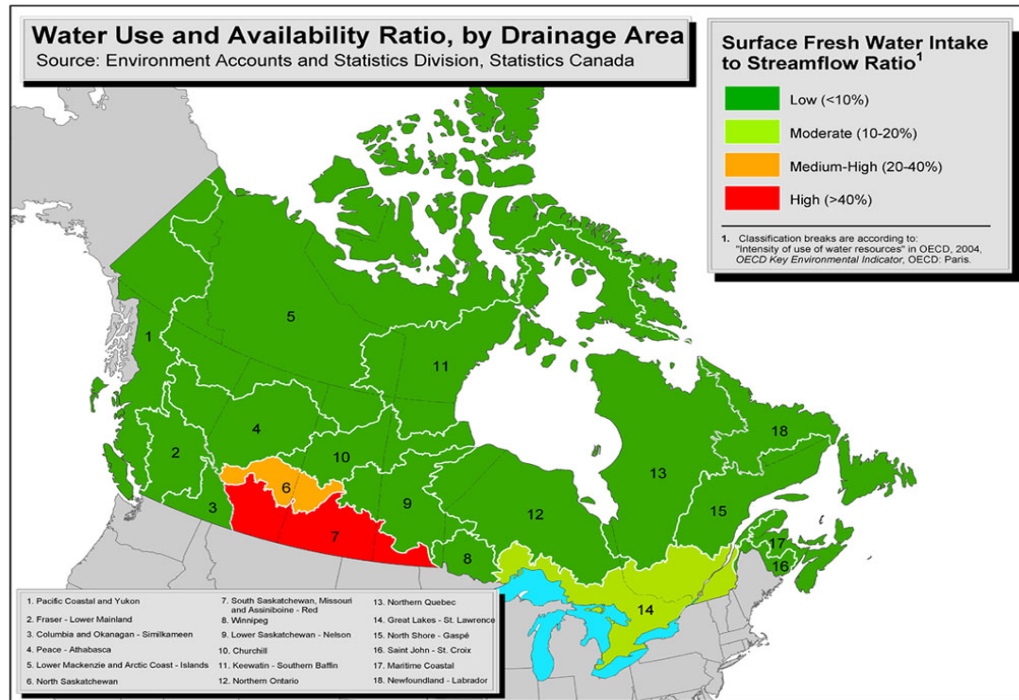
Canadian Freshwater Withdrawals by Region and Sector (1996)⁶
(million m³/year)

Region	Thermal Power	Mfg (self-supply)	Municipal (all sectors)	Agriculture	Mining	Rural	Total
BC	4	990	715	778	143	116	2,746
Prairies	2,337	350	544	3,030	61	121	6,443
ON	23,228	2,448	1,832	173	56	250	27,987
QC	809	1,032	1,519	103	38	238	3,739
Atlantic	522	470	285	16	177	115	1,585
Total	26,900	5,290	4,895	4,100	475	840	42,500

3.4 SUSTAINABLE USE: AVAILABILITY VS. DEMAND

The following figure provides a snapshot of broad regional differences in the ratio of water demand or use to resource availability. Challenges being faced in areas where the ratio is moderate to high are briefly highlighted in the next section and are then looked at in greater detail in Chapter 4.

Water Use and Availability within Major Drainage Basins



Environment Canada . See online at www.ec.gc.ca/water/images/manage/use

3.5 CROSS-COUNTRY LOOK AT ISSUES AND CONCERNS

Balancing water allocations and demands to keep within the bounds of the naturally occurring availability of supply has long been problematic in selected areas of the country. Such situations are likely to become more challenging and more widespread in the future without demand intervention. Contributing factors include pre-existing water deficits, urban population growth and economic development pressures, the debt burden imposed by aging infrastructure, the impacts of climate change, and inadequacies in current water allocation processes.

3.5.1 Water Allocation Processes

Inflexibility and gaps in existing water allocation rules and decision-making processes can contribute to creation of situations that force governments and water users to implement after-the-fact conservation initiatives. Problems stem from both legislative and information shortfalls.

Laws that limit mandatory licensing of surface and ground water withdrawals (other than de-minimus and emergency takings) or create inalienable rights of access can make it difficult to allocate

and manage water resources in the long-term public interest. The legal principles of ‘prior appropriation’, as generally prevails in the western provinces, and ‘riparian rights’, as found in eastern Canada, may hinder government action in situations where demands on the resource approach or surpass the sustainable yield of the resource. As growth and development proceed, the collective public interest in water often changes. This brings with it the expectation that existing allocations must also change. As is often the case, environmental and ecological sustainability needs may lose out in favour of the demands of extractive uses.

The lack of accurate information on water availability and current water use together with limited exposure to the tools needed in using this information in water allocation decision-making increase the risks of authorizing levels of use that are not sustainable.

3.5.2 Water Waste and Energy Waste

Transporting, heating, cooling, treating and doing other things with water (and wastewater) normally involve the use of significant quantities of electrical and thermal energy. Global estimates place the amount of energy consumed in water-related processes at 7% of total energy consumption⁷. Reports from southern California estimate that the amount of energy used in providing water to residential customers equates to one third of the average household electrical consumption in the region⁸.

The corollary is that reducing demand and making more productive use of water will result in less energy consumption and important cost savings for all water users.

3.5.3 Climate Change Impacts

The impacts of climate change on Canadian water resources are predicted to include periods or events involving more widespread, more prolonged, more frequent, and more extreme conditions of low-water and high-water affecting both surface and ground water⁹. Other changes such as increased water temperatures are anticipated to alter the forms, behaviour and health of fish and other aquatic life. These anticipated effects vary among regions.

- Worsening drought conditions in the Prairies could lead to increased irrigation water demands, which, in turn, could increase soil salinity and degrade productive capacity.
- Producer interest (driven by a warmer climate) in expanding prairie agriculture further north could be countered by potential conflicts with industrial and Aboriginal interests.
- Loss of soil moisture could put some forested areas at risk leading to increased soil erosion and loss of ability to store water and moderate runoff.
- Great Lakes water levels could fall by an average of 0.5-1.0 m and the St Lawrence River outflow could be reduced by 20%. Changes of this magnitude would have significant impacts on the availability of water to support hydroelectric power production, shipping, public and industrial water supplies, and ecosystem health.
- Renewed pressures are expected from a range of U.S interests regarding negotiation and ultimate approval of new and expanded water diversions or withdrawals from some transboundary drainage basins.
- Salt-water intrusion into and contamination of groundwater aquifers used by some Atlantic coast communities as a source of water supply would result in pressures on alternate sources.

3.5.4 Urban Growth: Water-Use Efficiency and Sustainable Infrastructure Concerns

Urban growth and boundary expansion continues across Canada. Driving forces are the ongoing consolidation in agriculture and other rural economic activities and influx of new immigrants

the vast majority of whom seek out urban areas in which to settle. Total water demands within cities and city regions continue to escalate in response not only to population growth but also to associated growth in industrial and commercial activity, institutional services and recreational services. Supply-demand conflicts and inefficiencies in the utilization of existing infrastructure are increasingly being felt within growing municipalities regardless of size.

Even in the absence of concerns over water availability, regulated and voluntary management of demand and the minimization of water losses within the distribution system benefit everyone. Conservation actions reduce overall capital and operating costs for both water and sewage services, save energy, create growth opportunities without the need to expand infrastructure, and can encourage residents and businesses to seek out other opportunities to reduce their environmental footprints.

In its Policy Statements on the Environment and Municipal Infrastructure, the Federation of Canadian Municipalities (FCM) continues to call on the federal government to work with provincial / territorial governments to “establish a national policy with goals for water conservation through efficiency of use including¹⁰:

- Goals for per capita consumption in water use;
- Public education on the range of options available, from voluntary to rate-driven programs;
- Changes in the national building code to mandate water-conserving equipment for domestic and industrial use;
- Support for moving toward universal metering; and
- Rates that reflect total costs.”

In 2001, the Federation passed a resolution “[urging] the federal and provincial governments to introduce legislation to facilitate increased water conservation practices.”

With respect to municipal infrastructure sustainability, FCM recommends that:

- “Municipalities be encouraged to establish water user fees and sewer surcharges that reflect the true cost of current service and provide revenues for upgrading water and wastewater infrastructures;
- Each municipality be encouraged to use water meters instead of flat rates;
- Municipalities undertake water audits, and develop water conservation policies within their own operations;
- Municipalities undertake public awareness programs designed to encourage efficient use of water; and
- Further program initiatives place a particular emphasis on environmental remediation, energy and water efficiency retrofits in partnership with the private sector, with a focus on sustainability.”

While the intent by municipal leaders to have communities use water more efficiently and to recover the true cost of services from water users appears to be there, progress has been slow and uneven across the country as evidenced by recent Environment Canada and Canadian Mortgage and Housing Corporation surveys¹¹.

3.5.5 Northern Communities: Unique Issues and Concerns

Communities in the Yukon Territory, Northwest Territories and Nunavut and in the northern regions of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Newfoundland and Labrador provide water services in ways that differentiate them from their southern counterparts. Generally speaking, per capita water use can be much lower within those communities where water is

delivered to residential customers in bulk rather than via piped systems. Other factors include the reduced intensity and duration of seasonal outdoor activities that drive peak demands and the greater costs involved in supplying and purchasing water. Countering this view of lower demand is the situation facing other communities where individual customers require free-flow or thermostatically controlled bleeders to guard against frost damage and rupture of piped water services.

Even though conflicts between water availability and demand or among users are not generally an issue, conservation and efficient use are continuing concerns because of the higher costs for treated and delivered water within these communities.

Governance systems are also in a state of transition as powers over natural resources management are being transferred from the Government of Canada to the governments in Nunavut and the Northwest Territories. The transition period may add to the complexity and timelines in taking coordinated action on any new conservation initiatives.

3.5.6 Southern Prairies Region (South Saskatchewan River Basin)

Canada's Prairie region, which extends across the southern portions of Alberta and Saskatchewan and southwestern Manitoba, is among the world's largest and most important producers of wheat and other grains. The area is also a significant player in the global production of cattle.

In an average year the southern Prairie region receives less than 400 mm of precipitation and exhibits a net water deficit, i.e. accumulative evaporative losses exceed precipitation inputs. In average and drier years, agricultural crop production cannot be sustained without the use of irrigation. The water demands of irrigation, in turn, cannot be met without seasonal enhancement of naturally occurring supplies of water through the use of storages and in some cases diversions. Not unexpectedly, the region accounts for approximately 75% of the total land under irrigation throughout Canada.

Future expansion of irrigated agricultural production on the prairies is seen both regionally and nationally as fundamental to sustaining the Western Canadian economy and feeding an ever growing global population. Clearly this expectation will drive the need for innovative, aggressive and integrated demand management approaches in conjunction with the development and use of new water sources.

3.5.7 Great Lakes Basin

The Ontario portion of the Great Lakes Basin is home to 11.6 million Canadians. The region accounts for 45% of Canada's industrial capacity and 25% of its agricultural production¹². Some 88% of Ontarians, virtually all of the province's thermal power production capacity, and the majority of manufacturing are served by water supplies taken directly from the lakes themselves.

In spite of the vast volumes of water found in the Great Lakes, increasing concern is being expressed by basin governments, the International Joint Commission (IJC), professional organizations and NGOs that the current water use practices of basin residents and businesses are not sustainable. Major concerns surround issues relating to water-resource development approvals, water diversions, bulk removals, consumptive uses, accommodation for future growth and development, and the impacts of climate change.

As early as 1965, the IJC was asked by governments to examine water withdrawals, diversions and consumptive uses. Since then, the Commission has undertaken three additional studies. The February 2000 IJC report entitled *Protection of the Waters of the Great Lakes* spoke

directly to the issue of conservation. The Commission recommended that “governments of the Great Lakes states and Ontario and Quebec, in collaboration with local authorities, should develop and launch a coordinated basin-wide conservation initiative, with quantified consumption reduction targets, specific target dates, and monitoring of the achievement of targets....” It laid out eleven specific items and actions for governments to consider. In its most recent report, (August 2004)¹³ the IJC criticized governments for their lack of progress in implementing its February 2000 recommendations. They again call on Canadian and U.S governments at all levels to pursue the Commission’s earlier recommendations ‘with urgency’ and recommend that no new water diversions be entertained unless and until the governments of the proposed destinations of the diverted water are doing all they can to conserve and manage properly their existing water supply.

A second public consultation on a revised draft agreement between the eight Great Lakes States, Ontario and Québec was held from June 30 to August 29, 2005. The draft *Great Lakes Basin Sustainable Water Resources Agreement* will be the first time that sub-nations of different countries will be signing an agreement on the management of water withdrawals from a cross-border water basin. It provides for the implementation of commitments made by the Governors and Premiers in 2001, in the Great Lakes Charter Annex. The States and Provinces seek by this means to adopt common standards for the use and protection of water, which they will apply when making decisions on the use of water resources in the Great Lakes Basin and the St. Lawrence River.

3.5.8 Southwestern Ontario

Southwestern Ontario encompasses some of Canada’s most productive agricultural land, is home to 1.58 million people (not including the Greater Toronto Area), and possesses a relatively diversified economy¹⁴. Most major rivers and streams in the area are subject to some degree of flow control primarily for the purpose of flood protection. Groundwater resources serve multiple uses including municipal, rural domestic and agricultural.

Successive dry years experienced in the late 1990s and early 2000s (see figure) demonstrated the susceptibility of many area watersheds and aquifers to water usage conflicts between extractive users and between extractive uses and in-stream needs.

The problems, which were most severe in areas where extensive crop irrigation occurs, triggered development of the multi-stakeholder Ontario Low Water Response Plan. Continued population growth and an expanding economy suggest that drought response measures alone will not be sufficient to ensure sustainable water use in this part of the province. Tighter controls over water allocation and concerted efforts to manage demand and improve water-use efficiency are needed.

3.5.9 Southern British Columbia (Lower Fraser, Okanagan and Thompson Valleys)

The drought conditions of 2003 affected much of southern British Columbia, reducing water flow in many streams and rivers to historic lows. A survey of water utilities in September of that year indicated that 2.2 million people were affected by the drought with 84 public water systems being under stress. Even in an average year, much of the region receives less than 400 mm of precipitation. Agricultural production often experiences water shortages in late summer months even in wetter areas since most precipitation occurs over the winter months¹⁵.

Currently, over 17% of the province’s surface water sources have reached or are nearing their capacity to reliably supply water in a normal year. Observation wells indicate that groundwater levels

are declining in some areas of the province. The water resources of the Okanagan Basin are anticipated to be fully allocated within 25 years unless current per capita usage rates are reduced¹⁶.

3.5.10 Atlantic Provinces

Canada's Atlantic-provinces have generally not experienced the levels of concern over water use sustainability felt in other parts of the country. This is a combined product of high water-renewal rates in proportion to demand and slower rates of population and economic growth. Recent drought-like conditions approaching historic lows have, however, begun to raise concerns in parts of Nova Scotia, New Brunswick and Prince Edward Island.

4.0 COMPARISON OF JURISDICTIONAL APPROACHES

4.1 INTRODUCTION

This chapter examines driving forces, legal frameworks, policy-positioning, and overall approaches that characterize water conservation activities in each of the study jurisdictions. Evaluation focuses on the role and actions of senior governments. The intent is to look for lessons learned and to identify alternative strategies with potential application in a Canadian context.

The most obvious drivers underlying public interest and government involvement in water conservation are the incidence, severity and impacts of water shortages and unsustainable water use. Are there concerns regarding the adequacy of water supplies needed to support communities, the economy, the environment and future growth? The more widespread and severe these concerns are, the more likely they are to become a matter of public interest and government priority.

In terms of water availability and renewal rates, Canada finds itself in as good or better position than most nations including those selected for comparison in this analysis. The existence of local and regional water resource sustainability concerns in many parts of the country are, however, becoming of provincial and national interest because of their broader importance in relation to water and wastewater infrastructure investments, business competitiveness, the management of shared watercourses, and international commitments surrounding sustainable development.

Differences in program development and delivery approaches are also influenced by the constitutional division of water management mandates and responsibilities among national, state/provincial and local levels of government. In Canada and Australia, much of the responsibility resides at the provincial level with federal powers generally focusing on inter-jurisdictional and international matters, fisheries, trade and taxation. In Europe and the United States federal mandates for water resources management are more extensive.

4.2 WATER GOVERNANCE FRAMEWORKS

Most jurisdictions and governments follow a basic policy and program development approach in deciding needs and directions in water conservation. In its most comprehensive form, this involves defining the origin and scope of the problem, identifying the regulatory audience and other stakeholders, setting goals and objectives, identifying information needs, seeking a balance between regulatory and other measures, assessing costs and benefits, forming partnerships, establishing timetables and milestones, developing an implementation resourcing strategy, and monitoring performance.

Preference is usually given to building upon existing laws and processes rather than starting from scratch. Legislation and processes dealing with water allocation and licensing are a common starting point.

The following table outlines basic principles that might be considered in arriving at an effective approach. The project team looked for evidence regarding how these principles were being addressed within each study jurisdiction.

Generic Program Planning Principles for Government Water Conservation Initiatives

Principle	Rationale
Goal-Oriented	<p>As with other sustainable resources-management programs, the objectives and desired outcomes of water conservation and water-use efficiency initiatives need to be properly thought out and clearly communicated. Some typical questions to ask are what will conservation initiatives do to:</p> <ul style="list-style-type: none"> • Reduce or eliminate water-use conflicts among extractive users or between extractive and in-stream uses • Enhance environmental flows and protect ecological functions and aquatic communities • Avoid or defer the need for costly water and/or sewage infrastructure expansions and upgrades and/or help free-up money that could be used for the replacement or renewal of existing infrastructure • Eliminate or reduce the need to augment water supplies through potentially harmful or undesirable diversions from other watersheds • Create opportunities for additional growth and development • Assist with achieving energy-efficiency goals • Produce cost savings and other benefits for agricultural producers, manufacturing facilities and commercial enterprises • Prevent or mitigate the socially unacceptable consequences of drought conditions • Further public and private interest in conservation and wise use of other resources
Legislatively Supported	<ul style="list-style-type: none"> • Voluntary conservation efforts supported through effective outreach and education are often successful in meeting more modest water savings targets and providing short-term relief to supply-demand issues. • Regulatory tools may, however, be necessary supplements in order to achieve larger savings and provide equity. They can enable governments to appropriately allocate and regulate the use of available water resources, protect water quality and aquatic ecosystems, ensure that individual water users share in the attainment of required savings in proportion to their contribution to the problem being addressed, and recover the costs of programs and services.
Well-Informed	<ul style="list-style-type: none"> • Voluntary conservation efforts supported through effective outreach and education are often effective in meeting more modest water savings targets and in providing short-term relief to supply-demand issues. • It is difficult to make sound water management decisions in the absence of good information on the availability and variability of supply, on the extent of current and future demand within each water-use sector, and on the availability of practicable conservation measures. • The solution starts with mandatory requirements for the accurate measurement and routine reporting of surface and ground water takings along with enhancement of water level and flow monitoring networks. At the next level, additional resources need to be committed to the refinement and use of analytical tools in determining water balances, predicting the impacts of climate variability and change, and projecting how water demands may change under different growth alternative water use practices scenarios.
Demographically Connected and Participatory	<ul style="list-style-type: none"> • Many water users are able to reduce their usage and make a return on their investment. Others can incur considerable expense to achieve sizeable water savings. Feasibility, cost, fairness and effectiveness are important considerations in selecting the mix of conservation measures and in apportioning responsibilities for achieving targeted water savings. • Where various water users are called upon to find the required savings all affected parties should be engaged in searching for an approach that incorporates and blends these considerations. History suggests that this approach must bridge user-pay and beneficiary-pay principles. This is particularly the case with protection of in-stream uses and environmental flows

	since extractive users commonly expect that governments and the broader public should assume some portion of the implementation costs.
Adaptive	<ul style="list-style-type: none"> • Independent of human demands, water levels and flows are subject to event, seasonal and longer-term variability associated with changing weather and climate conditions. Stream hydrographic, lake level, and water-well elevation logs taken from most locations in the country will affirm the dramatic differences that can occur week to week, season to season and year to year. • Water allocation decisions need to recognize and respect this variability. They must incorporate the adaptive measures needed to maintain social and environmental sustainability in the face of severe or prolonged drought while allowing for ongoing and productive use at other times. They must also be precautionary in considering longer-term impacts of climate change and global warming on water availability and demand. • Over time, growth and development may alter the distribution of social and economic interests in and uses within a watershed. Water allocation rules and processes must contain appropriate flexibility to amend and reprioritize water entitlements for the public good.
Adequately and Appropriately Resourced	<ul style="list-style-type: none"> • The general principles of user-pay, beneficiary-pay, cost recovery and sharing of responsibility should apply while allowing for innovation in how to effectively garner the necessary resources.

4.3 CANADA

4.3.1 Introduction

The scale and form of water conservation approaches in use among Canadian jurisdictions were anticipated to be quite variable. This assumption was made based on a prior understanding of the differences in geographic extent, severity and origin of sustainability issues and concerns throughout the country. The one area of common ground was felt to be that surrounding mutual interests and efforts in the promotion and facilitation of water-use efficiency within the municipal utility sector. As will be seen later, the absence of a more comprehensive or multi-sectoral approach distinguishes Canada from other study jurisdictions.

4.3.2 Canadian Council of Ministers of the Environment (CCME)

The release of the CCME 'National Action Plan for Encouraging Municipal Water-Use Efficiency' in 1994 was important in bringing the issues of sustainable water use and sustainable water and wastewater infrastructure investments to the national forefront. It has also served as an example of the power and benefits of coordinated policies and actions in tackling mutual concerns. Even though community, industry and business profiles may differ across the country, the same principles apply in understanding the 'why' and 'how' of resource conservation and wise use.

4.3.3 Canadian Federal Initiatives¹⁷

With its limited mandate for the regulatory aspects of water-use management, the federal government has focused much of its attention on outreach and education and the advancement of water-efficient technologies and practices. These efforts have primarily targeted communities and public water systems with some more limited programs or projects aimed at the crop-irrigation and primary manufacturing sectors. Under the auspices of an inter-departmental committee the government has also acted to ensure the use of efficient plumbing fixtures and water-use practices in federal facilities

The Federal Water Policy (1987), which was formulated during a period of intense debate surrounding the pros and cons of large-scale water diversions, states that the government will “promote the wise and efficient management and use of water”.

The *Government Organization Act (1979)* assigns national leadership over water management to the Minister of the Environment. Environment Canada is, however, joined by several other federal departments in promoting and implementing its conservation agenda as illustrated in the following table.

Canadian Federal Initiatives in Water Conservation

Department / Agency	Activities
Environment Canada	<ul style="list-style-type: none"> • Responsible for the Federal Water Policy, Canada Water Act, Canadian Environmental Protection Act and Canadian Environmental Assessment Act. • Disseminates information on best practices for water-use efficiency and supports operation of the Water Efficiency Experiences Database. • Maintains the Canadian Pollution Prevention Information Clearinghouse that provides technical advisory services on best environmental practices to Canadian communities and businesses. • Partners with Infrastructure Canada in development of sustainable resource- use criteria as a basis for authorizing federal financing of municipal works projects. • Conducts periodic water use and water-use practices surveys covering all major water-use sectors. • Participates with the provinces in monitoring streamflows and lake levels.
Agriculture and Agri-Food Canada	<ul style="list-style-type: none"> • Oversees the Agricultural Policy Framework that includes provisions for the protection and conservation of water and other natural resources • Provides crop irrigators with technical and cost-share assistance for the adoption of improved water-use practices. • Oversees the National Water Supply Expansion Program, the National Farm Stewardship Program and the National Agri-Environmental Health Analysis and Reporting Program. • Promotes crop diversification for the enhancement of water-use productivity and economic well-being.
Fisheries and Oceans	<ul style="list-style-type: none"> • Administers provisions of the <i>Fisheries Act</i> regulating activities that could interfere with water levels and flows to the detriment of fish and fish habitat.
Indian and Northern Affairs	<ul style="list-style-type: none"> • Provides transitional assistance to the governments of Northwest Territories and Nunavut in water management.
Industry Canada	<ul style="list-style-type: none"> • Promotes investment in industrial innovation and sustainable production practices. • Assists government and private-sector research into water and energy efficient technologies and processes for industry. • Compiles and disseminates case study information on eco-efficient practices.
Canada Mortgage and Housing Corporation (CMHC)	<ul style="list-style-type: none"> • Conducts research and disseminates technical information on water efficient technologies and practices for sustainable communities and buildings.
Foreign Affairs & International Trade	<ul style="list-style-type: none"> • Responsible for the <i>International Boundary Waters Treaty Act</i>, amended to prohibit the diversion or bulk removal of ‘boundary’ waters for any purpose including export. Each province has subsequently enacted complementary legislation preventing diversions and bulk transfers out of major river basins and out of province.
Inter-Departmental Committees (EC, NRCan, et al)	<ul style="list-style-type: none"> • Oversees the Code of Environmental Stewardship, which commits government departments to the sustainable use of water, energy and other resources in federal facilities and projects.

4.3.4 British Columbia¹⁸

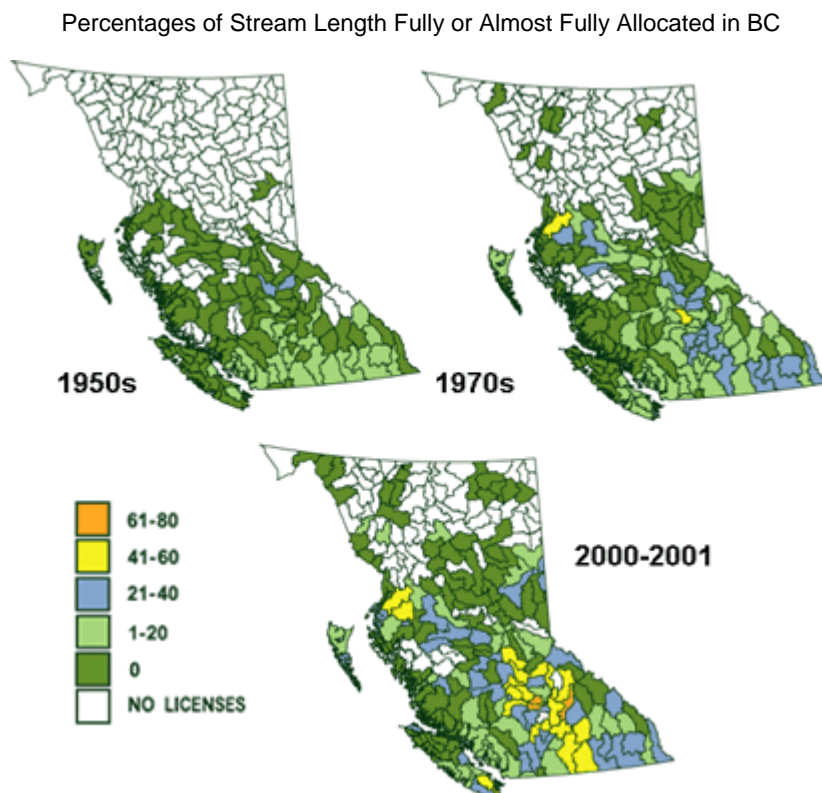
Water Availability and Demand

British Columbia (BC) is blessed with large supplies of renewable freshwater resources. A sizable portion of this water wealth is, however, not easily accessible or well located relative to areas of greatest need. In 2003, a significant drought affecting southern British Columbia reduced water flow in many streams and rivers to historic lows. A survey of water utilities in September 2003 indicated that 2.2 million people were affected by the drought, 84 public water systems were under stress.

Currently, more than 17% of surface water sources have reached or are nearing their capacity to reliably supply water in a normal year. Water shortages and sustainable use concerns are most prevalent in the interior semi-arid watersheds of the south where there is strong competition among agricultural and public water supply interests (see figure). Observation wells indicate that groundwater levels are also continuing to decline in some areas of the province. Ground water sources serve the potable supply needs of 20% of BC residents.

Total water withdrawals (excluding waterpower production) were estimated at about 2,750 million m³ in 1996. Distribution by sector was as follows:

- Industrial/commercial - 47%
- Public water supply - 31%
- Agriculture - 22%
- Other <1%



BC Environment. *Environmental Trends in BC 2002*. See online at www.env.gov.bc.ca/soerpt/publications

An estimated 76% of BC residents living with municipally serviced areas are on unmetered services. This includes most residents in the Greater Vancouver area. Full metering is more common among municipalities on Vancouver Island and in the Okanagan Valley. Estimated average per capita usage among the unmetered population was 524 L/day in 1999. Per capita usage among the metered population was 455 L/d or about 13% less. Overall (domestic + ICI) municipal per capita usage was 678 L/day.

Water Allocation and Conservation

Water licenses are issued by Land and Water British Columbia Inc (LWBC) under authority of the *BC Water Act*. Licences are granted on a prior appropriation basis. While the licensing of surface water withdrawals has been in place for many years, ground water licensing only came into effect in 2004. Each licence holder pays an administrative fee (application processing) and annual volumetric water rental charges. The metering / monitoring and reporting of actual water usage may be imposed on a case specific basis.

The February 2004 'Water Sustainability Action Plan for British Columbia' is the latest in a series of provincial documents encompassing the government's desired directions in implementing sustainable water management on a province-wide basis. It builds upon the earlier initiatives, which included the 1998 'Water Conservation Strategy', the 'Water Use Efficiency Catalogue', the 1999 'Freshwater Strategy' and the 2003 Drought Management Action Plan. Accomplishments under these earlier initiatives include:

- Water Conservation Plumbing Regulation (2004) - requires use of low-flow toilets and other devices in the Capital Region District
- 1999 Municipal Sewage Regulation - supports use of reclaimed wastewaters for non-potable use.
- The 'Water Smart' Program - promotes and assists municipal conservation and efficiency initiatives that contribute to reducing water and sewage infrastructure costs
- Requiring mandatory review of water use practices as a condition in granting a water licence
- Public education and incentives in support of metering, leak detection and repair, pressure regulation and xeriscaping
- Preparation and release of several Ministry of Agriculture and Food and BC Irrigation Association best practices guides/manuals for use by the province's broad-based agricultural industry. Topics include crop-specific irrigation requirements, irrigation scheduling, irrigation equipment selection and costing, and irrigation efficiency
- Audit and revocation of unused or dormant water licences.

The new Action Plan is a joint effort of the BC Ministry of Water, Land and Air Protection and the Water Sustainability Committee of the BC Water and Waste Association. Its basic tenets argue that:

- The drought, forest fires and floods of 2003 were a "wake-up" call surrounding the need to fundamentally change how water is viewed, valued and managed
- Water management planning and land use planning are inextricably linked. Land developments must be examined using time scales extending from the present out to the 50-year planning horizon
- Sustainability is best achieved through shared involvement and partnerships at all levels from the provincial to the household and across all water-use sectors. It requires influencing individual and group values, choices and behaviours
- Watersheds are the water management planning units of choice

- Actions should start from and build upon existing and emerging government policies, legislation and programs
- Effective and ongoing communications are front and centre in getting the message out and in encouraging feedback
- The principles of adaptive management and continuous improvement should apply.

The Action Plan is framed around six elements.

- Water Sustainability Website Partnership – A multi-partner, centralized and comprehensive website for finding out what’s going on in water management.
- Water Save Tool Kit – Everything individuals and communities need to know to achieve conservation and efficiency objectives.
- Water Sustainability Roundtable – Multi-stakeholder forum for dialogue on issues, directions and partnerships.
- Green Infrastructure Partnerships – Initial efforts focus on developing a best practice ‘Model Subdivision Bylaw and Green Infrastructure Standards’ for use in land development regulation.
- Water Balance Model – A web-based evaluation tool for enhanced land development decision-making with a focus on site-level stormwater controls.
- Watershed/Landscape Based Approach to Community Planning – 10-step methodology stressing watershed features requiring consideration and protection.

Specific to the issue of water conservation, the Water Save Tool Kit is being designed as a ‘living document’. It will be a focal point for the compilation, evaluation and dissemination of information on conservation achievements around the province; for the identification of knowledge gaps, barriers and opportunities; and for the formulation of adjustments that ensure continuous improvement. Even now, BC government websites provide access to an extensive collection of online resources (their own and others through hotlinks) pertaining to water conservation and efficiency, e.g. the BC Water Efficiency Catalogue.

4.3.5 Alberta¹⁹

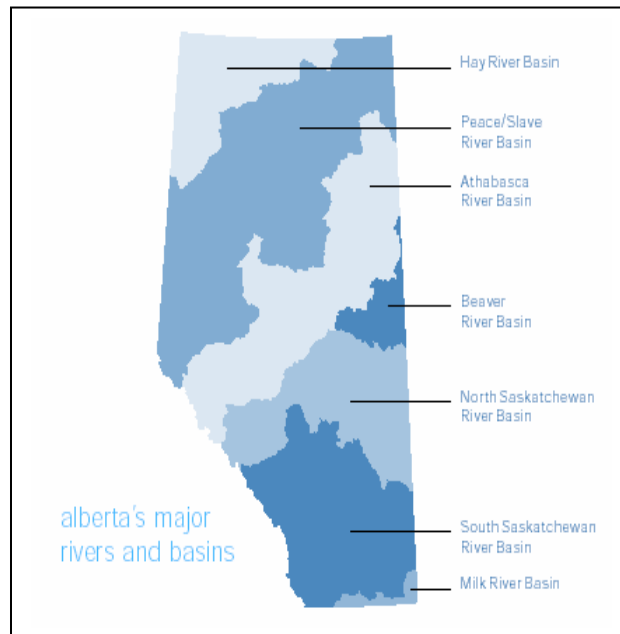
Water Availability and Demand

Eighty percent of Alberta’s renewable freshwater supplies are located in the northern half of the province while 80% of the demand for water lies in the south. The Hay, Peace/Slave and Athabasca watersheds drain in a northerly direction to their eventual discharge to the Arctic Ocean. These basins are also home to Alberta’s largest lakes.

The North and South Saskatchewan Rivers that originate in the glaciers of the Rocky Mountains flow easterly into Saskatchewan (see figure). The Milk River in the extreme south enters the province from Montana and returns there after flowing in an easterly direction.

Surface water sources dominate Alberta’s overall withdrawals accounting for 97.5% of all extractive usage. Estimates for 2001, indicate that crop irrigation allocations accounted for 45.7% of all surface water withdrawals with commercial (cooling) and municipal supplies making up 26.7% and 10.8% respectively. Ground water allocations are primarily for enhanced oil recovery operations 26.4%, municipal supply 26.3%, and commercial uses 12.7%. The nature and extent of sectoral usage is discussed in greater detail in chapters 5-7.

Alberta's Major River Basins



Alberta Environment. *Water For Life – Background*. See online at www.waterforlife.gov.ab.ca/html/background3

Water Allocation and Conservation

Water use sustainability has long been under scrutiny in Alberta, particularly in the south where semi-arid conditions and limited water availability prevail. The sizable and growing demands of agriculture, industry and communities compete with the need to safeguard aquatic ecosystems and honour apportionment agreements that require Alberta to reserve 50% of the natural flows in the North and South Saskatchewan Rivers for Saskatchewan.

In comparison to other Canadian jurisdictions, Alberta has a much more sectorally balanced approach to water conservation programming. It has taken steps to cap crop-irrigation water usage and protect in-stream flows in the agriculturally significant and urbanizing south (1991 South Saskatchewan Basin Regulation) and has moved to limit and rollback the freshwater withdrawals by primary oil producers (Ground Water Allocation Policy for Oilfield Injection Purposes) .

The province's current approach to water management and conservation is embodied in the 2003 Water For Life Strategy. The Strategy's goals target sustainable water resource development and use from the combined perspectives of quality and quantity. The desired outcomes are:

- Safe, secure drinking water supply
- Healthy aquatic ecosystems
- Reliable, quality water supplies for a sustainable economy

The Strategy calls for the adoption of best water management practices within all major water-use sectors and sets as a target a 30% improvement in overall (i.e. province-wide) water-use efficiency and productivity over a 10-year period, i.e. 2005-2015²⁰.

To assist in reaching its Water For Life goals and targets, Alberta is focusing attention on three core areas, i.e. knowledge and research, partnerships and conservation. In this regard, the strategy commits the province to undertake the following actions:

Short Term

- Establish a system to monitor and report actual water use by all sectors on an on-going basis.
- Determine and report on the true value of water in relation to the provincial economy.
- Complete an evaluation and make recommendations on the merit of economic instruments to meet water conservation and productivity objectives.
- Establish a public awareness and education program on water conservation in Alberta.

Medium term

- Prepare water conservation and productivity plans for all water using sectors.
- Implement economic instruments as necessary to meet water conservation and productivity objectives.

Long term

- Establish an on-going monitoring program to ensure all sectors are achieving water conservation and productivity objectives.

The Alberta government also works with its municipalities in the promotion of broad-based conservation and efficiency initiatives and maintains an active water conservation website. The website contains best practices guidance for residential and ICI water users. Specific examples are presented in Chapter 5. The majority of Alberta cities and towns are on full metering.

4.3.7 Saskatchewan²¹²²

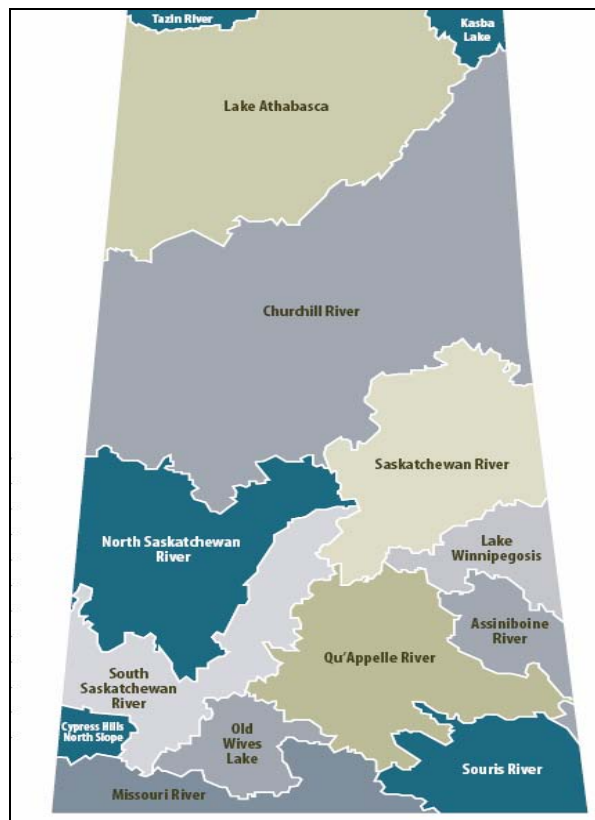
Water Availability and Demand

Saskatchewan is home to 7% of Canada's renewable freshwater resources but, as in other provinces, most of these resources lie in the north away from the area of demand. Agricultural uses are responsible for 67% of total withdrawals, followed by municipal supply 21%, industrial supply 6%, mining 3%, thermal power 2% and oil and gas extraction 1%. The largest concentration of withdrawals is in the South Saskatchewan, North Saskatchewan and Qu'Appelle river basins, which together account for 70% of total abstractions (see figure). The Missouri River basin in the extreme south accounts for an additional 10% of province-wide takings.

Saskatchewan's southern prairie ecozone, which is both agriculturally important and home to most of the province's population, is semi-arid, having mean annual precipitation levels in the range of 350-420 mm.

The overall average per capita water usage within Saskatchewan municipalities was reported to be 375 L/d in 2003. Domestic/residential usage on its own was estimated to be 293 L/day, which is well below the Canadian average. Ground water serves as the source of potable water supply for more than 40% of Saskatchewan residents. The majority of Saskatchewan communities are on metered services.

Saskatchewan's Major River Basins



Saskatchewan Watershed Authority. *Conserving Our Water- A Water Conservation Plan for Saskatchewan*. See online at www.swk.sk.ca/waterconservation/documents

Water Allocation and Conservation

All extractive uses of water, except domestic takings of less than 5,000 m³/yr (13,700 L/d), require a Water Rights Licence (*Saskatchewan Watershed Authority Act*). In a manner similar to its water-sharing agreement with Alberta, Saskatchewan is required to restrict overall allocations to ensure that at least 50% of the natural flow of the North and South Saskatchewan Rivers continuously flows to Manitoba.

The Saskatchewan government recently released the document 'Conserving Our Water: A Water Conservation Plan for Saskatchewan' as a component of its existing Safe Drinking Water Strategy. The discussion paper highlights current water usage and water availability, examines pressures to conserve, identifies possible conservation measures and their potential application on a province-wide and sectoral basis, and requests public input on preferred approaches. The Saskatchewan Watershed Authority (SWA) is charged with receiving input at public meetings held in January-February 2005 and with finalizing the Plan for Cabinet consideration in 2005.

The government has indicated that the final Plan will be guided by and reflect the following principles:

- Water sustains life
- Water is a renewable yet finite resource
- Water is a public trust, a shared legacy and a collective responsibility

- Water efficiency / productivity
- Fair value for water
- Comprehensive, integrated and long term approach
- Citizen involvement and participatory decision-making
- Leadership

Water-Use Efficiency Options Identified in Saskatchewan's 2004 (Draft) Water Conservation Plan

Sector	Potential Water Efficiency Measures
Cross-Sectoral	<ul style="list-style-type: none"> • Full-cost accounting and cost recovery • Amend water allocation processes and licences to specifically require identification and use of conservation measures • Require universal metering/measurement and reporting of all water usage
Agriculture	<ul style="list-style-type: none"> • Convert from flood irrigation to sprinkler irrigation technologies and from open channel to closed-pipe delivery systems • Convert from high-pressure to low-pressure sprinklers • Irrigate when it is most beneficial • Use drip irrigation systems where appropriate
Municipal / Domestic	<ul style="list-style-type: none"> • Retrofit dwellings and other buildings with low-flow plumbing fixtures • Amend Plumbing Regulations to require low-flow fixtures in new construction • Allow some domestic grey water recycling • Encourage use of efficient washers and dishwashers • Demonstrate government leadership with efficient practices in public buildings • Promote water efficient landscaping • implement full metering and conservation pricing structures • Reduce distribution system losses
Manufacturing	<ul style="list-style-type: none"> • Document and share best practices information • Conduct facility water audits • Amend relevant legislation, regulations and policies • Use financial incentives to encourage conservation and water recycling
Oil & Gas Extraction	<ul style="list-style-type: none"> • Document and share best practices information • Conduct facility water audits • Develop and promote alternative methods (solvent extraction and carbon dioxide injection) for enhanced oil recovery operations • Amend relevant legislation, regulations and policies • Use financial incentives to encourage conservation and water recycling
Thermal Power Generation	<ul style="list-style-type: none"> • Two of the province's three existing coal-fired stations already use extensive water recycling. The third uses reclaimed effluent from the Estevan wastewater treatment facility • The utilities also pay water use charges on the consumptive usage component of their water withdrawals.

The Watershed Authority has also produced a watershed and aquifer planning model and process as part of the government's source protection commitments. The participatory process is led by a SWA planning team supported by a Watershed Advisory Committee and a Technical Committee. So far, planning is underway in seven areas including the North Saskatchewan / Battle River Watershed, South Saskatchewan Watershed, Upper Qu'Appelle Watershed, Yorkton Aquifer, Upper Assiniboine Watershed, Lower Souris Watershed and Moose Jaw River Watershed.

Industries taking water from the South Saskatchewan River, Lake Diefenbaker, Buffalo Pound Lake or the Qu'Appelle River are required to pay a water charge of \$0.03915/m³ to the Saskatchewan Watershed Authority. The purpose of the charge is "to reflect and emphasize the value

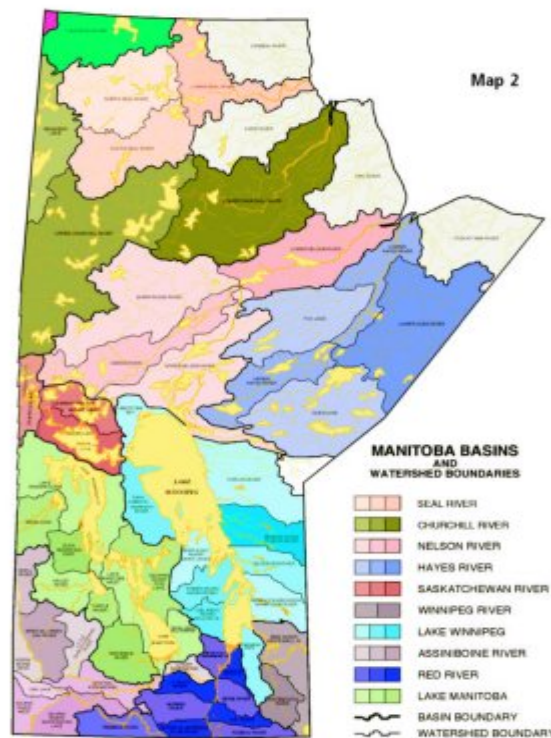
of water, promote wise water usage and help offset the costs of managing our water resources”. All agricultural users and industries serviced by municipal water utilities are exempt.

4.3.8 Manitoba²³

Water Availability and Demand

Thirteen percent of Canada’s freshwater resources drain through Manitoba into Hudson Bay. Major river inflows are received directly from Saskatchewan, North Dakota, Minnesota, Ontario and the Northwest Territories (see figure).

Manitoba’s River Basins



The Manitoba Water Strategy 20

Manitoba Conservation. (2003). *The Manitoba Water Strategy*. See online at www.gov.mb.ca/waterstewardship/waterstrategy

Mean annual precipitation varies from less than 400 mm in the southwest Prairie region to a range of 600-900 mm in the central and northern regions. Year to year variability can produce both flood and drought conditions that impact adversely on agricultural communities. Excluding hydropower production, the three sectors of crop irrigation, public water supply and industrial uses account for most water withdrawals. Eighty percent of Manitobans receive their drinking water from public water utilities with 85% of those people depending on surface water as their source of supply. On the other hand, 55% of the province’s 400 public water systems are served by ground water

sources. Residents living in Winnipeg and most other southern communities are on fully metered services.

Water Allocation and Conservation

The 2003 Manitoba Water Strategy document identifies the province's overarching directions in water management. In the area of conservation it commits to development and use of outreach and education programs, financial incentives, and taxation measures applied within a watershed planning framework. Watershed management plans are to be developed on a priority watershed basis. The province has already formulated aquifer management plans for the Winkler, Oak Lake and Dauphin Lake aquifers.

A companion Water Efficiency Strategy is also in the works. Public debate and input will be encouraged through the planned release of a discussion document entitled 'Wise Use of Water'. It includes discussion of directions and options under consideration in the areas of:

- Data collection and management
- Identification, evaluation and prioritization of alternative approaches
- Integration of water efficiency into codes, standards, and funding criteria
- Measures for reducing water losses in municipal water distribution systems
- Use of water charges and fees
- Outreach, education; and partnerships

A follow-up scientific/technical research document is also planned. It will identify existing and projected water use by sector, analyze the costs and benefits of various water efficiency alternatives, and suggest appropriate changes to provincial policy. It is intended that this document will be updated every three years.

Water withdrawals, except domestic takings of less than 25,000 L/day, are subject to licensing under the *Water Rights Act*. Licence holders are required to measure and record water use (on a form approved by the Minister) and to report water usage on an annual basis.

In late 2004, the government introduced (Bill 22) the *Water Protection Act* in the legislature. It calls for the establishment of watershed planning authorities with responsibilities for the development of comprehensive watershed management plans. Municipal councils would be required to follow these plans in making planning and development decisions. Each plan would contain objectives, policies and recommendations concerning some or all of the following conservation-related measures:

- Protection, conservation and restoration of aquatic ecosystems and drinking water sources
- Water demand management, water use practices and priorities, the conservation of water supplies, and the reduction of water use and consumption during droughts and other periods of water shortage.

The proposed Act also provides for the adoption of regulations establishing water conservation programs and other measures aimed at the reduction of water usage in Manitoba. A Water Stewardship Fund would help finance research, projects and activities in support of the Act. Projects that "promote wise and efficient use of water" may also be eligible for grant assistance under the existing Sustainable Development Innovation Fund (*Sustainable Development Act of 1998*).

4.3.9 Ontario²⁴

Water Availability and Demand

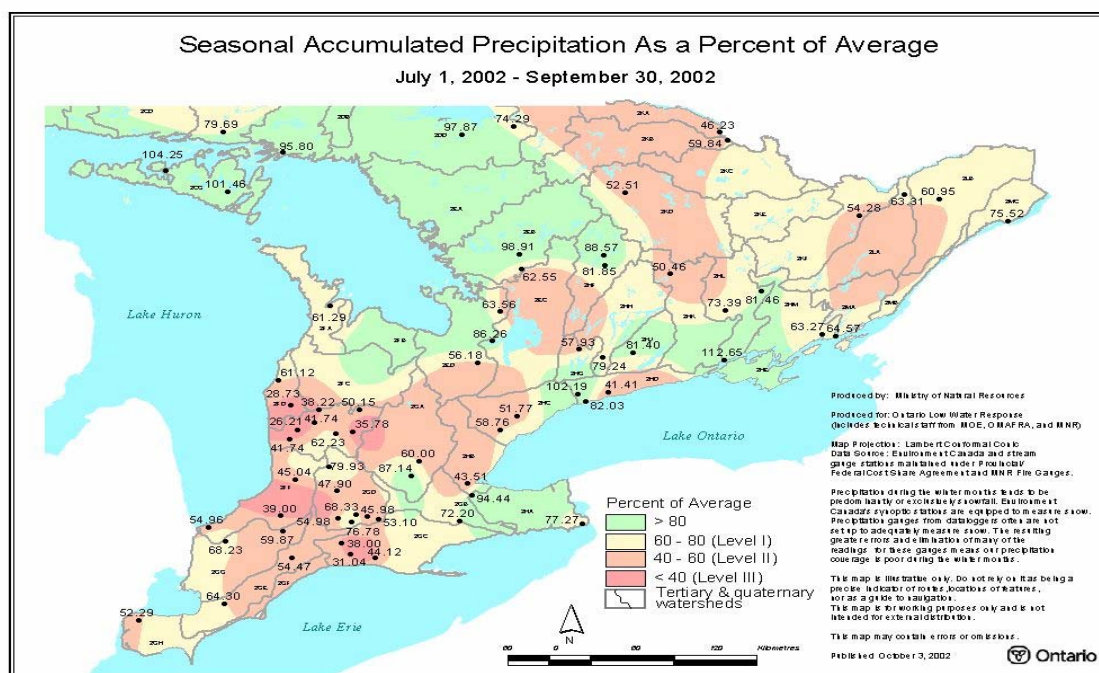
Ontario is unique among Canadian jurisdictions in having the Great Lakes system to draw upon for meeting a large portion of its water supply needs. The Great Lakes are a direct source of supply to the majority of Ontario's urban population, to virtually all of the province's thermal power generating capacity and its largest waterpower facilities, and to the primary manufacturing industries. Indeed, the province's current social and economic status and prospects for continued growth are closely linked to this vital resource.

While the Great Lakes are Ontario's most significant water resource asset and heritage, the province also has a wealth of northern rivers and lakes and extensive ground water resources. A small portion of those resources serves large and small municipalities, numerous rural residents, as well as mining, manufacturing and agricultural interests.

Freshwater renewal rates are generally high throughout the province as a result of mean annual precipitation in the range of 600-1,000 mm. Year to year and longer term variations (below average conditions) in water renewal coupled with heavy demand have, however, exerted recurrent and worsening pressure on water use sustainability particularly in the southern and southwestern parts of the province.

Environment Canada data for 1996 show total provincial freshwater withdrawals amounted to almost 28,000 million m³ or about 66% of all national water usage. Thermal power production accounted for 83% of the Ontario total. The next largest water users were manufacturing at almost 9% and public water supply at about 6.5%. While they account for only 0.4% of total annual withdrawals, agricultural water uses are most frequently at the centre of Ontario's more serious and/or widespread water shortage situations. This is a function of the seasonality of demand and the strong competition over available surface and ground water supplies in areas of concentrated crop irrigation activity.

Sample Low Water Conditions in Southern Ontario



Water Allocation and Conservation

Ontario's first province-wide conservation undertakings came in the late 1980s and early 1990s. The two-pronged approach included an extensive conservation awareness and education campaign aimed at municipalities and their customers and Building Code amendments requiring the use of low-flow toilets, showerheads and other fixtures in new construction and renovation. Cutbacks and tighter eligibility conditions on provincial grants for municipal water and sewage infrastructure projects were simultaneously causing growth municipalities to look at a variety of demand management alternatives as a way of addressing the challenges of increasing water demands.

For the next several years the province's conservation and water-use efficiency initiatives clearly emphasized the municipal sector. Other self-supply sectors began to become more involved with the introduction of the 1998 Water Taking and Transfer Regulation, more clearly identified government objectives and powers in evaluating applications for new or expanded water takings. In the absence of sector-based conservation planning guidelines the usefulness of these powers in driving water-use efficiency was limited to a case-by-case approach.

The sustainability of agricultural water-use practices, particularly within the crop-irrigation sector, are beginning to receive more attention as a fallout of widespread drought-like conditions experienced in southern Ontario in the late 1990s. Escalating conflicts among extractive users and evidence of stresses to aquatic environments led to the development of the inter-agency Ontario Low Water Response strategy. The strategy, initially released in 2000, established province-wide guidelines for determining levels of drought severity and defined staged water-use restrictions that would be applied based on the level reached. Local watershed committees with representation from government ministries, conservation authorities, municipal officials, water users and other stakeholders assist in coordinating implementation of the restrictions.

Water-use efficiency practices of industry have not been specifically targeted by provincial conservation initiatives. They are, however, the subject of industry attention and action as a by-product of tighter wastewater discharge requirements imposed by provincial and federal regulations.

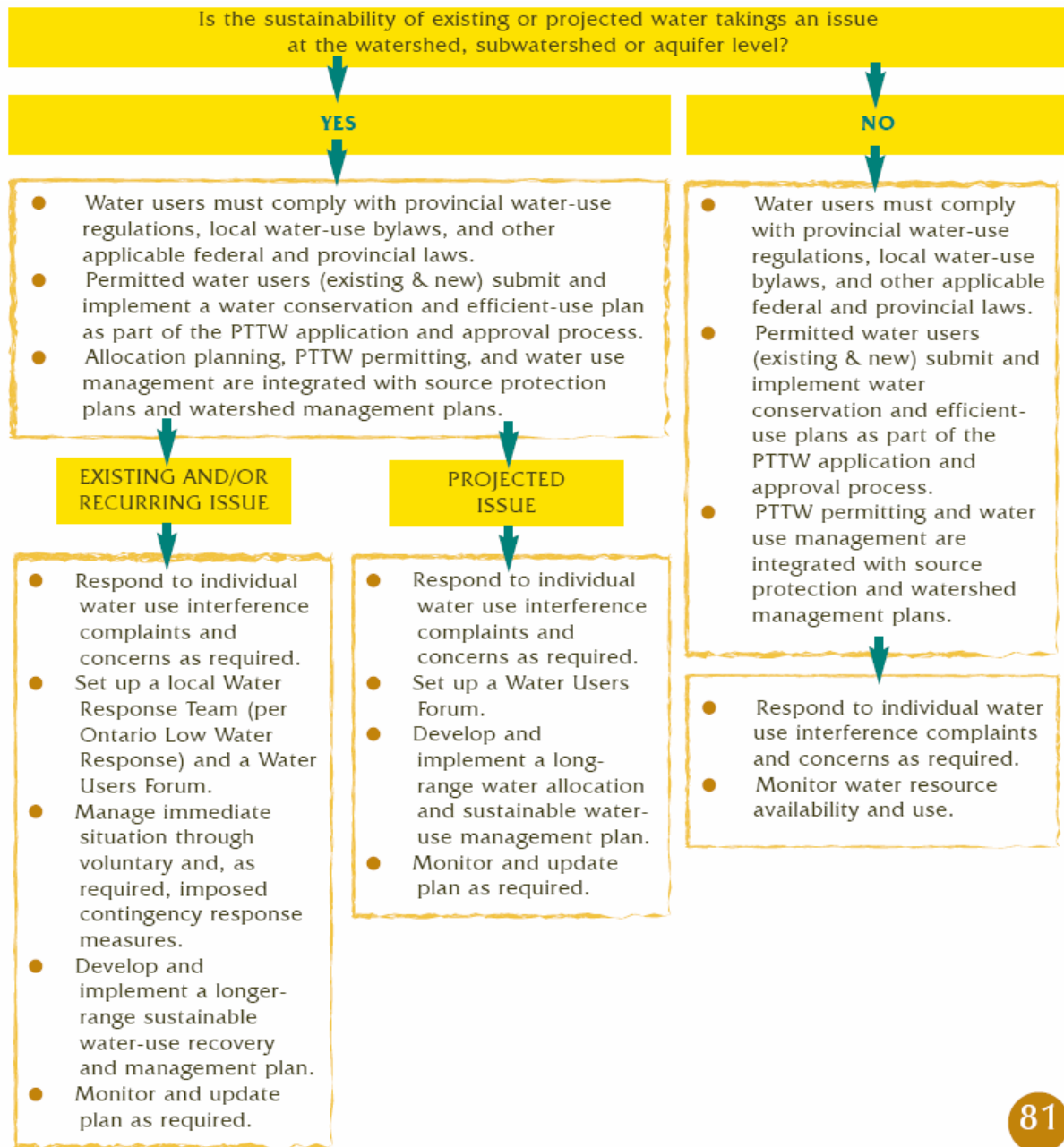
The province has recently strengthened its Water Taking and Transfer Regulation, which is the primary instrument governing water withdrawal permits. The amended regulation requires mandatory measurement and reporting of all permitted withdrawals, designates sensitive watersheds where further withdrawals may be prohibited, strengthens requirements for conservation planning, and requires upfront documentation of measures that will be taken to prevent or mitigate impacts on other users and the environment. The regulation provides for the establishment of sectoral water-use efficiency standards. Universal metering of residential and ICI services is now common within most southern Ontario towns and cities while a majority of northern residents remain on unmetered services.

The *Drinking Water Source Protection Act* and the *Sustainable Water and Sewage Systems Act* are also supportive of water conservation objectives. The former arose out of recommendations from the judicial inquiry into the Walkerton drinking water tragedy²⁵. It requires development of watershed-based plans that include rationalization (through a water balance or budget) of future water demands against water resource availability. Development of such plans will ultimately be required for all watersheds in the province. The latter legislation requires and empowers municipalities and other service providers to implement water-use charges based on full-cost accounting and cost recovery. Charges can be levied to cover the costs of infrastructure renewal and source protection.

The principles and concepts involved in integrating water allocation, water conservation, and source protection planning along with other water management decision-making were examined as part of a series of best practices pilot projects supported by the provincial government, Conservation Ontario and a number of individual conservation authorities back in 2002-03²⁶. A suggested framework for accomplishing this type of integration on the basis of watersheds was developed and was further delineated for areas of varying levels of water sustainability concern. A universal commitment to some level of water conservation planning and implementation was viewed as essential irrespective of the existence of existing conflicts between water availability and demand (see figures).



Government of Ontario, Conservation Ontario et al. (2003). *A Framework for Local Water Use Decision-Making on a Watershed Basis*. See online at www.conservation-ontario.on.ca/projects/watershed



Government of Ontario, Conservation Ontario et al. (2003). *A Framework for Local Water Use Decision-Making on a Watershed Basis*. See online at www.conservation-ontario.on.ca/projects/watershed

4.3.10 Québec²⁹

Water Availability and Demand

Quebec's renewable freshwater resources are the largest among all Canadian provinces. They are also among the most extensively utilized taking into consideration the province's leadership role in hydropower production.

There are more than 430 significant watersheds distributed among four major drainage basins, i.e. the St Lawrence River, James Bay, Hudson Bay and Ungava Bay. The St Lawrence Basin is home to most of the province's population and a majority of its non-hydropower based economic activity. On its own, the St Lawrence Basin accounts for 40% of Quebec's renewable freshwater resources. The provincial land base is also underlain by extensive ground water resources that are only marginally developed. Mean annual precipitation across the entire province is about 750 mm but is notably higher in the St Lawrence River Basin.

Total freshwater withdrawals (excluding hydropower) are estimated at 3,740 million m³/year. These are shared among public water supply (41%), industrial (28%), thermal power (21%), agricultural (6%) and rural domestic (3%) uses. Takings from surface water sources account for 80% of all public water supply and virtually all of the water used in the other sectors.

Environment Canada municipal water use surveys show Québec's mean per capita domestic water usage is about 400 L/day making it among the highest in Canada. This may reflect in part the limited use of residential water metering in a majority of the province's towns and cities.

Water Allocation and Conservation

Until recently, conservation and use-efficiency initiatives have been limited and have focused on outreach, education and technical assistance programs targeting municipal water utilities and their customers. The non-profit organization Réseau Environnement has been providing services in this area since 1977. Some 70 municipalities currently participate in the organization's 'Water Conservation Campaign'.

Québec's current policy directions for moving forward in the field of water management are laid out in the document 'Water: Our Life, Our Future'. Release of this important document in 2002 followed extensive public consultations dating back to 1997. The main themes are:

- Reform of water governance
- Integrated management of the St. Lawrence River
- Protection of water quality and aquatic ecosystems
- Continuation of water clean-up and improved management of water services
- Promotion of water-related recreational tourism activities.

Conservation-related undertakings committed to under the new provincial water policy include development of:

- A provincial charge (recently announced at \$0.01/m³) on water withdrawals.
- Guidelines for how municipalities calculate and recover the cost of water services.
- A funding strategy that makes provincial assistance to municipalities (for drinking water system enhancements) contingent upon adoption of measures to conserve water and reduce leakage. This strategy will be based on achieving a) a minimum 20% reduction in average per capita water consumption for all of Québec over 7 years and b) reduction of water losses through leakage to no more than 20% within 10 years.
- A water-conservation program to be implemented in all government buildings.
- Institutional, financial and technical support for 33 watershed-based agencies that have been assigned the task of preparing watershed master plans.

4.3.11 New Brunswick³⁰³¹³²

Water Availability and Demand

Most of New Brunswick receives in excess of 1,100 mm of precipitation in a typical year with 20-33% of that coming in the form of snow. While the spring and early summer period tends to be dry, there is generally ample rain during the growing season.

Water use by sector in 2001 was distributed as follows: industrial uses 35%, public water supply 24%, aquaculture 28%, rural domestic 9%, and other uses (agriculture, golf courses, ski hills and bottled water) 5%. Surface water sources supply about two-thirds of the province's municipal population. Full metering is common among the province's larger towns and cities.

Water Allocation and Conservation

Under the *Water Quality Regulation* of the *Clean Environment Act*, all waterworks withdrawing/using greater than 50 m³/day (50,000 L/d) require a permit to operate. Domestic wells not connected to a distribution system are exempt from this requirement. Development of such a waterworks is also a trigger to register under the *Environmental Impact Assessment Regulation* under the *Clean Environment Act*.

While the *Water Quality Regulation* permit is not strictly speaking a water allocation tool, it does provide a link to the new (July 2004) Water Supply Source Assessment Process. Under this process a determination is made relating to the long-term sustainability of the proposed taking and any measures that may be required to mitigate interference with other uses. Water abstraction from a municipal watershed designated under a *Watershed Protected Area Designation Order* is restricted. The *Order* requires that the withdrawal be controlled so that a flow of not less than 25 % of the mean monthly flow is maintained in the watercourse at all times. The allowable abstraction from a municipal well designated under a *Wellfield Protected Area Designation Order* is also restricted.

The Department of the Environment and Local Government maintains a web page containing water conservation and efficiency tips for homeowners. Residential water utility customers in New Brunswick's largest city of Saint John can elect to pay an unmetered flat-rate water charge or to have a meter and volumetric (declining-block) pricing. The provinces next two largest cities (Fredericton and Moncton) have mandatory metering.

4.3.12 Nova Scotia³³

Water Availability and Demand

Mean annual precipitation varies from 1,000 mm along the Northumberland north shore, to 1,500 mm along the southern shore and more than 1,600 mm in the Cape Breton Highlands. Rain accounts for approx 85% of total precipitation except in Cape Breton where up to 30% of precipitation may come as snow.

The adequacy of Nova Scotia's renewable supplies of freshwater in meeting current and foreseeable public and private demands has generally not been of much concern. Water shortages when they have occurred have tended to be localized and of short duration.

Fifty-four percent (54%) of Nova Scotians are served by municipal water systems. The remaining largely rural population is served by private or communal ground water supplies. A majority of the province's communities are on universal metering.

Water Allocation and Conservation

A provincial approval (*Environment Act*) from the Ministry of Environment and Labour is required for any water withdrawal exceeding 23,000 L/day. Applications for a water withdrawal approval (*Activities Designation Regulations*) must include a water budget assessment showing that the proposed withdrawal is sustainable. The permit may include long-term monitoring requirements to assess impacts on streamflows and/or groundwater levels.

The Department of Environment and Labour provides water-related technical guidance and project funding assistance to municipalities, the tourism industry and other businesses under the auspices of its Pollution Prevention (P2) Program. A three-year pilot project launched in Lunenburg in 2001 is helping to demonstrate and test actions that combine water efficiency and water quality enhancement. The project features distribution of residential water conservation kits, xeriscaping demonstrations, and development of a green business network. The pilot will form the basis for similar initiatives in other Nova Scotia cities and towns. Delivery of the department's outreach and education programs is providing employment and practical experience to young people through the activities of the Nova Scotia Youth Conservation Corps.

An interdepartmental water committee, chaired by the Department of Environment and Labour, provides direction on implementation of the provincial Drinking Water Strategy and for the management of other province-wide water quality and quantity issues.

4.3.13 Prince Edward Island³⁴

Water Availability and Demand

Prince Edward Island (PEI) is blessed with a large store of ground water resources that is regularly renewed by abundant rainfalls averaging 1,000-1,100 mm/year. It is estimated that about one third of this precipitation finds its way into the provinces extensive sandstone bedrock aquifers.

Prince Edward Island is the only Canadian province that is almost totally dependent on groundwater supplies for drinking and most other uses. Fifty-seven percent (57%) of island residents obtain their drinking water through private wells. Drought conditions and increasing economic development in recent years are starting to put a strain on those resources.

Residential water use in most PEI communities is unmetered. The Environment Canada Municipal Water Use Database (1996) indicates, however, that PEI's per capita domestic water usage is among the lowest in Canada at 186 L/day.

Water Allocation and Conservation

A water withdrawal permit (*Environment Protection Act*) is required for takings in excess of 10,000 gal/day (45,460 L/d). PEI's irrigation water allocation policy restricts the rate of an individual groundwater taking to a level not exceeding 50% of the annual recharge rate over the area influenced by the well. Surface water withdrawals are similarly restricted so as to maintain a downstream flow of not less than 70% of the flow rate that is exceeded 50% of the time during any month.

In watersheds where there is a high crop irrigation demand, stakeholder committees are established to coordinate irrigation allocations and scheduling. The committees are comprised of each irrigating farmer and representatives of the Departments of Environmental Resources and Agriculture.

Notwithstanding the abundance of its ground water supplies, the Province has stated that "water efficiency programs are a likely part of PEI's future". The province unveiled its Sustainable

Resource Development Policy in November 2002. The policy brought together previously independent resource management policies with the objective of providing more coordinated and comprehensive direction to the management actions of all government departments. Initial attention has focused on the agricultural sector with the intention of progressing on to include forestry, aquaculture and fisheries. Measures targeting improvements in water efficiency are an integral part of environmental farm planning.

Prince Edward Island is at the midway point in implementing a three-year \$2.3 million federal-provincial cost share program with a water conservation focus. The program provides technical and financial assistance to agricultural and rural organizations for a variety of projects including:

- Ground and surface water characterization studies
- Promotion of irrigation efficiency measures
- Promotion of water metering and use of low-flow technologies

Low interest rate loans are available from the PEI Department of Agriculture, Fisheries and Aquaculture to encourage and assist farmers in upgrading the efficiency of irrigation systems.

4.3.14 Newfoundland and Labrador³⁵

Water Availability and Demand

Mean annual precipitation over most of Newfoundland exceeds 1,000 mm. Some parts including the south coast typically receive more than 1,650 mm/yr making them the wettest in eastern Canada. Spring and early summer are generally the driest periods with occasional drought conditions. Rainfall in the summer of 1987 was in the range of 50-70% of normal leading to some water shortage concerns for farmers.

The annual renewable water resources of Newfoundland and Labrador are large and generally well distributed relative to water demands. Water shortages and conflicts are rare outside of the seasonal peak demand pressures exerted on municipal systems.

Eighty-eight percent of total public water supply withdrawal is from surface water sources with public systems serving some 83% of the province's population. Environment Canada water use surveys indicate that the province's per capita usage is highest among all provinces. Recent provincial estimates put the domestic component of municipal water use at 450 L/capita/day. Most residential water use in Newfoundland and Labrador is unmetered.

Current water allocation by sector has been estimated as follows:

- Thermal power generation- (estimate not available)
- Municipal supply- 125.65 million m³/year
- Pulp and paper- 118.0 million m³/year
- Fish processing- 8.24 million m³/year
- Aquaculture- 5.0 million m³/year
- Water bottling 0.0075 million m³/year

Newfoundland and Labrador requires more accurate estimates from those of 1995 and 1996 in relation to its water use sectors and enabling provisions in its *Water Resources Act*.

Water Allocation and Conservation

Legislative mechanisms for regulating and managing water use only recently came into force with passage of the 2002 *Water Resources Act*. Its water licensing provisions are unique among Canadian jurisdictions in that they subject all non-domestic water abstraction to application and licensing regardless of magnitude, i.e. there are no size related exemptions. While licence holders are expected to record and report water usage there is as yet no mandatory requirement surrounding the form and accuracy of measurements.

The *Act* provides a foundation for future conservation management initiatives by permitting the province to enact additional regulations for the use of “economic measures such as incentives, royalties, subsidies, administrative and other fees, and water use charges, for the purposes of ensuring the conservation and proper utilization of water resources, and for the financing of programs and other measures”.

The province’s non-regulatory approach to conservation and use-efficiency has, to date, focused on encouraging and working with larger municipalities in reducing peak demands associated with seasonal water use and in reducing distribution system losses. The lack of universal or even extensive metering of residential water use in most towns and cities can be an impediment in achieving full effectiveness from these initiatives.

4.3.15 Nunavut³⁶

Water Availability and Demand

While water resources may appear abundant in Nunavut, the occurrence of significant surface water flows is seasonally restricted and groundwater resources are generally not accessible.

Portions of each of the communities of Iqaluit, Rankin Inlet, and Nanisivik are served by piped (above-ground) water distribution but in general most residential customers in Nunavut are served by trucked supply. Only 16% of all Nunavut and NWT residents are connected to centralized water systems. Regardless of the form of water delivery, metering or other measurement of the waters provided to each customer is common.

While trucking water involves significant operating costs, lower investments in construction and maintenance makes it more economic than piped service for most northern communities. Water usage among customers receiving trucked service is generally less than 200 L/capita/day.

Water Allocation and Conservation

The *Nunavut Water and Surface Rights Tribunal Act (2002)* clarifies the licensing mandates of the Water Board and the Surface Rights Tribunal established in accordance with the 1993 Nunavut Land Claims Agreement. Although the efficient use of water is not mentioned directly in the act, it is indirectly addressed by the requirement that the Board is prohibited from issuing, renewing or amending a licence that could have a substantial adverse affect on the quality, quantity or rate of flow of waters through Inuit-owned land (unless the applicant has entered into an agreement with the Inuit to compensate for any loss or damage or the Board has determined the appropriate compensation). The Nunavut Water Board could require conservation measures as a condition of licensing. The Nunavut Tunngavik Water Policy (2003) stipulates that Inuit traditional knowledge as well as scientific analysis will be used in managing water use.

On Inuit owned lands, regional Inuit organizations representing the regional population, are responsible for granting land use permits, which are a prerequisite for the receipt of a water license.

On federally owned lands the Canadian government is responsible. Work continues on a proposed Freshwater Management Framework that is based on ensuring a harmonized watershed-approach to managing the quality and quantity of Nunavut's water resources. Water conservation, sustainable development and integrated management are proposed as guiding principles.

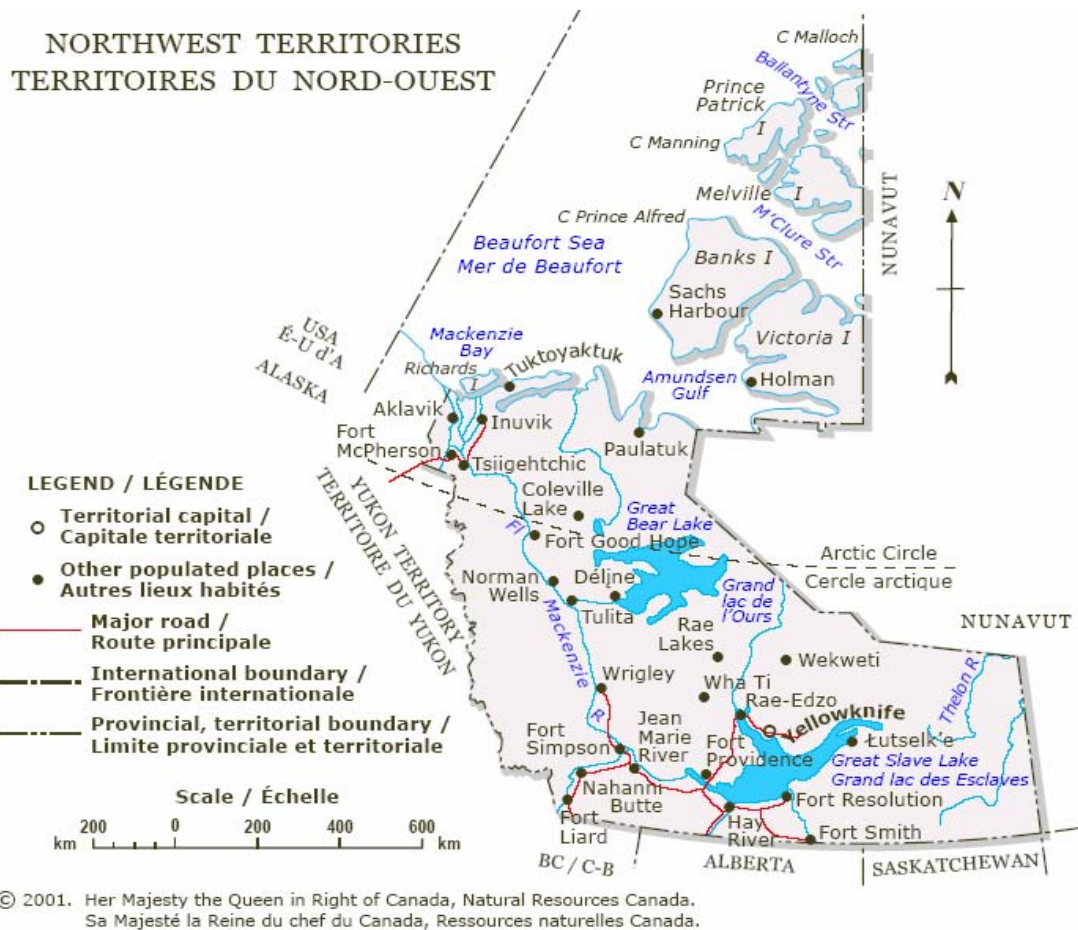
Conservation-related initiatives underway at this time include multi-unit residential dwelling pilot projects in Iqaluit and Cape Dorset for the treatment and recycling of grey water and black water for non-potable use as well as enhancements to existing groundwater resource monitoring and characterization programs.

4.3.16 Northwest Territories³⁷³⁸

Water Availability and Demand

The Northwest Territories occupy a large portion of the lower Mackenzie River Basin with a mean annual discharge of approx 9,000 m³/sec. Great Slave Lake and Great Bear Lake are both wholly contained within the basin boundaries (see figure). The Mackenzie River flows out of Great Slave Lake at Fort Providence and passes the communities of Fort Simpson and Norman Wells before discharging to the Beaufort Sea near Inuvik.

The Mackenzie's eastern tributaries flow from the Taiga Plains and Southern Arctic ecozones while its western streams originate in the more mountainous Taiga Cordillera. The hydrology of many tributary rivers, especially in the north, is characterized by large spring (May-June) snowmelt flows, highly variable summer peak flows in response to rain events, and very minimal flows throughout the late fall and winter periods. Mean annual precipitation throughout the region is typically in the range of 250-350 mm.



Water Allocation and Conservation

The *Northwest Territories Act* (1989) contains basic provisions for the licensing and management of extractive water use.

Current water efficiency initiatives focus on projects targeting water savings and operational cost reductions within municipal/communal systems. These include conversion of free-flow frost protection bleeders to thermostatically controlled devices, reclamation of grey water for non-potable use, and conservation outreach and awareness campaigns. Public outreach on conservation is identified as a component in the December 2003 policy framework document 'Managing Drinking Water Quality in the Northwest Territories'.

Sixty-three percent (63%) of the total NWT population lives in Yellowknife and other communities surrounding Great Slave Lake. City of Yellowknife alone has 18,700 residents or about 45% of the NWT population. Metering or other forms of measurement of customer water usage are common to most communities.

The government's overall directions in the conservation of water and other natural resources are established in the 1997 Sustainable Development Policy. Perhaps the most significant principle spelled out in this document is that stating that "natural resources should be managed so that opportunities for future resource uses are maximized and maintenance of ecosystems is ensured".

4.3.17 Yukon³⁹⁴⁰

Water Availability and Demand

The Yukon has a vast store of freshwater resources distributed among lakes, wetlands, streams, glaciers, snowpacks and ground water systems. The territory experienced drought-like conditions in the late 1990s with 1998 being the driest in 51 years of recorded weather history. Anecdotal evidence suggests that ground water tables have been declining in the Whitehorse area leading to well water shortage concerns in some of the rural subdivisions surrounding the city.

The distribution (1998) of permitted water withdrawals based on type of use was municipal supply 75.4%, placer mining 12.6%, conservation 6.9%, hard rock mining 2.1%, agriculture 0.9% and other uses 2.1%. The current extent of metering or measurement of actual levels of municipal domestic water use appears lower in the Yukon than in its sister territories. Only 50% of Whitehorse households were reported as having metered service in the 1999 Environment Canada survey.

Water Allocation and Conservation

Responsibility for water management was transferred from the federal government to the Yukon government on April 1, 2003. The *Water Act 2003* created the Yukon Water Board, an independent administrative tribunal with responsibility for the issuance of water use licenses. The *Act* defines the purpose of licensing as providing “for the conservation, development and utilization of waters in a manner that will provide the optimum benefit from them for all Canadians and for the residents of the Yukon in particular.”

Water withdrawal licences are required in designated “water management areas” as defined through regulation. Domestic uses, industrial takings of less than 100,000 L/day, and agricultural water takings of less than 300,000 L/day are exempt. While conditions of use may be imposed on a licence there are no mandatory provisions regarding conservation planning or practices.

Given the relative scarcity of water use conflicts it is not surprising that current conservation initiatives are municipally oriented. Initiatives include leak detection and repair, replacement of free-flow bleeders with thermostatically controlled devices, outreach and education on water conserving best practices and local bylaws requiring use of low-flow toilets in new construction and renovation. Cooperatively funded programs are assisting municipalities with characterizing the ground water resources underlying their communities.

4.3.18 Canadian Non-Government (NGO) Initiatives

National and provincial organizations representing municipal water utilities, large industries, commercial enterprises and water management professionals endorse strengthened measures for the promotion and facilitated implementation of water-use efficiency. The following table provides examples from a cross-section of water-use interests.

Water Conservation Policy Positions of Selected Canadian NGOs

Organization	Policies and Activities
MUNICIPAL UTILITIES	
Federation of Canadian Municipalities (FCM)	FCM has called upon senior governments to work together in establishing policies and legislation aimed at water-use efficiency and sustainable infrastructure development. Suggestions include: <ul style="list-style-type: none">• Goals on per capita consumption• Support for universal metering

	<ul style="list-style-type: none"> • Public education on available options from voluntary to rate-driven programs • Changes to building codes to mandate water-conserving plumbing fixtures and equipment for domestic, commercial and industrial use • Rates reflecting total costs including the cost of current services and the cost of upgrading infrastructure
Canadian Water and Wastewater Association (CWWA)	<p>CWWA has adopted policies that:</p> <ul style="list-style-type: none"> • Encourage development and implementation of water-use efficiency and conservation policies and programs by all water service providers. • Encourage all water utilities to implement universal metering programs • Encourage water and wastewater services to set rates on the basis of recovering the full costs of their systems • Encourage water and wastewater services to integrate environmental, public health and sustainable development principles in their planning, decision-making and day-to-day operations • Support the concept and principles of environmental sustainability and in particular watershed and water recharge area management • Welcomes sustained and coordinated federal, provincial and territorial intervention in funding municipal water and wastewater infrastructure taking into account differences in local financial capacity, e.g. as faced by smaller and northern communities <p>CWWA also operates the municipal Water Efficiency Experiences Database.</p>
AGRICULTURE	
Canadian Federation(s) of Agriculture (CFA)	<p>The Canadian Federation of Agriculture (CFA) does not have a documented position specific to water conservation and water-use efficiency. In respect of broader environmental protection issues, CFA has requested that governments consider:</p> <ul style="list-style-type: none"> • Long-term and stable funding for environmental farm planning • Funds to facilitate information and technology transfer • Capital cost allowances for environmental investments • Funds to encourage and facilitate land set-aside and stewardship initiatives for achieving public environmental benefits <p>With respect to recent changes to Ontario's Water Taking and Transfer Regulation, the Ontario Federation of Agriculture (OFA) stated that it:</p> <ul style="list-style-type: none"> • Applauds the goal of improving irrigation efficiency; favours guidelines over sectoral standards • Believes that agricultural takings should have precedence over commercial and industrial uses in 'high use watersheds' and during low-water periods in all watersheds • Opposes administrative or usage charges for agricultural takings
RESOURCE EXTRACTION AND MANUFACTURING	
Forest Products Association of Canada (FPAC)	<p>While FPAC has not identified water use and conservation as a "current issue" facing the industry, the Association states that its members are "constantly finding more ways to recycle and use resources more efficiently". It cites industry-wide data showing improvements in water-use productivity as evidence of this.</p>
Canadian Chemical Producers Association (CCPA)	<p>CCPA's 'Responsible Care® Program' is based on a set of principles two of which are inferred to promote water conservation. Member companies are expected to:</p> <ul style="list-style-type: none"> • Continuously reduce emissions with the goal of preventing unacceptable risk to the environment, and • Apply a broad range of options including reducing, reusing, recycling and recovering to effectively manage the environmental impact of processes. <p>Member companies of the American Chemistry Council (CCPA's U.S. counterpart) also subscribe to the Responsible Care® Program</p>
Mining Association of Canada (MAC)	<p>MAC's 'Environmental Policy' commits member companies to:</p> <ul style="list-style-type: none"> • Develop, design and operate facilities based upon the efficient use of energy, resources and materials.

	<ul style="list-style-type: none"> Establish an ongoing program of review and improvement of environmental performance, taking into account technical and economic developments, scientific understanding and environmental effects of operations <p>In its submission to the Government of Canada on Bill C-33, MAC reported that:</p> <ul style="list-style-type: none"> Modern mining industry practices have long recognized the need for prudent use of water resources... and that, It is widely accepted [by the industry] that the long-term management, protection and conservation of water resources prevails over the immediate interests of individual user groups
Canadian Petroleum Products Institute (CPPI)	<p>CPPI's hierarchical approach to environmental protection gives 'first consideration' to CCME's definition of pollution prevention, i.e. "the use of processes, practices, materials, products or energy that avoid or minimize the creation of pollutants and waste, at the source".</p> <p>CPPI's 'Guiding Principles' commit member companies to develop management systems that support efficient utilization of natural resources</p>
Canadian Steel Producers Association (CSPA)	<p>CSPA's 'Sustainable Development Principles' commit member companies to:</p> <ul style="list-style-type: none"> Maximize resource efficiency in the development, production and use of steel products including making efforts to use energy and water more efficiently. Work to continuously improve company and sector environmental performance through adoption of new or improved processes, practices, technologies and products
Canadian Association of Petroleum Producers (CAPP)	<p>CAPP has identified freshwater use per unit of production as one of its stewardship benchmarking parameters. Member companies are required to report their usage on an annual basis.</p> <p>CAPP encourages its members to:</p> <ul style="list-style-type: none"> Exceed what is expected to reach the highest degree of water protection Develop new technologies to monitor, report and reduce water use Recycle used water Proactively improve practices Support research into water conservation and recovery methods
OTHER	
Royal Canadian Golf Association (RCGA)	<p>RCGA's 'Environmental Principles' encourage golf course designers, developers, owners and operators to:</p> <ul style="list-style-type: none"> Ensure adequate water supply is available for both potable and irrigation needs of the facility and neighbouring properties Design irrigation systems to efficiently use water only when and where needed Investigate the feasibility of alternative and supplemental sources of irrigation water including the use of reclaimed water and the collection, storage and use of stormwater runoff Develop and implement self-initiated action plans to conserve and enhance natural resources. <p>RCGA supports:</p> <ul style="list-style-type: none"> Individual course participation in and certification under the Audubon Cooperative Sanctuary Program for Golf Courses. Water conservation is a program component. Research into the development of drought tolerant grasses.
Canadian Water Resources Association (CWRA)	<p>CWRA supports governments, business, the public and water-resource professionals working together to encourage water conservation and protection of water quality through:</p> <ul style="list-style-type: none"> Recognizing the value and limits of water resources and the costs of providing water in adequate quantity and quality Acknowledging water's consumptive and non-consumptive values to humans and other species

	<ul style="list-style-type: none"> Balancing education, market forces and regulatory systems to promote choice and the recognition of the responsibility of beneficiaries to pay for their use of the resource. <p>CWRA has also asked federal and provincial governments to restore and enhance their commitments to hydrometric and meteorologic monitoring networks.</p>
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4.4 AUSTRALIA

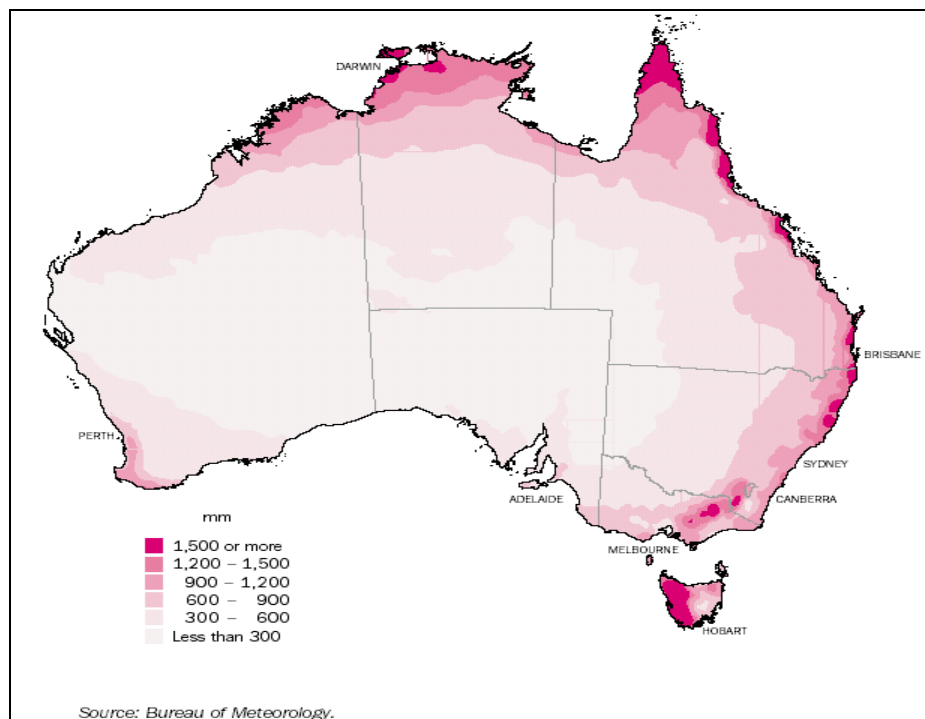
4.4.1 Legal and Institutional Context

The constitutional division of water management powers in Australia gives lead responsibility to the eight states and territories. Large differences in the size and nature of state economies, in the distribution of natural resources wealth, and in the depth of environmental policies and laws have contributed to difficulties in managing water resources in a coordinated and sustainable manner. This is particularly true in the case of shared river systems and regional aquifers⁴¹.

4.4.2 Water Availability and Water Use

The Australian Continent is the most arid in the world with more than half of the land area receiving less than 300 mm of precipitation in an average year. Appreciable rainfall is distinctly seasonal in nature and is essentially confined to areas close to the eastern and northern coasts. This accounts for the fact that most of Australia's population resides in the coastal region particularly in the more temperate east and southeast. Some of the interior arid and semi-arid areas of the country are fortunate to lie atop the Great Artesian Basin that provides the only reliable water supply for much of the arid outback⁴².

Average Annual Rainfall - Australia



Commonwealth Bureau of Meteorology. (2003). See online at www.bom.gov.au/climate/map

Most of the country's continuously flowing river basins are comparatively short and discharge directly along the coastline. A significant exception is the 1.06 million km² Murray-Darling Basin that drains approx. one-seventh of the continent's landmass. The Murray-Darling is located in the southeast and discharges to the South Australian Basin of the Indian Ocean near the City of Adelaide. It is home to close to 2 million people or 11% of Australia's population and accounts for more than 40% of the country's agricultural production⁴³. An additional 1 million living outside the basin also depend on it as a source of supply.

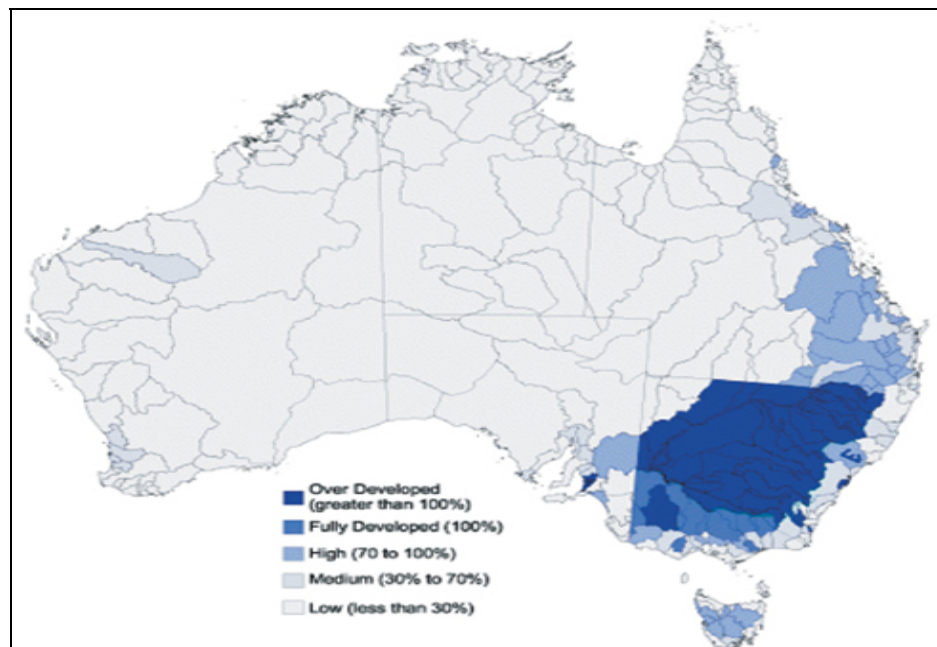
Annual water withdrawals (1997) for all uses amount to some 24,060 million m³⁴⁴. Water use has increased by 65% since the mid 1980s. Crop irrigation uses 17,940 million m³ of water annually or 75% of total withdrawals. Urban/industrial and rural uses (domestic + livestock watering) account for 20% and 5% respectively of total takings. Seventy-nine percent (79%) of withdrawals come from surface water sources.

There are 2.1 million ha of crop and pasture lands under irrigation in Australia with 1.5 million ha or 71% of those situated in the Murray-Darling Basin.

An estimated 26% of Australia's surface water management areas are close to or have already exceeded sustainable extraction limits with the greatest problems occurring in the Murray-Darling (see figure). While national and state governments agreed that water withdrawals from the basin should be 'capped' at levels as they existed in 1993-94, Queensland has not yet agreed to their share and New South Wales has not been successful in staying within the cap in the tributary Barwon watershed. River systems in the north and west of Australia are generally not stressed but are expected to see increased pressure from agricultural interests in future.

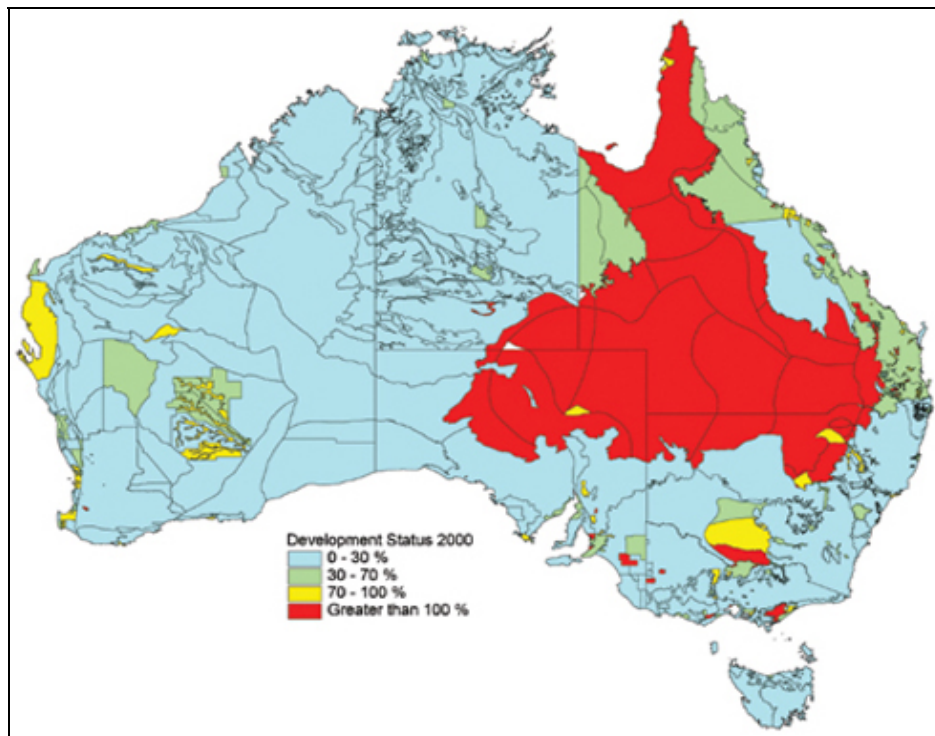
Total annual ground water abstractions increased by 90% from 1995 to 1997. Total usage is divided between crop irrigation (51%), urban-industrial uses (32%), and stock watering and rural domestic uses (17%). Four million Australians are totally or partially dependent on ground water supplies for their domestic needs. The rapid growth in ground water use has led to unsustainable levels of withdrawal in some areas (see figure).

Sustainable Development Status of Australia's Surface Waters



Department of Environment and Heritage. (2001). *Australia State of the Environment 2001*. See online at www.deh.gov.au/soe/2001/water

Sustainable Development Status of Australia's Ground Waters



Department of Environment and Heritage. (2001). *Australia State of the Environment 2001*. See online at www.deh.gov.au/soe/2001/water

4.4.3 National and State Water Reforms

In the late 1980's in response to the gravity of its water management problems, the Council of Australian Governments (COAG) began a search for a coordinated approach to finding and implementing changes. This resulted in a 1994 agreement to develop a "strategic framework to achieve an efficient and sustainable water industry". The framework addressed the following areas of need:

- Water entitlements and trading
- Environmental requirements
- Institutional reform
- Public consultation and outreach
- Water pricing
- Research

Australia's National Competition Policy (1995) provides annual payments to individual states and territories based on their progress in implementing the agreed to water reforms. A state/ territory must continue implementation and observance of agreed to measures and timetables in order to receive its full share of the available payments. Annual payments under the program have been in the range of \$ 500-700 million AU. A number of jurisdictions received reduced funding in some years because of inadequate progress.

4.4.4 Current Reforms Status

Progress in implementing the COAG reforms has been more challenging than initially anticipated particularly in the area of enhanced water allocations and trading systems. The timetable for full implementation has, therefore, been extended to 2005⁴⁵⁴⁶.

Reported achievements to date under the ongoing reforms include:

- A “genuine” recognition of the needs of the environment in water use decision-making. Governments generally are not granting new water allocations from overused rivers and aquifers and are no longer building dams that are ecologically unsustainable. Water management plans are being developed that provide for environmental flows and aim to preserve ecologically significant environments.
- Institutional reforms involving significant enhancements to legislation, organizational structures and interagency coordination
- Implementation of partial cost recovery in irrigation areas
- Early progress on securing water entitlements and enhancing trading arrangements has led to improvements in water efficiency and allowed water to be reallocated to higher value crops
- Implementation of full cost recovery (including environmental costs) and block-rate pricing for most public-utility supplied water
- Formal introduction of a Water Efficiency Labeling and Standards Scheme applicable to toilets, urinals, washers, dishwashers, showerheads and faucets
- Extension and refinement of watershed-based planning and management with broader stakeholder participation. The large Lake Eyre Basin in central Australia and the Diamantina River and Cooper Creek watersheds in South Australia are cited as leading examples
- Restructuring and consolidation of water reforms into a new package entitled the National Water Initiative (NWI).

The NWI will address the establishment of:

- A nationally compatible system of water access entitlements
 - Firm pathways and open processes for returning overallocated systems to environmentally sustainable levels of extraction
 - Identification and assignment of risks and responsibilities between governments and water users over possible future reductions in water availability
 - Commitment to sharing lessons learned and to continuous improvement in water-sharing plans
- More efficient water markets
 - Expand markets to their widest practical geographic scope
 - Harmonize policies and rules within major basins, e.g. Murray-Darling
- Strengthened institutional arrangements for the recovery and management of water for the environment
 - Use of flexible markets and other mechanisms, e.g. capital improvements to water infrastructure, to capture water for the environment when needed
- Improved cost accounting and institution of ‘best practice’ water pricing
 - Apply the principles of user pay and full cost recovery including, as appropriate, the cost of delivery, planning and environmental impact
- Further improvements in urban water management
 - Promotion of water reuse and recycling
 - Adoption of more efficient technologies
 - Review effectiveness of pricing policies

- Improved measuring, monitoring and information management systems
 - Recognition that accurate measurement and routine reporting are fundamental to making the water management system function in a reliable, equitable and transparent manner
 - Governments will invest in improving scientific understanding of water resources, water use and ecosystems

4.5 UNITED STATES

4.5.1 Legal and Institutional Context

Under the constitution, major water management powers are vested in the federal government. While states also have important law-making powers relating to water, their processes and end results must adhere to minimum national standards in order for them to access related program funding available from various federal agencies involved in water management. Given the extensive ‘carving-up’ of watersheds and major aquifers by state boundaries, the vestige of ultimate power over water with the federal government is critical to its effective management.

As in Canada, U.S water allocation principles and laws differ from east to west, i.e. riparian or common law rights in the east vs. prior appropriation rights in the west.

4.5.2 Water Availability and Water Use

At the global scale, the U.S is considered to have a large natural endowment in renewable water resources relative to its per capita needs. These resources are, however, not evenly distributed. Water demands in many western states, which have characteristically arid or semi-arid climates, do exceed naturally renewable supplies. This has required construction of several large-scale diversions and storages and is resulting in overdrafting of some ground water aquifers.

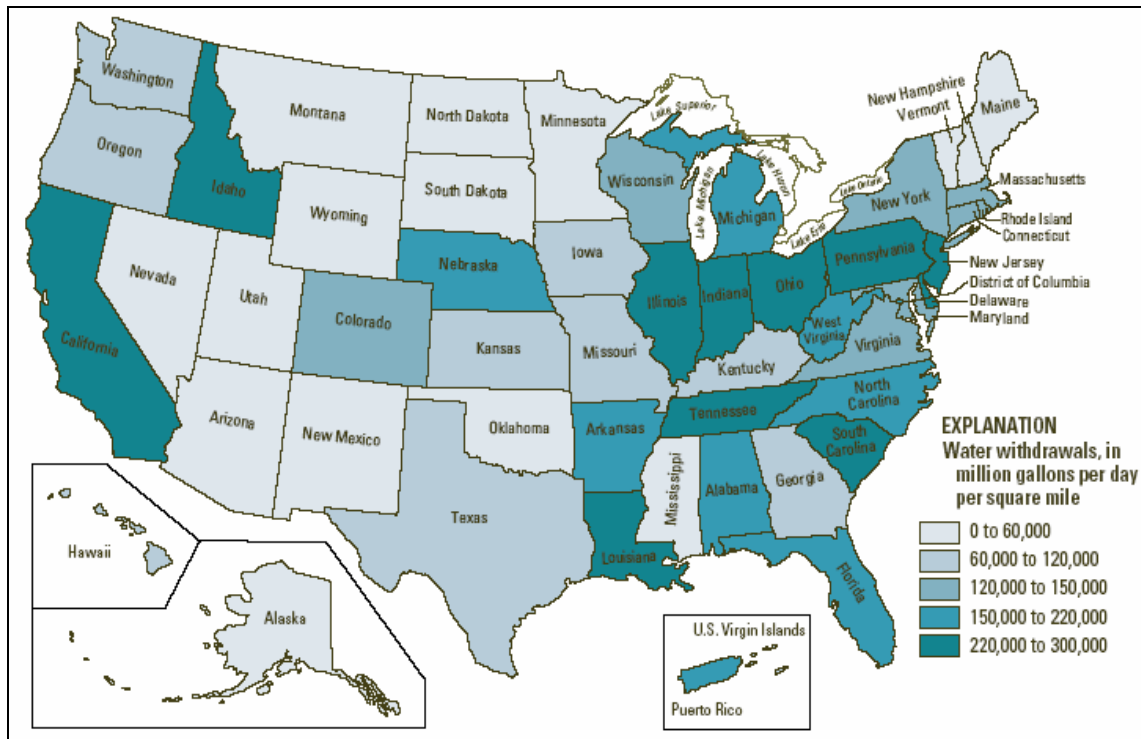
Total U.S freshwater withdrawals (excluding hydropower) in 2000 amounted to 345 billion US gallons per day, which equates to 477 billion m³ for the year (see accompanying figure and table)⁴⁷. Surface water withdrawals accounted for 76% of the total. Withdrawals by major sector were crop irrigation 39.7%, thermal power 39.4%, public water supply 12.6%, industrial 5.4%, livestock (including aquaculture) 1.6%, self-supply domestic 1.0%, and mining 0.6%. While water withdrawal intensity is generally higher in the east, existing and potential sustainability concerns are more serious in the west (see figure).

The water-use significance of crop irrigation relates not only to the extent of overall withdrawals but also to the fact that the largest acreages and heaviest demands occur in the arid or semi-arid western states. Thirteen (13) states each use more water for irrigation than what is used across all of Canada. California, Idaho, Colorado, Nebraska, Texas and Montana together account for more than 60% of total U.S. crop-water usage. The nature, distribution and impacts of crop irrigation are examined in more detail in Chapter 7.

Within the thermal power generation sector, facilities with once-through cooling account for 91% of sectoral withdrawals⁴⁸. Water-cooled power plants operating in arid states such as Arizona, New Mexico, Nevada and Utah are exclusively based on closed-loop systems. These systems also see extensive use in many other states including Delaware, Kentucky, Minnesota, Pennsylvania, South Carolina and Texas. Since the 1970s most new thermal plants and many existing plants have been built or converted to use closed-loop or air cooling in response to stricter federal water quality requirements on return flows and water shortages. Today, these technologies account for 60% of total installed steam-generation capacity within the thermal power sector. As a result of these changes,

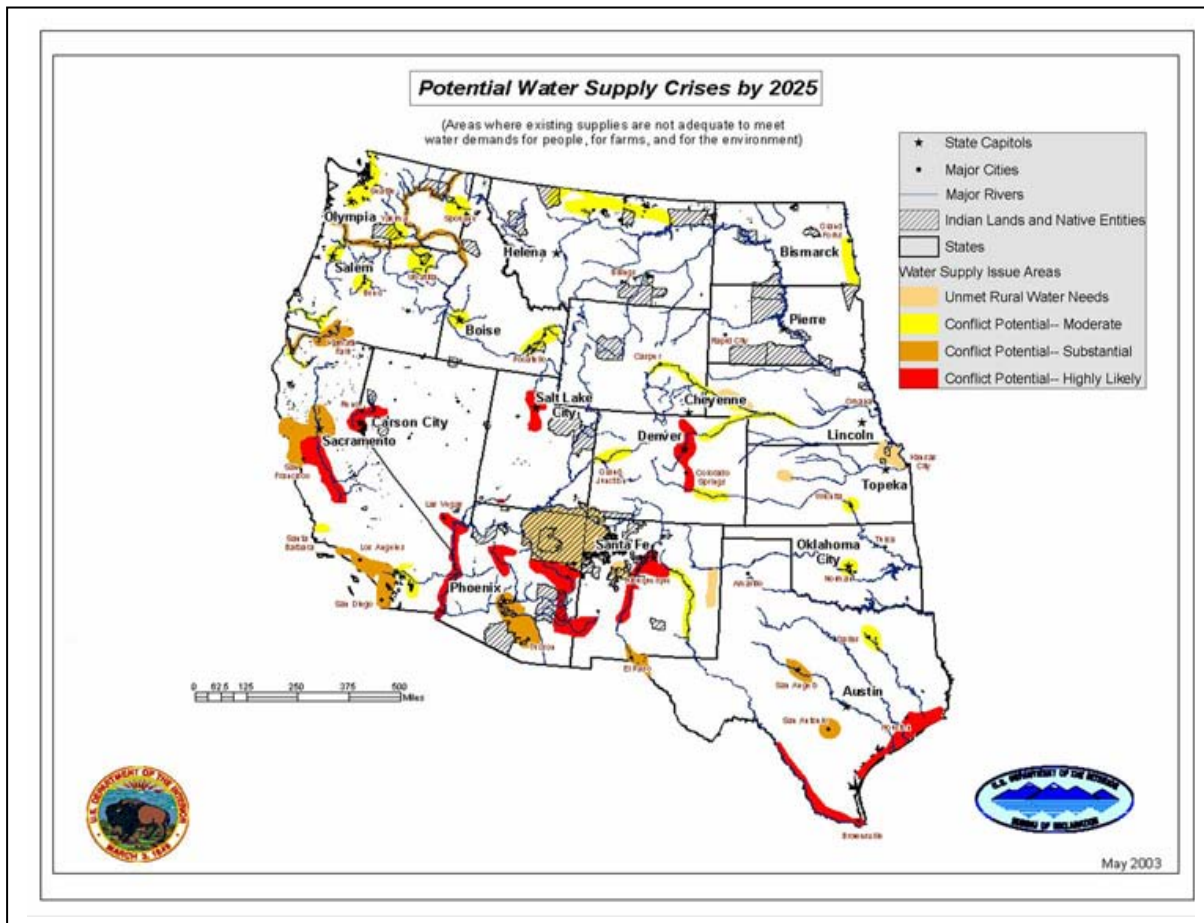
water-use productivity in U.S. thermal-electric power generation has improved from 63 US gallons per kWh in 1950 to 21 US gal/kWh in 2000.

Intensity of U.S. Freshwater Withdrawals by State⁴⁹



US Geological Survey. (2000). *Estimated Use of Water in the United States in 2000*. See online at www.usgs.gov/watuse

Watersheds of Existing and Emerging Concern in the U.S. West



US Department of the Interior. (2003). *Water 2025: Preventing Crises and Conflict in the West*. See online at www.doi.gov/water2025/supply.html

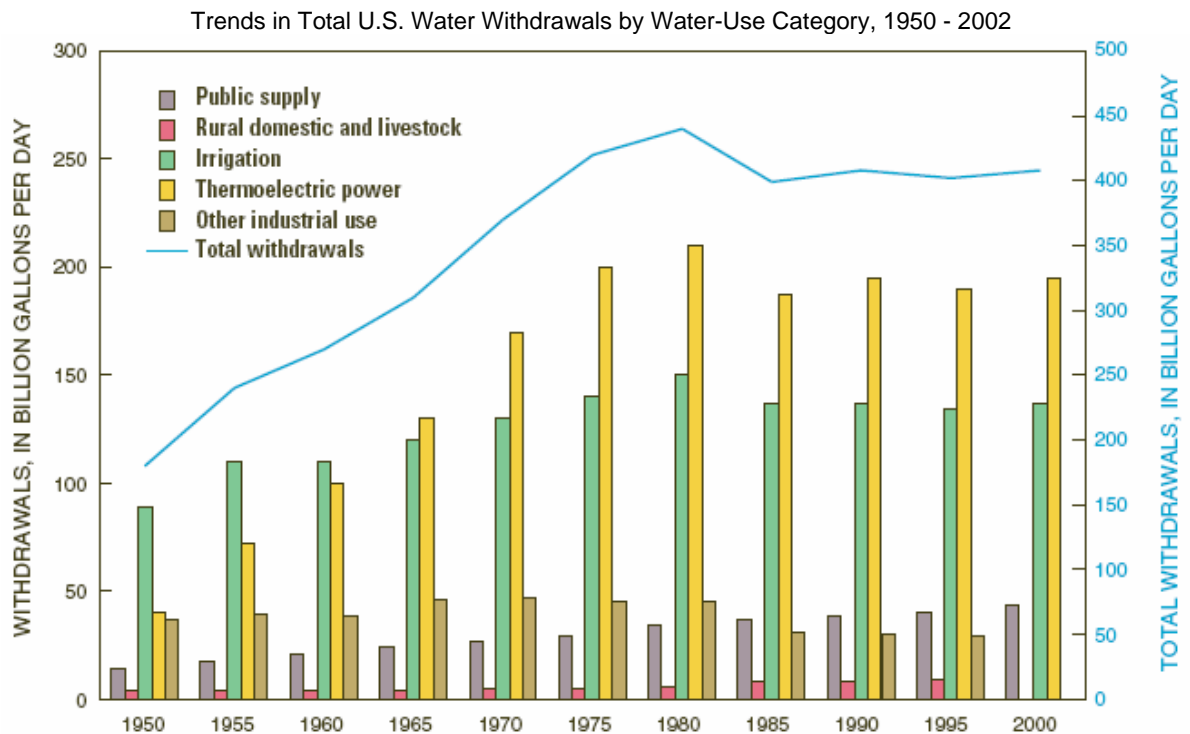
Total U.S Water Withdrawals by Sector and State (2000)⁵⁰
(Million US gallons per day)

STATE	PUBLIC SUPPLY	DOMESTIC	IRRIGATION	LIVE-STOCK	AQUA-CULTURE	INDUSTRIAL		MINING		THERMOELECTRIC POWER		TOTAL		
	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Saline	Fresh	Saline	Fresh	Saline	Fresh	Saline	Total
Alabama.....	834	78.9	43.1	—	10.4	833	0	—	—	8,190	0	9,990	0	9,990
Alaska.....	80.0	11.2	1.01	—	—	8.12	3.86	27.4	140	33.6	0	161	144	305
Arizona.....	1,080	28.9	5,400	—	—	19.8	0	85.7	8.17	100	0	6,720	8.17	6,730
Arkansas.....	421	28.5	7,910	—	198	134	.08	2.78	0	2,180	0	10,900	.08	10,900
California.....	6,120	286	30,500	409	537	188	13.6	23.7	153	352	12,600	38,400	12,800	51,200
Colorado.....	899	66.8	11,400	—	—	120	0	—	—	138	0	12,600	0	12,600
Connecticut.....	424	56.2	30.4	—	—	10.7	0	—	—	187	3,440	708	3,440	4,150
Delaware.....	94.9	13.3	43.5	3.92	.07	59.4	3.25	—	—	366	738	582	741	1,320
District of Columbia	0	0	.18	—	—	0	0	—	—	9.69	0	9.87	0	9.87
Florida.....	2,440	199	4,290	32.5	8.02	291	1.18	217	0	658	12,000	8,140	12,000	20,100
Georgia.....	1,250	110	1,140	19.4	15.4	622	30.0	9.80	0	3,250	61.7	6,410	91.7	6,500
Hawaii.....	250	12.0	364	—	—	14.5	.85	—	—	0	0	640	.85	641
Idaho.....	244	85.2	17,100	34.9	1,970	55.5	0	—	—	0	0	19,500	0	19,500
Illinois.....	1,760	135	154	37.6	—	391	0	—	—	11,300	0	13,700	0	13,700
Indiana.....	670	122	101	41.9	—	2,400	0	82.5	0	6,700	0	10,100	0	10,100
Iowa.....	383	33.2	21.5	109	—	237	0	32.8	0	2,540	0	3,360	0	3,360
Kansas.....	416	21.6	3,710	111	5.60	53.3	0	31.4	0	2,260	0	6,610	0	6,610
Kentucky.....	525	27.5	29.3	—	—	317	0	—	—	3,260	0	4,160	0	4,160
Louisiana.....	753	41.2	1,020	7.34	243	2,680	0	—	—	5,610	0	10,400	0	10,400
Maine.....	102	35.7	5.84	—	—	247	0	—	—	113	295	504	295	799
Maryland.....	824	77.1	42.4	10.4	19.6	65.8	227	8.31	.02	379	6,260	1,430	6,490	7,910
Massachusetts.....	739	42.2	126	—	—	36.8	0	—	—	108	3,610	1,050	3,610	4,660
Michigan.....	1,140	239	201	11.3	—	698	0	—	—	7,710	0	10,000	0	10,000
Minnesota.....	500	80.8	227	52.8	—	154	0	588	0	2,270	0	3,870	0	3,870
Mississippi.....	359	69.3	1,410	—	371	242	0	—	—	362	148	2,810	148	2,960
Missouri.....	872	53.6	1,430	72.4	83.3	62.7	0	16.9	0	5,640	0	8,230	0	8,230
Montana.....	149	18.6	7,950	—	—	61.3	0	—	—	110	0	8,290	0	8,290
Nebraska.....	330	48.4	8,790	93.4	—	38.1	0	128	4.55	2,820	0	12,200	4.55	12,300
Nevada.....	629	22.4	2,110	—	—	10.3	0	—	—	36.7	0	2,810	0	2,810
New Hampshire.....	97.1	41.0	4.75	—	16.3	44.9	0	6.80	0	236	761	447	761	1,210
New Jersey.....	1,050	79.7	140	1.68	6.46	132	0	110	0	650	3,390	2,170	3,390	5,560
New Mexico.....	296	31.4	2,860	—	—	10.5	0	—	—	56.4	0	3,260	0	3,260
New York.....	2,570	142	35.5	—	—	297	0	—	—	4,040	5,010	7,080	5,010	12,100
North Carolina.....	945	189	287	121	7.88	293	0	36.4	0	7,850	1,620	9,730	1,620	11,400
North Dakota.....	63.6	11.9	145	—	—	17.6	0	—	—	902	0	1,140	0	1,140
Ohio.....	1,470	134	31.7	25.3	1.36	807	0	88.5	0	8,590	0	11,100	0	11,100
Oklahoma.....	675	25.5	718	151	16.4	25.9	0	2.48	256	146	0	1,760	256	2,020
Oregon.....	566	76.2	6,080	—	—	195	0	—	—	15.3	0	6,930	0	6,930
Pennsylvania.....	1,460	132	13.9	—	—	1,190	0	182	0	6,980	0	9,950	0	9,950
Rhode Island.....	119	8.99	3.45	—	—	4.28	0	—	—	2.40	290	138	290	429
South Carolina.....	566	63.5	267	—	—	565	0	—	—	5,710	0	7,170	0	7,170
South Dakota.....	93.3	9.53	373	42.0	—	5.12	0	—	—	5.24	0	528	0	528
Tennessee.....	890	32.6	22.4	—	—	842	0	—	—	9,040	0	10,800	0	10,800
Texas.....	4,230	131	8,630	308	—	1,450	907	220	504	9,820	3,440	24,800	4,850	29,600
Utah.....	638	16.1	3,860	—	116	42.7	5.08	26.3	198	62.2	0	4,760	203	4,970
Vermont.....	60.1	21.0	3.78	—	—	6.91	0	—	—	355	0	447	0	447
Virginia.....	720	133	26.4	—	—	470	53.3	—	—	3,850	3,580	5,200	3,640	8,830
Washington.....	1,020	125	3,040	—	—	577	39.9	—	—	519	0	5,270	39.9	5,310
West Virginia.....	190	40.4	.04	—	—	968	0	—	—	3,950	0	5,150	0	5,150
Wisconsin.....	623	96.3	196	66.3	70.2	447	0	—	—	6,090	0	7,590	0	7,590
Wyoming.....	107	6.57	4,500	—	—	5.78	0	79.5	222	243	0	4,940	222	5,170
Puerto Rico.....	513	.88	94.5	—	—	11.2	0	—	—	0	2,190	620	2,190	2,810
U.S. Virgin Islands	6.09	1.69	.50	—	—	3.34	0	—	—	0	136	11.6	136	148
TOTAL	43,300	3,590	137,000	1,760	3,700	18,500	1,280	2,010	1,490	136,000	59,500	345,000	62,300	408,000

US Geological Survey. (2000). *Estimated Use of Water in the United States in 2000*. See online at www.usgs.gov/watuse

Total water withdrawals from all sectors combined were about 8% lower in 2000 than the peak levels reached in the early 1980s. They have been relatively constant since 1985 (see figure). The decline is largely attributed to cooling-system changes in the thermal power generation sector and improved water conservation practices in crop irrigation. Overall water use is also down in the industrial sector as a result of water efficiency improvements (triggered by stricter water quality

standards) and some decline in domestic production among primary industries. Total public water-supply withdrawals have continued to rise but at a slower rate than the rate of population growth.



US Geological Survey. (2000). *Estimated Use of Water in the United States in 2000*. See online at www.usgs.gov/watuse

4.5.3 Federal Initiatives

One or more federal agencies may be involved in water conservation planning and implementation depending on the water-use sector. Key agencies include the Environmental Protection Agency (US EPA), Dept of Agriculture (UDSA), Dept of Energy (DOE), and Dept of the Interior (DOI).

US EPA has been active in the development of water conservation program planning guidance for public water utilities in conjunction with its responsibilities for administering the *Safe Drinking Water Act* (1996). The agency's Guidelines for Preparing Water Conservation Plans formally released in 1998 currently serve as a model for municipal water authorities both in the U.S and other countries⁵¹. EPA's effluent quality standards and watercourse standards have also played a significant role in encouraging water-use intensive industries and municipalities to reduce their water usage.

EPA continues to promote water conservation as a cost-saving element of infrastructure renewal and sustainability initiatives and as integral consideration in integrated water/watershed management planning. It is also considering the establishment of a national water efficiency labeling program for water-using appliances and other devices similar to that of the Energy StarTM Program.

USDA and DOI are involved in promotion and facilitation of conservation initiatives in crop irrigation particularly in the West (see Chapter 7). DOI is also the home of the U.S. Geological Survey (USGS) with its responsibilities in monitoring, compiling, evaluating and disseminating information on water availability and water use throughout the country. The Dept of Energy may

emerge as a more significant player in water conservation efforts with its active involvement in promoting the synergistic benefits of water and energy conservation (see Chapter 6)⁵².

4.5.4 State Initiatives

Arizona⁵³

In 2000, Arizona water users withdrew an average of 6,720 million US gal/day (9,285 million m³/yr) of freshwater from surface and ground water sources. Crop irrigation accounted for 80% of total usage with public water supplies accounting for most of the remainder at 16%. Severe overdrafting of groundwater resources has been reported throughout many parts of the state.

Arizona's system of water management involves granting and administration of surface and ground water rights, controls on well drilling, promotion and facilitation of ground water recharge measures, monitoring and assessment of water resources, and long-range planning. The Arizona Dept of Water Resources is the lead agency. The state's Ground Water Code requires the preparation of water resource management plans within designated Active Management Areas (AMAs). These plans include provisions that generally prohibit additional irrigation development, set 5-year targets for conservation improvements, and require metering of wells withdrawing more than 35 US gallons/min or 190,000 L/day. Land developers can be required to demonstrate the availability of a 100-year assured supply of water before growth approvals are granted.

Cost-share and technical support is available under the Water Management Assistance Program to help irrigators in implementing water efficiency measures.

California⁵⁴

Californians use more water than people and businesses in any other state. Total freshwater withdrawals (2000) amounted to 38,400 million US gal/day (53,055 million m³/yr) or slightly more than 11% of all U.S. withdrawals. Crop irrigation accounts for 79% and public water supply 16% of state-wide withdrawals. It is estimated that in an average year the state uses 40-50% of all water that falls as precipitation or enters the state via Oregon, Colorado or Mexico.

The state Dept of Water Resources (DWR) together with the Office of Water Use Efficiency (OWUE) has lead responsibilities over most aspects of water management. DWR requires all utilities serving more than 3000 customers to develop Urban Water Management Plans that details the measures to be taken to ensure reliability of supply during normal, dry and multiple dry years.

State authorities work closely with urban water providers in implementing a range of education and incentive programs designed for the particular needs of residential, industrial, commercial and institutional water users. These programs combine efforts aimed at both water and energy conservation. Water providers coordinate their program approaches and outreach materials through the California Urban Water Conservation Council.

DWR and OWUE work with irrigation districts and water districts that provide water to the state's large irrigated crop industry. OWUE manages the California Irrigation Management Information System that provides growers with up-to-date information on weather and evapotranspiration rates to assist them in making decisions on scheduling and application rates. OWUE also disseminates information on best technologies and practices, conducts research and demonstration projects, aids in setting up mobile efficiency testing laboratories, facilitates the development of water reclamation and reuse projects, and provides loans and grants for conservation improvements.

Florida⁵⁵

Total statewide freshwater withdrawals in 2000 amounted to 8,140 million US gal/day (11,245 million m³/year). Crop irrigation and public water supply withdrawals respectively account for 53% and 30% of total usage making them a focal point for water efficiency efforts. Landscape and golf-course irrigation is also an area of focus.

Florida has enacted a State Water Use Plan that establishes targets for, provides ongoing direction to and monitors the performance of its five (5) watershed-based Water Management Districts (WMDs). The Plan is administered by the Florida Dept of Environmental Protection. Districts have a range of regulatory and coordination responsibilities covering the areas of surface and ground water monitoring and mapping, water-use permitting, drought response planning and management, public outreach and education, flood protection and conservation lands acquisition. Each WMD operates within the context of 5-year plans with annual performance evaluation and updating.

The state's water conservation goal is "to prevent and reduce the wasteful, uneconomical, impractical or unreasonable use of water resources". WMDs are required and empowered to work with and assist local and regional governments and other parties on conservation programs. Together they can develop and implement water-efficiency standards, enforce irrigation restrictions, impose conservation rate structures, take measures to reduce unaccounted-for-flows, require installation of water-efficient plumbing fixtures, require xeriscaping and irrigation rain sensors, and conduct public education programs.

The Florida Joint Statement of Commitment for the Development and Implementation of a Statewide Comprehensive Water Conservation Program for Public Water Supply (JSOC) is a negotiated agreement among state, district and local partners to collaborate on a range of measures for the continuous improvement of water-use efficiency.

Florida's Dept of Agriculture and Consumer Services (DACS) operates cost-share and technical extension services programs (in conjunction with USDA and other state and local agencies) that assist agricultural producers to implement better technologies and practices for conservation and water quality protection. DACS oversees development and implementation of best management practices (BMPs) and voluntary interim measures relating to irrigation retrofits, irrigation scheduling and integrated water management.

New Mexico⁵⁶

Crop irrigation water withdrawals account for 88% of all water usage in New Mexico. Public water supplies account for 9%.

Lead responsibilities in water management reside with the Interstate Stream Commission (ISC) and the Office of the State Engineer. Regional water planning, which has been in place since 1987, was endorsed as the basis of state programs in recognition of "the many variables in climate, water supply, water demand, and legal and institutional constraints". The state is divided into 16 planning regions.

Regions are guided in their work by a Regional Water Planning Handbook developed by the ISC in 1994. The planning process involves identification and monitoring of supply including determination of potential ground water availability, projection of demand, and development of alternative strategies for meeting the challenges of water shortages that are prevalent in this arid state.

The New Mexico State Engineer, together with the ISC, oversees the state-wide Water Management Program. The program mandates the State Engineer's Office to consider conservation practices in the granting of water rights permits. Applicants are required to "utilize the highest and best technology available to ensure conservation of water to the maximum extent practical".

Inter-State Programs

The above states plus many more outside of the list selected for study also actively work with sister states and other levels of government in promoting and implementing mutually beneficial or essential conservation measures. Such inter-state agreements and programs are relatively common because of the many major river basins that cross state boundaries.

The federal government frequently plays a role in inter-state water initiatives through agencies such as the Corps of Engineers and the Dept of the Interior. Because of the severity of sustainability concerns and problems in the West, U.S federal agencies led the recent development of the U.S. Water 2025 Report. This report examines the competing interests in and conflicts over water resulting from rapid urban expansion, ongoing irrigated-crop production, and escalating public demands for greater protection of fisheries and other instream uses. The report's conclusions endorse the urgency of modernizing and 'tightening-up' existing water supply infrastructure and of implementing a comprehensive range of other conservation measures.

Some western states including Colorado, Montana and Washington have introduced legislation intended to assure the protection of fisheries in the face of historically over allocated resources. Other examples of U.S state and local initiatives are referenced in other chapters and cited in Appendices B and C.

4.5.5 Non-Government and Industry Initiatives

Several national organizations representing a cross-section of water interests have become active in the promotion of integrated water resources management and water conservation. Two of the largest and most influential are the American Water Works Association (AWWA) representing public water utilities and the Irrigation Association (IA) that represents the agricultural and landscape irrigation industries. Excerpts from the conservation policy positions of AWWA and the IA are presented below.

Similar groups advocate for improved water management practices among primary manufacturing industries (pulp and paper, steel, chemicals and energy production), service industries (laundries, car washes and food), recreational industries (golf courses and ski resorts) and institutional facilities (schools and hospitals). The role and contributions of several of these are discussed in Chapters 5-8. There are also a variety of locally, regionally, nationally and internationally based environmental NGOs who have made the wiser and sustainable use of water a cause. These include countless watershed partnerships, Great Lakes United and the World Watch Institute.

American Water Works Association Position on Water Conservation
(Excerpts from the June 1995 AWWA White Paper)

- Water conservation programs should emphasize lasting improvements in water-use efficiency.
- Conservation should be used to reduce current and future water demands to the benefit of the customer, the utility and the environment.
- Water utilities should adopt sound water management practices including;
 - Reducing unaccounted-for water through universal metering and accounting for water use, routine meter testing and repair, and distribution system leak detection and repair
 - Use of cost-of-service water rates
 - Using public information and education programs to promote conservation and assist customers in implementing improvements
- The reliability of conserved water depends on accurate estimates of potential savings. Careful planning and analysis is a prerequisite to major utility investments in conservation programs.
- There is an ongoing need to monitor and document program effectiveness.
- In the event of water shortages, utilities with broad-based conservation programs will be better able to mitigate the impacts on the utility and its customers.
- While the upfront costs of conservation initiatives can be considerable and the full benefits materialize over time, the impact of reduced water sales can normally be accommodated through periodic rate adjustments.
- In growing municipalities, conservation can defer the need for or reduce the size of capital investments in expanded infrastructure and reduce operating costs.
- Conservation reduces wastewater collection and treatment costs and improves effluent quality.
- The first goal of any rate structure is to generate sufficient revenues to maintain efficient and reliable utility operations. The second goal is fairness in allocating service costs. The rate structure should have the capability to encourage conservation and penalize excessive use.
- Conservation-oriented rate structures by themselves do not constitute an effective water conservation program. They need to be coupled with concerted and ongoing customer education and assistance with changing technologies and practices.

The Irrigation Association Water Conservation Policy
(Formally adopted in 1990)

- Measure all water use.
- Price water so as to recognize its finite nature. Pricing mechanisms should provide incentives to water users who conserve water, as well as penalties for those who waste it.
- Hold all water users responsible for protecting the quality of water resources at their disposal.
- Create financial systems to reward users for efficient irrigation systems. Key elements to observe are system design, operation, and maintenance combined with effective scheduling and management practices.
- Create national education programs for all water users emphasizing the absolute necessity of supporting regulatory policies which reward conservation and efficient use.
- Support water reclamation initiatives, particularly for irrigation, including the use of reclaimed water from municipal, industrial, agricultural and other available sources, where practical.
- Give increased support to developing new water resources, conveyance and storage facilities to enhance dependable water supplies for urban and agricultural use, with proper consideration for legitimate environmental concerns.
- Participate in water conservation planning as an ongoing program. These plans must be in place prior to a critical need and must provide for each water user's acceptance of a fair share of any conservation effort.
- Institute studies to assess water use and misuse within all sectors as a basis for sound decision-making on the equitable distribution of water during periods of shortage.
- Promote policies which allow for the lease, sale or transfer of established water rights, and/or the lease, sale or transfer of water without jeopardizing established water rights, whenever possible.

4.6 EUROPE

4.6.1 Constitutional and Legal Context

The European Union continues on the path toward harmonization of national laws governing the development, use and protection of water and other natural resources. Harmonization is being achieved through negotiation and formal adoption of legally binding Framework Directives and Environment Action Programmes. These establish EU-wide policies and standards that serve as benchmarks for the introduction or amendment of state laws and guidance in the coordination of programmes. Oversight of the Water Framework Directive (WFD) is under the auspices of the European Commission. The European Environment Agency (EEA) is responsible for compiling and disseminating information that will assist member states in achieving Framework objectives and for progress reporting.

Promotion of sustainable water use based on the “long-term protection of available water resources” is an identified purpose of the WFD⁵⁷. Specific policy requirements are still being developed surrounding water conservation and water-use efficiency. Member countries are currently required to conduct economic analyses of water use at a river basin level taking into account the principles of cost recovery for services including environmental and resource costs.

The Integrated Pollution Prevention Directive of 1996 establishes “best available techniques” guidance and water efficiency targets for the pulp and paper industry and for the hog and poultry sectors of the intensive livestock production industry⁵⁸. These are discussed in chapters 6 and 7.

An objective of the Sixth Environment Action Programme (2001-2010) is “to provide products and services using fewer resources, such as water, and encouraging resource efficiency through more sustainable consumption patterns”. It goes on to say that, “to achieve this objective, measures to improve the efficiency of water use in different economic sectors have to be implemented at national, regional and local levels”.

EU Directive 97/11/EC obligates member countries to enact formal Environmental Impact Assessment (EIA) requirements as part of approval processes associated with large water withdrawals (≥ 10 million m³/yr) and inter-basin transfers (≥ 100 million m³/yr).

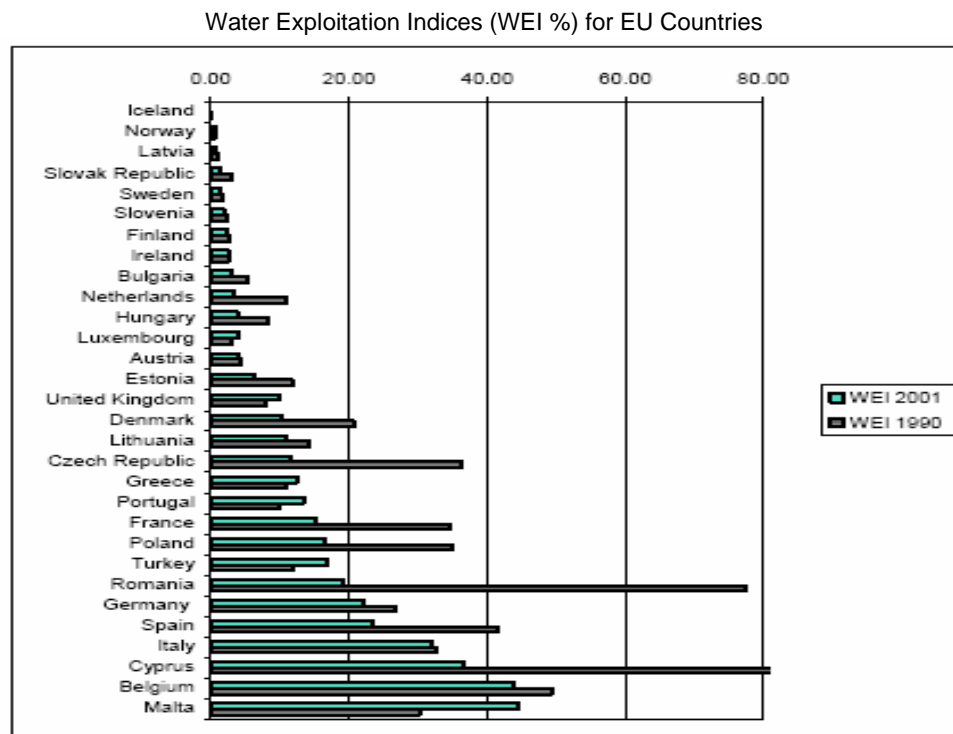
4.6.2 Water Availability and Water Use

Generally speaking the European continent is blessed with abundant freshwater resources but there are important regional disparities in the level of renewable supplies. The extent and severity of sustainability concerns reflect differences in geography, climate, population densities and the sectoral distribution of economic activity across the continent. Countries in the south with their sizeable agrarian economies, e.g. Spain, Italy and Turkey, experience more problems than their northern neighbours (see figures)^{59,60}. Some eastern accession countries including Romania, Poland and Slovakia, which historically experienced sustainable water-use issues, have seen some reduction of concern albeit as a result of the partial collapse of their agrarian economies.

Water-resource sustainability is becoming an issue in the United Kingdom with its relatively limited crop irrigation, relatively abundant precipitation and more temperate climate. France lies somewhere in the middle of the overall European experience since higher agricultural water demands are balanced off by higher annual water resource renewals. This is not to say that these countries don't suffer from localized problems with respect to maintaining a balance between water availability and water use.

Surface water withdrawals account for the largest portion of water takings in most countries⁶¹. They constitute close to 80% of all withdrawals in the UK, 85% in France and 90% in Finland. Exceptions are Denmark, Iceland and Slovenia where ground water is the basis of more than 80% of total water withdrawals. Ground water is the primary source of public water supply in rural areas of most European countries. Large scale ground water withdrawals, primarily for public supply, have resulted in worsening saltwater intrusion problems for the coastal aquifers of Denmark, southern Baltic countries and countries bordering the Mediterranean Sea.

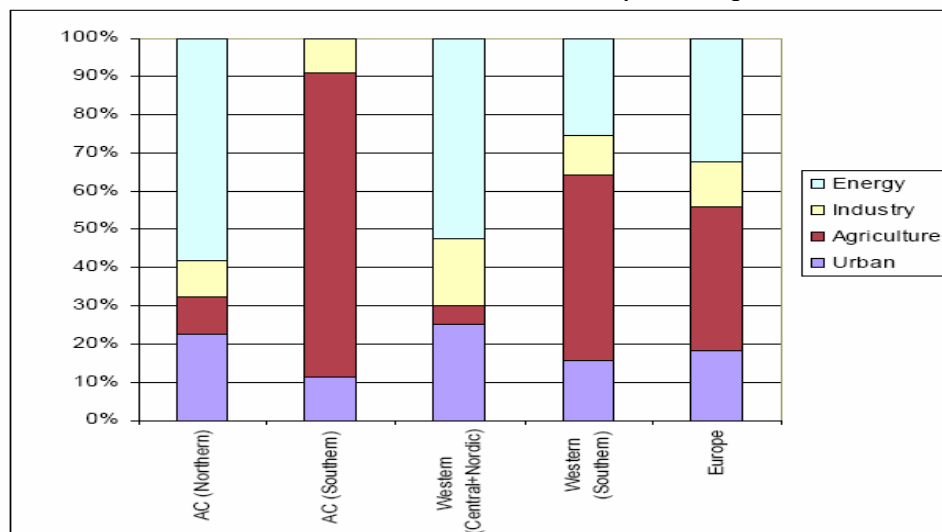
The last decade has seen a higher incidence and severity of drought-like conditions in parts of Europe leading to increased attention being focused on measures that will improve water-use efficiency and productivity.



European Environment Agency. (2004). *Indicator Fact Sheet: Water Exploitation*. See online at www.eea.eu.int/indicators/all_factsheets_box

Note: WEI or water withdrawal ratio is defined as the mean annual total abstractions of freshwater divided by the mean annual renewable freshwater resources.

Sectoral Water-Use Distribution within Major EU Regions



European Environment Agency. (2004). *Indicator Fact Sheet: Water Use by Sectors*. See online at www.eea.eu.int/indicators/all_factsheets_box

Notes:

- Western (Southern) region consists of **France**, Greece, Italy Portugal, Spain
- Western (Central+Nordic): Austria, Belgium, Denmark, Finland, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Sweden, Switzerland, **United Kingdom**
- AC (Southern): Acceding countries of Cyprus, Malta, Turkey
- AC (Northern): Bulgaria, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia

4.6.3 Water Pricing and Cost Recovery

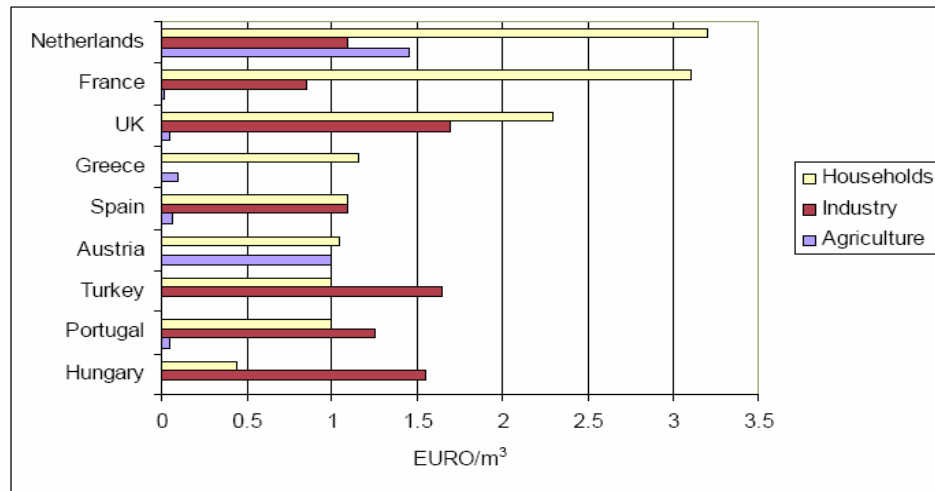
The EU Water Framework Directive obliges all member states to have full-cost recovery pricing policies in place by 2010⁶². Increased water prices are being viewed as “an enabling mechanism” in altering behavioural responses on the part of water users. Most EU countries now use water-rate structures that combine fixed and volumetric charges and have been progressively raising prices by several percentage points annually. Removal of pricing subsidies in Eastern Europe contributed to decreases in average domestic water use by as much as 32% in recent years. Domestic water bills range from 0.2% of household income in Oslo, Norway to 3.5% in Bucharest, Romania. As a point of reference, the World Bank has stated that the cost of water services should not exceed 5% of household income.

Across Europe, municipal water prices tend to be lower in Mediterranean countries and in most countries with abundant water supplies. The highest prices are typically found in the cities of northern Europe. In-country differences are common as is the case in Spain where prices in the resort island areas are 2.0-2.5 times national average rates. Municipal water pricing in Europe and elsewhere is discussed in more detail in Chapter 5.

The agricultural sector is acknowledged as presenting the biggest challenge in moving toward full-cost recovery. Current agricultural water prices are typically an order of magnitude lower than those found in the municipal and industrial sectors. While this may appear justified on the basis of lower servicing costs, it runs counter to the sector’s status as the largest contributor to water quality degradation across the continent. Austria and the Netherlands are exceptions to this pricing disparity

as seen in the following figure. The EU Common Agricultural Policy provides for direct payments to farmers to assist with the implementation of resource and environmental protection measures. Payments are capped on the basis of crop types and acreages and require the adoption and ongoing use of environmentally acceptable production methods and practices.

Median Prices for Industrial, Agricultural and Household Water Supply (late 1990s)



European Environment Agency. (2004). *Indicator Fact Sheet: Water Prices*. See online at www.eea.eu.int/indicators/all_factsheets_box

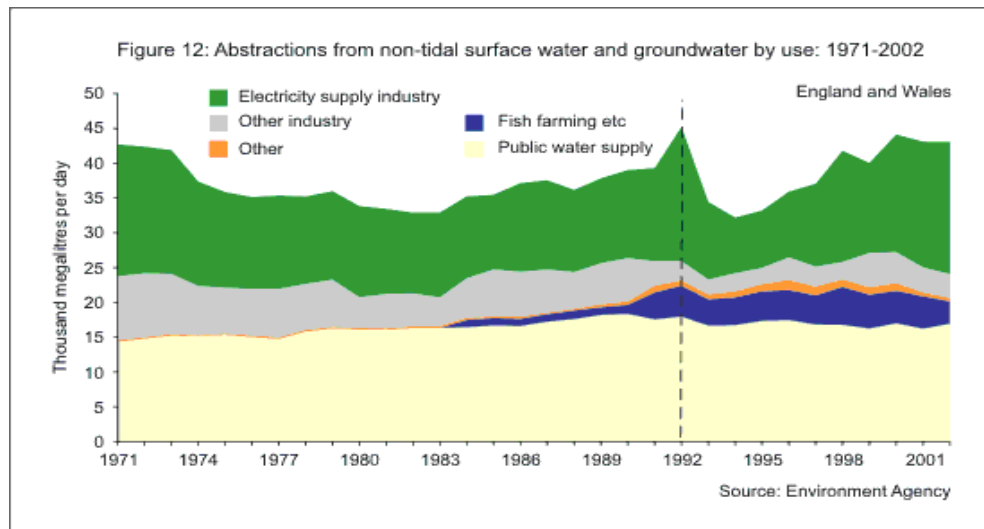
4.6.4 England and Wales⁶³

Water Availability and Water Use

While England and Wales are traditionally considered as having wet climates, total accumulated precipitation can vary widely from year to year. Drought-like conditions occur with some regularity during the summer period. This combined with a large and growing population living on a small land base can exert tremendous pressure on available surface and ground water supplies. The population is expected to increase by 2.8 million persons in the period 1996 to 2016.

Total annual water withdrawals from all sectors combined are about 16,000 million m³. Public water supply and thermal power plant withdrawals each account for about 42% of total abstractions (see figure). Industrial and commercial-aquaculture takings make up most of the remainder. With only 108,000 ha or 0.6% of all agricultural lands being irrigated and much of that for higher-value crops, the UK's agricultural crop-water use component is the smallest among jurisdictions included in this study.

Trends in Sectoral Water Withdrawals in England and Wales (1971-2002)



Environment Agency. (2002). *Your Environment- Environmental Facts and Figures*. See online at www.environment-agency.gov.uk/yourenv/eff

Water Management

Water management in the UK has gone through a succession of reforms in the past few decades that have seen responsibilities fully devolved to watershed authorities and then partially centralized again. The provision of public water supplies is generally the responsibility of private water companies. These companies typically provide water services to several communities and report to watershed-based regional offices of the Environment Agency (see figure).

U.K. Environment Agency Regional Offices



The *1991 Water Resources Act* and the more recent *U.K. Water Act (2003)* both incorporate provisions for regulating water-use sustainability. The former requires measurement and reporting of abstractive water usage within catchment management areas. It also established a Water Demand Management Department within the Environment Agency with responsibilities to further the science and practice of demand management and drought management. The *Water Act* strengthens requirements for sustainable use. Water companies are required to document the measures they are taking and the progress made in managing the water distribution system and in encouraging water-use efficiency among their customers. The Environment Agency has the power to revoke or amend water licenses if the water use is found to be damaging the environment.

The *Water Industry Act (1991)* regulates the prices that water companies charge customers. In addition to bringing needed price stability and certainty to the industry, the Act facilitates application of universal metering and cost recovery on actions taken to implement conservation and water-use efficiency. Price structures are reviewed every five years. *Water Supply Regulations* which accompany the Act set minimum national efficiency standards for toilets, washers and dishwashers and specify other plumbing requirements intended to minimize water waste. On the surface, these mechanisms together with the *Water Act* requirements would appear to require water companies to aggressively pursue water conservation. Recent government and independent reviews have, however, shown that the privatized water industry has been slow in introducing changes seen as a threat to its profit margins.

Since 2001, the Catchment Abstraction Management Strategies (CAMS) process has required the establishment of water budgets for designated river basins. The budgets will be used to determine sustainable abstraction levels and aid in the identification of actions needed to regulate water withdrawals in the face of future growth. Throughout England and Wales, a Water Abstraction Licence and/or a Water Impoundment Licence is required for any non-domestic surface or ground water taking in excess of 20,000 L/day.

The UK's 'Waterwise' and 'Envirowise' outreach and education programs offer detailed and regularly updated advice and technical assistance to homeowners, industries, commercial establishments, institutional facilities and farmers on selecting and implementing best technologies and practices for water efficiency.

4.6.5 France⁶⁴

Water Availability and Water Use

France is considered a water-rich nation with large annually renewable freshwater supplies and significant ground water reserves. Even the driest regions rarely receive less than 600 mm of precipitation on an annual basis.

Total annual freshwater withdrawals are in the range of 32,000 million m³, 85% of which come from surface water sources. Thermal power plants account for 60%, public water supplies 18%, agricultural uses 12%, and industrial uses 10% of total withdrawals. Water usage for crop irrigation has been on the rise in recent years particularly in western and south-western regions of the country where increases of as much as 75% have occurred since 1981.

Consumptive use has been estimated at 4,000 million m³ annually or about 12.5% of total withdrawals. Crop irrigation accounts for 68% of consumptive use, public water supply 24%, industries 5%, and power generation 3%.

In contrast to the norm of abundant supplies, hot and dry conditions have been prevalent in recent years. Record setting drought conditions in 2003 required widespread introduction of water use restrictions.

Water Management

The national or state role in water management is primarily focused on the regulation or authorization of water takings and wastewater discharges for the expressed purposes of protecting public health and safety and the health of aquatic environments. These powers are vested in the Water Department (Agence de l'eau) of the Environment Ministry.

Under the *Water Law (1992)*, the river basin unit figures prominently in how water is managed. Each of France's six major basins is overseen by an elected committee comprised of key stakeholders representing state and local governments and water users. The committee establishes basin objectives and a programme of interventions. Programme delivery is the responsibility of a financially independent state Water Agency with powers to raise revenues through both water charges and effluent charges. Monies are made available through loans and subsidies to assist communities, industries and farmers implement works deemed necessary and eligible within the current 5-year water management plan. These plans (created at the watershed and sub-watershed level) are expected to reflect all standards and measures as laid out in the EU water framework.

France has perhaps the most comprehensive and far-reaching system of water pricing among all study jurisdictions. Volumetric charges are levied not only as a basin (Water Agency) charge tied

to the magnitude of the abstraction but also as a state tax reflecting the extent of consumptive usage. The state tax is determined through a system of consumptive use coefficients assigned to the particular sector. The basin abstraction charge is higher (2-3.5 x) for ground water withdrawals and is also higher in water-short areas and areas where the source water is of higher quality.

Under provisions of the *Water Law*, wastewater reclamation and reuse in crop and landscape irrigation is both permitted and encouraged both to address water shortages and reduce pollutant discharges to surface waters.

The drought conditions experienced in 2003 led to the development of a national Drought Management Plan. It provides for the establishment of a national committee to be mobilized as required by Ministerial Order. The committee will ensure the development of guidelines for assessing drought risk and will disseminate the guidance required to ensure uniform approaches to the implementation of water-use restrictions. Actions are underway to modernize existing monitoring networks used to measure water availability and demand.

The Irrimieux Initiative jointly launched by the Ministries of Agriculture and Environment in the 1990s required crop irrigators to install volumetric metering. It also provides them with up-to-date weather and climate data to assist with irrigation scheduling and determination of appropriate application rates and offers guidance on other best practices.

4.7 DROUGHT PLANNING AND RESPONSE

Within all study jurisdictions special water management provisions and processes have been developed to deal with conditions of deep or prolonged drought. Notwithstanding the fact that governments are coming under increasing pressure to apply the precautionary principle in granting new water allocations or amending existing ones, it is generally accepted that the upper limits placed on individual extractive water uses cannot be so conservative as to absolutely guarantee that there will be no interference with other users or the aquatic environment under extreme low-water conditions.

In the extreme view, some might suggest that the total of the individual maximum permitted daily water withdrawals of all users sharing the resource not be allowed to exceed the minimum observed or predicted available flow less a prescribed environmental flow requirement. Not surprisingly those responsible for water licensing do not use such a strict interpretation. They recognize that the average daily withdrawals by self-supply water users are typically much lower (often 50% or more) than their permitted maximums, that higher shared demands are not likely to occur on the same day, that some portion of most withdrawals is returned, and that high cumulative demands do not necessarily coincide with the period of lowest streamflow.

The risk of adversely overlapping supply and demand conditions is strongest in rural areas where high seasonal-use demands from agriculture, golf courses and other users may coincide with depressed stream flows and ground water tables. Few jurisdictions manage to escape the drought or low water conflict scenario happening in some location. The ability to prevent it from happening or to move quickly and fairly in response is strongly linked to the accuracy, currency and completeness of information on water availability and demand.

Most drought contingency plans define a series of drought-severity stages that, when reached, require specific and progressively more water-use restrictive actions to be taken by individuals or groups of water users. Those actions involve a combination of restrictions on when water can be used (e.g. limited hours and days of use), progressively more stringent limits on the level of taking, and occasionally an outright ban on certain uses. Some jurisdictions use blanket regulatory powers such as a government declaration of a drought emergency backed up by enforcement and penalties. Others

encourage groups of water users in the affected area to work alongside agency staff in designing, negotiating and implementing a voluntary response plan. The latter approach offers the potential that water users can work together over time to tailor their individual and collective levels and patterns of use in a way that not only responds to crisis conditions but works to prevent a recurrence in future years.

4.8 CROSS-JURISDICTIONAL HIGHLIGHTS

4.8.1 Introduction

The following analysis focuses on where individual governments and Canada in general stand in their pursuit of sustainable water use practices relative to current and emerging directions and commitments observed both internally (i.e. domestically) and internationally. The intent is to reflect on similarities and differences in an objective manner.

It is important to note up front that Canada's domestic program differences, i.e. among provinces and territories, are larger in some respects than its fundamental differences with other countries over the selection of individual conservation measures and approaches. This should be viewed not as a point of criticism of one province's commitments against another's but rather from the perspective of where Canada may need to reorient itself nationally and internationally. The potential benefits of greater internal harmonization have as much to do with strengthening Canada's own growth and development opportunities, quality of life and sovereignty as they do with being a partner in the global economy and society.

4.8.2 Water Conservation as a Government Priority

Sustainable water-use concerns have yet to receive the same level of public attention and government priority in Canada as in the other jurisdictions selected for study. Canada's current water withdrawals and usage averaged over the entire national landscape are arguably less imposing when compared to the apparent availability of supply. On the other hand, if it were not for Canada's more limited involvement in irrigated crop production and the fact that a majority of its urban population and major industries draw water directly from the Great Lakes system and other large bodies of water, the country's current lack of efficient water-use practices could have produced concerns and events closer to those seen elsewhere.

The one area that reflects some level of similarity between Canada and other countries is the attention given to promoting and enhancing municipal water-use efficiency. All countries and governments share an inherent interest in demand management as an alternative to investing government resources in the costly expansion of water and wastewater systems or as a necessary response for avoiding community health and economic well-being concerns in the face of local supply shortages.

Within Canada, the level of priority devoted to promoting and facilitating water-efficient practices among residents and businesses varies widely. Provinces with longer histories of conflicts over water use or challenges in cost-effectively addressing the water demands of rapidly growing populations and economies generally have more comprehensive and mature programs. This includes Alberta, British Columbia, Manitoba and Ontario. Others like Quebec and Saskatchewan have recently begun to put similar frameworks in place. Current programs in the Atlantic Provinces and the Territories are more limited in scope and more voluntary in nature.

4.8.3 Inter-Governmental and Cross-Sectoral Integration and Harmonization

To date, Canadian water conservation efforts have seen relatively limited harmonization in target setting and program design between and among national and provincial/ territorial levels of government. As pointed out earlier, governments have also tended to limit their focus to the municipal sector in searching for potential water-efficiency savings.

The fundamental principles of equity and cost-effectiveness suggest that conservation needs and opportunities should be identified on the basis of what works best in achieving sustainability within individual communities and watersheds and on what is possible within each water-use sector. National harmonization of water efficiency targets and requirements within business sectors would also assist in maintaining current levels of competitiveness.

The use of watersheds as the basic management unit is now widely embraced throughout North America and on other continents. Many jurisdictions have taken steps to formally establish river basin or watershed management agencies and have given these agencies a range of powers in information collection, planning and implementation. This is consistent with the growing global recognition that water management responsibilities should be devolved to lowest practicable level subject to appropriate national and provincial/state guidelines and approvals.

Watersheds are in and of themselves integrators of upstream-downstream effects, cumulative impacts and land-water interconnections.

4.8.4 Legislative, Policy and Planning Frameworks

All study jurisdictions appear to have overarching policies that identify the sustainable development and productive use of water and other resources as intended goals. To be truly effective, such policies need to be backed up by appropriate legislation, regulations and guidelines. Even where a majority of individuals and businesses may voluntarily support conservation principles and objectives, history uniformly suggests the effectiveness of their actions is strongly dependent on coordinated planning, formal guidance and the knowledge that governments will step in to ensure shared accountability.

The collective Canadian experience demonstrates that the full range of regulatory, policy and planning tools in use in other jurisdictions have their parallels here. The differences lie in the fact that very few Canadian jurisdictions are currently using the broad spectrum of what's considered most productive for effective water resource management. Several basic tools already in place or being put in place in other jurisdictions are not yet widely used in Canada. This includes universal metering/measurement of water use, watershed-based planning (with respect to both water allocation and land use planning), water-efficiency standards for plumbing fixtures and other devices, mandatory conservation planning, and full-cost accounting and cost recovery. The variable nature of water availability coupled with the cumulative and expanding nature of water demands suggests that such tools should form an integral part of how water is allocated, used and managed.

Most jurisdictions utilize and build upon existing water resource protection laws and other legislation pertaining to land use planning and building standards as a basis for implementing conservation-oriented regulatory initiatives. These measures appear as the basic underpinning for conservation-oriented regulatory initiatives. The use of stand-alone conservation legislation is rare.

4.8.5 Informed Decision-Making

Decisions regarding water conservation undertakings fit within broader decision-making processes surrounding water allocation and management. They benefit from having good information on water availability and demand and a good understanding of the opportunities and potential effectiveness associated with a range of conservation alternatives. Water managers need to be aware

of the inherent variability in surface and ground water hydrology, of the possible impacts of climate change and variability on water resources, and of the projections for future growth and development. This information is compiled on the basis of watersheds, aquifers and utility service areas and evaluated through a process that examines water balances or budgets under a range of demand and supply conditions.

Accurate water availability and usage information is also a prerequisite in assigning responsibilities and costs and in evaluating progress. As this study has shown, Canada lags behind other study jurisdictions in the collection, analysis and dissemination of both water availability and water usage information. In general, governments have not committed sufficient resources to adequately characterize and understand local and regional water availability and have not imposed mandatory requirements for the accurate measurement and routine reporting of water usage. This is true even for most critical use areas.

Significant progress is being made in developing simulation models used for deriving both planning and operational-level water budgets. Their use will aid in reducing the risk of water licensing decisions overestimating or underestimating what may be safely and sustainably withdrawn.

4.8.6 Stakeholder Consultation and Participation

In the continuing era of tightly focused government mandates and increasing reliance on partnerships and voluntary approaches in managing and protecting natural resources, it is imperative that extractive water users and other stakeholders be kept informed of and consulted in the planning and implementation of water conservation policies, regulations and programs. Most if not all study jurisdictions appear to be communicating with affected stakeholders and the general public on a routine basis. In some cases this is driven by legislatively imposed 'right-to-know' requirements, in others it is voluntary.

Involving stakeholders typically means discussing drivers and targets, listening to concerns, presenting alternatives, obtaining buy-in, sharing successes, and recognizing contributions.

In future, greater efforts may be needed in explaining the rationale for and objectives behind such measures as full cost accounting and recovery, minimum sectoral requirements, priority of uses, and protection of environmental levels and flows.

4.8.7 Outreach and Education

Canada's approach to water conservation outreach and education largely parallels what is happening in other study jurisdictions at least with respect to its being seen as a critical component in building support for program objectives and assisting behavioural change. The use of media and other venues are also quite similar.

On the deficiencies side, most outreach programs fail to promote water conservation from the broader perspective of its energy saving and other benefits. Greater attention might also be given to drawing municipal and other water users together, e.g. on a watershed basis, to ensure that there is an awareness and acceptance of shared responsibilities.

4.8.8 Research, Demonstration and Continuous Improvement

Support for ongoing research is fundamental to finding better ways to reduce demand and make more productive use of water. Research assists in refining water-saving technologies and processes and in improving methods for collecting, analyzing and disseminating information.

In general, Canada has not been at the forefront in the development of new water-efficient technologies and innovative practices because it hasn't felt the need to be. Notwithstanding this reality, there are a number of government institutions (e.g. Canada Mortgage and Housing Corporation), private sector interests (primary manufacturers) and institutes of higher learning (e.g. University of Victoria), that continue to monitor developments in other parts of the world with a view to evaluating their applicability within Canadian communities and businesses. Continued support for monitoring and evaluation along with enhanced support for on-the-ground demonstration of new technologies and practices should be a priority in moving forward with regional and national conservation initiatives. The scope of these activities should encompass a broad range of Canadian settings and cut across all water-use sectors

4.8.9 Incentives and Resourcing

At the outset it is important to recognize the value of water conservation and sustainable use initiatives for their cost savings potential. While implementing conservation programs and projects requires up front investments by water users and ongoing costs for governments, most undertakings should result in savings and paybacks that more than cover the costs of implementation.

The above reality does, however, not negate the need to account for expenditures and returns. Program planning should include identification of the expected costs of promoting and educating, adding or replacing equipment, modifying processes and practices, expanding data collection, providing training, enforcing regulations and monitoring progress. A growing wealth of case studies and experience is available to assist in this task.

Governments, in consultation with affected stakeholders and the public, need to examine innovative resourcing strategies and alternatives beginning with the underlying principles of cost recovery, user pay and beneficiary pay. Financial incentives or assistance may be required in cases where the pace or depth of planned implementation could lead to some initial social disruption or economic hardship.

The use and role of incentives (e.g. equipment rebates or assistance for low-income households) should be considered in the context of an overall costing and resourcing strategy that looks at required expenditures (and expected savings) on the part of government agencies and water users. There is evidence that this is happening in Australia and Europe where commitments and timetables have been established for implementing full cost recovery and mechanisms are being worked out to provide financial assistance to those individuals and businesses that otherwise would not be able to pay for the required conservation measures. While some Canadian provinces and some important user groups have indicated their support for moving in a similar direction, the current situation lacks both uniformity and the certainty of formal timetables and commitments.

4.8.10 Performance Review and Adaptation

All conservation initiatives warrant monitoring during and after implementation to determine whether predicted savings are being obtained and to assess whether assumptions regarding influencing factors such as climate variability, rate of growth and levels of production still apply. The information obtained is used in validating program effectiveness and identifying where program adjustments might be needed or warranted.

The greatest initial needs in Canada in laying the groundwork for ongoing performance review are the implementation of mandatory water-use metering/monitoring and reporting and the upgrading of ground and surface water monitoring networks within critical use watersheds.

5.0 MUNICIPAL SECTOR CONSERVATION PRACTICES

5.1 INTRODUCTION

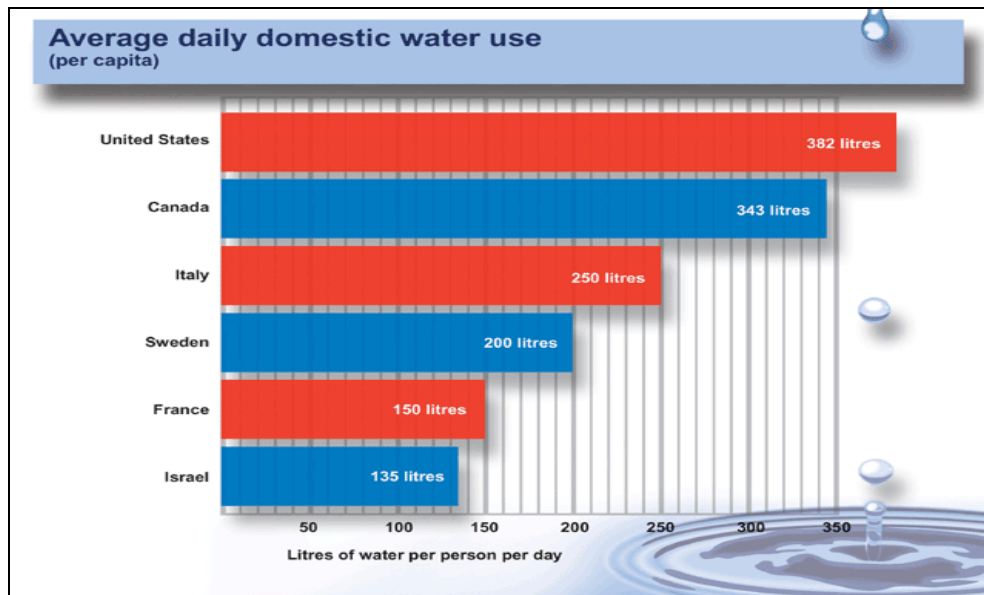
This chapter examines inter-jurisdictional similarities and differences in water use and conservation practices within the municipal sector. Evaluation focuses on the priority being given to the sustainable development and efficient use of water, the role of regulatory compliance vs. voluntary initiatives, the comprehensiveness of conservation planning, the linkages to other objectives and initiatives (e.g. energy conservation and pollution control), the selection of measures (new technologies, improved practices or process modifications) and accomplishments.

Case study documentation of municipal water conservation program initiatives and accomplishments across jurisdictions are captured as potential benchmarks for what may be more broadly achievable. The majority of reported examples were observed to deal with the household or domestic component of municipal usage. This is attributed to the fact that this sector typically accounts for at least 70% of total billed water usage in most Canadian municipalities as well as in most towns and cities in other countries.

Domestic per capita use by Canadians is among the highest in the world. As shown in the following figures, the average Canadian resident, served by a municipal utility, uses almost as much water as his/her U.S counterpart and more than twice as much as many Europeans.

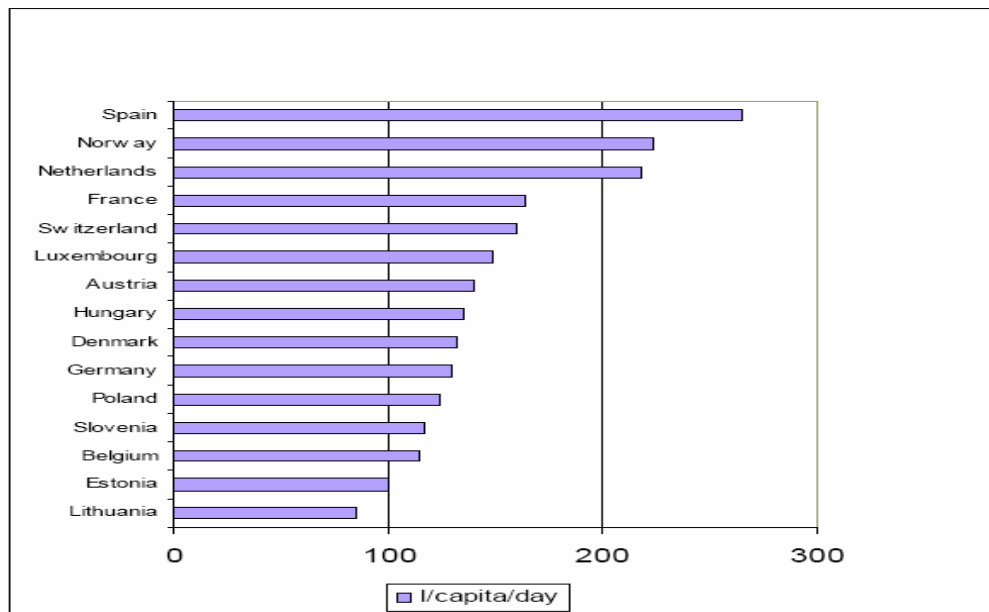
While there appears to be no global standard dictating the minimum amount of water required to meet basic human needs, some guidance is available on the subject. In 1996, Gleick recommended a minimum value of 50 L/cap/d which he broke out as follows: 5 L for drinking water, 20L for sanitation and hygiene, 15L for bathing, and 10L for cooking⁶⁵. More recently, World Health Organization investigators have suggested that a supply of 100 L/cap/d would meet all consumption and hygiene needs and protect human health in situations where water services are provided to individual households on a continuous basis, e.g. through piped systems.⁶⁶ This figure does not include water used for landscape maintenance and other outdoor uses which can account for 25% or more of residential water usage over the course of a year. While most Canadians are not likely to reduce their domestic water usage to the levels observed throughout most of Europe, there are opportunities to narrow the gap by addressing efficiency improvements both inside and outside the home.

Comparison of Domestic Water Use among Developed Nations



Environment Canada. *Water Use*. See online at www.ec.gc.ca/water/images/manage/use

Household Water Use in Selected European Countries



European Environment Agency. (2004). *Indicator Fact Sheet: Water Use in Urban Areas*. See online at www.eea.eu.int/indicators/all_factsheets_box

The following section focuses on conservation initiatives and opportunities with broad municipal applicability. It is followed by a section looking at the special issues faced by northern communities. Section 5.4 examines water-use efficiency practices and opportunities within the more specialized industrial, commercial and institutional customer components of the municipal water supply sector.

5.2 PRACTICES WITH BROAD APPLICABILITY

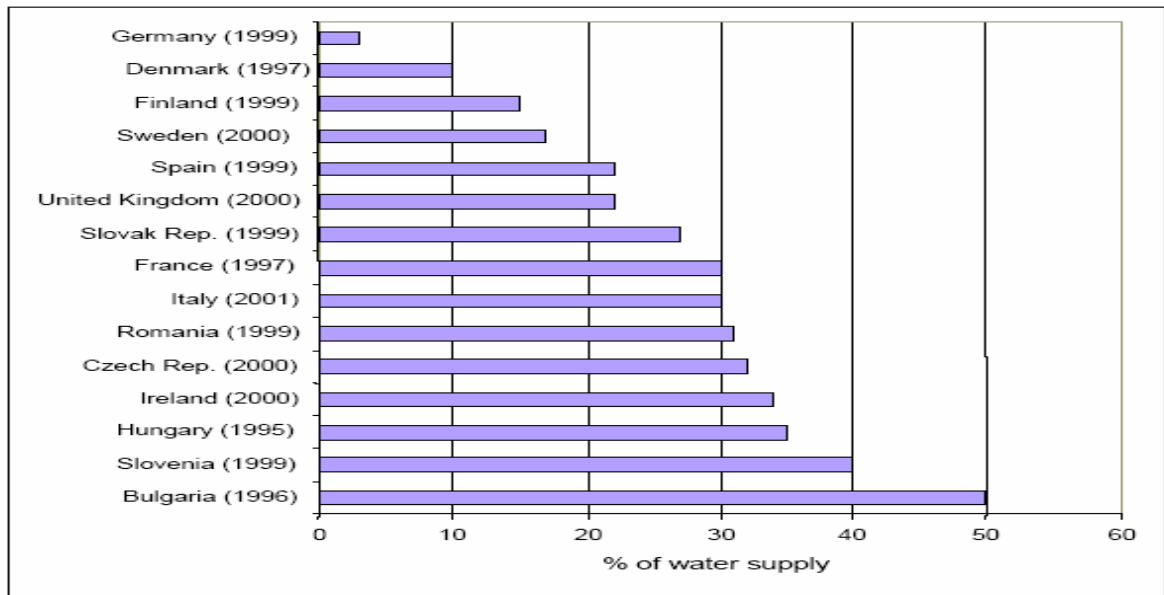
5.2.1 Background

Municipal conservation measures generally fall within two categories. The first is focused on reducing losses or waste associated with the design and operation of the treatment and distribution system itself. The second encompasses measures intended to reduce individual and cumulative user demands.

Across Canada, distribution system losses and other ‘unaccounted-for-flows’ also referred to as ‘non-revenue water’, are typically in the range of 10-15% of actual water withdrawals but can amount to as much as 30%⁶⁷. Higher losses can be reflective of older distribution systems, systems subject to recurrent frost damage, or systems lacking routine inspection and maintenance.

Distribution system losses are a significant problem in some parts of Europe particularly in accession countries of the Eastern block (see figure)⁶⁸.

Average Public Water Distribution System Losses in Europe (late 1990s)



European Environment Agency. (2004). *Indicator Fact Sheet: Water Use Efficiency (in cities): Leakage*. See online at www.eea.eu.int/indicators/all_factsheets_box

Most Canadian municipalities with active water conservation programs are implementing a selection of measures but few have taken a truly comprehensive approach. The following table summarizes the results of a 2000 survey of municipalities selected on the basis of already being involved in a variety of conservation initiatives. The survey was commissioned by the Intergovernmental Committee on Urban and Regional Research, Canadian Mortgage and Housing Corporation (CMHC). Statistics are based on the 65 responses received out of the 102 municipalities contacted.

Uptake of Conservation Measures among CMHC-Surveyed Municipalities (Yr 2000)

Measure	Percent of Surveyed Municipalities Using Measure
Metering	full metering - 60%; partial metering - 21%; no metering - 19%
Conservation rate structures	Increasing block rate - 18%; uniform/constant rate - 19%
Leak detection and repair	66%
Plumbing retrofits	60%
General outreach and awareness	87%
Outreach and education regarding outdoor water use	80%
School programs	65%
Watering restrictions	57%
Xeriscaping demonstrations	22%
Conservation bylaws	35%

A more extensive survey undertaken by Environment Canada in 1999 showed the percentage of Canadian municipalities with populations greater than 1,000 that were not on universal metering is larger than that represented by the CMHC results⁶⁹. It found that some 44% of Canadians were using unmetered services. While community size appears to play a role, it is worth noting that only 40% of cities in the 20,000-50,000 size range and almost half of Canada's largest cities were not on full metering. Several cities had no residential metering. The following table indicates the percentage of communities with full metering (assumed to be at least 90% coverage of residential users) for different size intervals.

Extent of Universal Water Metering by Canadian Municipalities - 1999⁷⁰

Municipality Size (Population)	# of Municipalities in Range	Municipalities with Full Metering
1,000 - 3,000	467	35%
3,001 - 5,000	200	26%
5,001 - 10,000	227	40%
10,001 - 20,000	200	48%
20,001 - 50,000	103	40%
50,001 - 200,000	71	59%
> 200,000	15	53%
Totals	1,283	38%

Environment Canada data showed that per capita water use within unmetered households was, on average, 70% greater than that observed within metered dwellings. Lack of metering is a handicap to both water users and water managers in implementing and monitoring water-use efficiency.

Both surveys show that more than 60% of Canadian municipalities continue to use pricing structures that do not encourage conservation, i.e. they are using declining block-rate or flat-rate pricing. By comparison, a recent U.S. Environmental Protection Agency (US EPA) survey indicated that more than 70% of American municipalities with populations greater than 10,000 were using either increasing-block or uniform-rate volumetric pricing⁷¹. In the U.K (England and Wales), flat-rate pricing predominates as only some 25% of households are metered⁷². Most U.K. commercial, industrial and institutional customers are metered and do pay volumetric rates.

Many Canadian communities appear to rely solely on outreach and education measures to manage and reduce the seasonal demands of turf and landscape irrigation and other outdoor water

usage. Only 57% of the municipalities surveyed by CMHC indicate they have watering restrictions in place and some of these may not have bylaws in place to enforce compliance.

Practicable measures for responding to these and other issues are addressed in the following analysis. The discussion begins with an examination of the role of system-wide or comprehensive planning and then looks at observed best practices on a program component basis. It concludes with an examination of practices specifically applicable within the residential/domestic and ICI sectors.

5.2.2 Comprehensive or System-Wide Program Planning

It stands to reason that all municipalities would benefit from following a systematic conservation program development and implementation process. The process assesses driving forces, defines objectives and targets, evaluates a range of possible conservation measures, selects a preferred approach, monitors progress, and adapts to new information and opportunities. This approach is common in the United States where the US EPA has developed program planning guidelines the depth of which varies according to community size⁷³. The guidelines are directed at utility managers and adherence to them is not a legal requirement under federal law.

The involvement of both in-house and outside water supply specialists and customer representatives in program design provides greater assurance that the recommended conservation program is well thought out and is likely to receive broad public support. Case studies highlighted at the end of the section illustrate the multi-dimensional nature and accompanying results of programs being implemented in a range of U.S., Canadian and other cities.

Several larger Canadian municipalities are successfully using processes similar to those found south of the border. Some of these are also highlighted as case studies at the end of the section. The CMHC in cooperation with the Canadian Water and Wastewater Association (CWWA) and others is in the process of finalizing a made-in-Canada system-wide planning tool for municipal water managers⁷⁴. The resulting Water Efficiency Plan Template will provide Canadian municipalities with information on a range of useful conservation measures. It will include documentation of the potential water savings, anticipated costs and probable payback periods associated with each measure.

The following best practice guidelines were adapted from the EPA model with added consideration given to addressing watershed influences, the risks associated with climate change and variability, and the long-term costs of infrastructure renewal.

Best Practice: Water Conservation Program Planning Guidelines for Municipal Water Systems

Step	Description
Establish preliminary water conservation goals and targets	<ul style="list-style-type: none"> Define preliminary goals and targets in terms of anticipated benefits for the water system and its customers. Involve the local community and customers and consult with watershed stakeholders as required.
Describe the current water supply system and its operating environment	<ul style="list-style-type: none"> Describe the design and operating characteristics of the existing water supply system. Highlight conditions and issues relative to water availability, competing water uses, wastewater collection and treatment system capacity, climate change and variability, current water taking approvals, and any other factors that could have implications for conservation planning and implementation.
Prepare demand forecasts	<ul style="list-style-type: none"> Develop forecasts of anticipated water demand for selected time periods out to and beyond 20 years. Take into consideration potential changes in customer (i.e. residential, commercial, industrial and institutional) profiles and demands.

	<ul style="list-style-type: none"> Factor in water demand forecasts for other water users/uses sharing the same source of supply.
Evaluate needed improvements to existing facilities	<ul style="list-style-type: none"> Summarize and cost out improvements to the water and wastewater systems that would be required in the absence of additional conservation measures. Include both capital and operating costs including cost projections for water distribution and sewage collection Infrastructure renewal.
Identify conservation measures	<ul style="list-style-type: none"> Develop a list of planned and potential conservation measures having regard for experiences in other similar systems.
Evaluate anticipated costs and benefits	<ul style="list-style-type: none"> Calculate the anticipated costs of implementing each potential conservation measure and assess the expected water savings. Rank potential measures based on cost-effectiveness.
Select the preferred measures	<ul style="list-style-type: none"> Develop the preferred suite of measures using cost-effectiveness and other criteria such as budgetary considerations, ratepayer impacts (fairness and affordability), environmental impacts, and linkages to other programs such as source protection and energy conservation.
Modify demand forecasts and servicing plans	<ul style="list-style-type: none"> Revise existing water and wastewater servicing plans taking into consideration the anticipated benefits and costs of implementing the conservation measures.
Develop the implementation strategy	<ul style="list-style-type: none"> Develop a strategy and timetable for implementing the conservation plan and integrate them with the system improvement and expansion plans. Incorporate performance reviews of conservation measures effectiveness and adjust plans and programs as required.

Using the EPA guidelines as a starting point, the State of Maryland has made comprehensive water conservation planning a requirement for all municipal water supply systems serving 10,000 or more persons and for some smaller systems as determined on a case by case basis⁷⁵. The planning requirements are codified in the *Maryland Water Conservation Act 2002*. Several conservation measures are required elements of the municipality's plan. These include full metering, water accounting and loss control (leak detection and correction), conservation pricing, and outreach and education programs. Other measures are designated recommended elements including user-specific water audits, plumbing retrofits, rebates and incentives, water re-use and recycling, pressure management, and outdoor water-use regulations.

The City of Toronto Water Efficiency Plan (2002)⁷⁶ (overviewed in the following table) and the BC Capital Region Strategic Plan for Water Management (2004)⁷⁷ were developed following processes similar to the above.

Comprehensive Planning Case Study: City of Toronto Water Efficiency (WEP) Plan (2002)

Program Overview and Targets	
<ul style="list-style-type: none"> Toronto's population is projected to grow to 2.86 million by 2011 (10% increase from 2001). Annual (2000) average day and peak day water demands are 1,258 ML/d and 1,700 ML/d respectively. Water and wastewater infrastructure expansion to accommodate this growth had been estimated to cost \$220 million. The WEP alternative is being implemented over an 11-year period at a cost of \$74.3 million (includes incentives and program support costs). Water reduction targets were set by City Council at 15% of both the peak day and annual average day water demands and 15% of the wastewater flows that would otherwise occur at 2011 in the absence of efficiency measures. Reduction targets include savings attributable to Ontario Building Code requirements for use of water-efficient plumbing fixtures in new construction. WEP focuses on 7 measures deemed to be 'technically feasible, applicable and socially acceptable'. The initial list contained more than 70 measures identified from a review of practices in other jurisdictions. It was subsequently shortened to 21 'potentially acceptable' measures. 'Best management practices' previously committed to and not included in the list of 7 WEP measures include universal metering, ongoing meter calibration and replacement, watermain rehabilitation, 	

public education, and enhanced school programs.

Measures Selected for Immediate Implementation

Category	Description	Timetable (Cost)
Municipal	<ul style="list-style-type: none"> - Leak detection - Computer controlled irrigation - Watering restrictions (as needed) 	<ul style="list-style-type: none"> - 2004-05 (\$0.5M) - 2003-2007 (\$2.0M) -
Single-Family Residential	<ul style="list-style-type: none"> - Toilet replacement (includes low-flow faucet aerators and showerheads where applicable) - Clothes washer replacement - Outdoor water audits 	<ul style="list-style-type: none"> - 2002-11 (\$18.7M) - 2003-07 (\$3.0M) - 2003-11 (\$11.0M)
Multi-Unit Residential	<ul style="list-style-type: none"> - Toilet replacement (includes low-flow faucet aerators and showerheads where applicable) - Clothes washer replacement - Outdoor water audits 	<ul style="list-style-type: none"> - 2001-07 (\$16.8M) - 2003-11 (\$1.5M) - 2003-11 (\$1.8M)
ICI	<ul style="list-style-type: none"> - Toilet replacement (includes low-flow faucet aerators and showerheads where applicable) - Clothes washer replacement - Outdoor water audits - Indoor water audits 	<ul style="list-style-type: none"> - 2002-11 (\$7.1M) - 2003-11 (\$0.7M) - 2003-11 (\$1.1M) - 2003-11 (\$1.6M)

Measures Selected for Further Consideration

Category	Description	Remarks
Municipal	- Pressure modulation	
Residential and ICI	<ul style="list-style-type: none"> - Rainwater re-use - Xeriscaping - Conservation rate structures - Seasonal pricing - Grey water re-use 	<ul style="list-style-type: none"> - City has focused on harmonizing rate structures that existed prior to amalgamation. A rate study is planned. - Use of grey water for domestic purposes is currently prohibited by the Ontario Building Code.

Municipal Case Studies: Comprehensive Conservation Programs

Municipality	Description	Results
CANADA		
Capital Region District, BC ⁷⁸ (Pop'n 319,000)	The CRD began a comprehensive program of water conservation measures in 1994.	Current total per capita water use inclusive of all domestic and ICI uses averages 538 L/d. Average year-round domestic use is 380 L/cap/d. Average winter domestic use is 281 L/cap/d. The current volumetric water rate in Victoria is uniform at \$0.513/m ³ . Other CRD municipalities have uniform rates ranging from \$0.424/m ³ in Oak Bay to \$1.013 /m ³ in the Western Communities
Association of Manitoba Municipalities (AMM)	The AMM has developed and published water efficiency booklets for small and medium sized communities, motels/small hotels, schools, water plant operators and hospitals . Funding was provided through the provincial Sustainable Development Innovations Fund.	

Barrie, ON (Pop'n 115,000)	<p>The City initiated its Water Conservation Program in 1995 in partnership with the Ontario Clean Water Agency and MOE. The goal is to reduce water use by an average of 50L/day per person across 15,000 households.</p> <p>Components include free distribution of a Water Efficiency Handbook, adoption of a restrictive lawn watering bylaw, provision of rebates for residential toilet, showerhead and washing machine retrofits/replacements, use of mandatory metering, and adoption of an increasing block-rate structure for all residential users.</p>	<p>As of 2002, 15,000 ultra-low flush (ULF) toilets had been installed and 3000 washing machine rebates awarded.</p> <p>Monitoring results indicate that ultra low flush toilets have created water savings of 62 L/cap/d in targeted households. System-wide savings equal 55L/cap/d. The combined efforts have saved the City \$ 17.1 million in net deferred capital expenditures.</p>
Union Water System, Ruthven, ON ⁷⁹ (Pop'n 53,000)	<p>The Union W.S. serves 7 communities, several food-processing plants and a number of greenhouses. By mid 1990s, system was capacity was exceeded by combined consumer demands in late summer. A comprehensive program was started including installation of full metering and low-flow showerheads in the two largest communities, promotion of water-efficient landscaping, initiation of a leak detection/correction program, and subsidization of rain barrel purchases.</p>	<p>Sustainable demand-supply conditions were restored and need for expansion was deferred.</p>
Lunenburg, NS ⁸⁰ (Pop'n 2,570)	<p>Residential services are currently unmetered with flat rate pricing. Commercial and industrial users pay declining block rate charges ranging from \$0.50/m³ for usage up to 1.5 million gallons/month to \$0.088/m³ for usage in excess of 2.5 million gallons/month.</p> <p>A 3-year town/province pilot program started in 2001. Program seeks to reduce water pollution, safeguard sewage system and conserve water. It involves residents, businesses and institutions. Water conservation initiatives focus on home "tune-ups" (evaluations, recommendations and conservation kits), a green-business network and xeriscape demonstrations. The pilot is intended to serve as a model for other NS communities.</p>	
OTHER		
City of Albuquerque, NM (Pop'n 472,000)	<p>The City's goal is to reduce water usage by 40% by 2014.</p> <p>To achieve this, it is using a mix of regulatory, outreach and incentive measures.</p> <p>Water Conservation and Water Waste Ordinance:</p> <ul style="list-style-type: none"> - defines water waste as any water, other than natural precipitation, that flows from one person's property to the public right-of-way or to an adjacent property - penalties range from \$20 for a first offence up to \$1000 per occurrence - upon the 8th violation, a flow limiter is installed on the water service allowing only enough water for basic drinking water and sanitation 	<p>Water usage dropped from 250 US gallons per capita per day when the program began in 1995 to 193 US gpcd in 2003. Residential demands, which account for nearly 70% of total usage, decreased by 32% over the period.</p> <p>Uptake to date has included:</p> <ul style="list-style-type: none"> - 50,000 toilets - 2,000 xeriscape conversions covering more than 3,000,000 square-feet - 6,000 washing machines - 9,000 residential water audits and retrofits - 23,000 multi-family unit customer

	<p>needs.</p> <p>Time-of-Day Watering Ordinance: - watering is not permitted between 10am and 6pm from April 1 to Sept 30.</p> <p>The City has one of the US's most comprehensive incentive programs. Each household can obtain a free water audit and free installation of low-flow shower heads, high-efficiency faucet aerators, auto-shutoff hose nozzles and a toilet dam.</p> <p>Several water-efficiency rebates are offered including: - low-flow toilets (\$125 US / toilet) - washing machines (\$100 US / machine) - dishwashers - rain water barrels - sprinkler timers - xeriscaping (\$800) - hot water recirculation units</p> <p>Commercial and residential customers are also eligible for rebates.</p>	audits and retrofits
Phoenix, AZ (Pop'n 1.4 million)	<p>The City initiated its first water conservation program in 1982. The current (1998) program involves 15 components. The city has universal metering, a multi-media public and school education program, promotes wastewater re-use for irrigation and industrial uses, has turf limitation bylaw, has xeriscaping requirements for public areas, and requires water recycling in water features. Volumetric charges increase according to season.</p>	<p>Total per capita water use inclusive of all domestic and ICI uses is 204 US gal/d (772 L/d). Domestic use averages 170 US gal/cap/d (643 L/cap/d). Current volumetric charges are \$ 0.46/m³ US (Dec-Mar), \$ 0.54/m³ US (Apr-Nov) and \$ 0.69/m³ US (Jun-Sep).</p>
Lompoc, CA ⁸¹ (Pop'n 42,000)	<p>The City has universal metering, uses an extensive multi-media education; distributes water conservation kits; has comprehensive bylaws imposing watering restrictions, prohibiting use of potable water for washing driveways and sidewalks, requiring positive shut-off hose nozzles, and prohibiting serving of water in a restaurant except upon customer request; requiring mandatory use of ultra low-flow fixtures in new construction; and promoting gray water re-use.</p>	<p>The current uniform volumetric water rate is \$ 0.706/m³ US.</p>
Los Angeles, CA ⁸² (Pop'n 3,800,000)	<p>The City initiatives include universal metering (since the early 1900s), an extensive multi-media education program, 20% higher water rates in summer, mandatory installation of low-flow showerheads and toilet dams, toilet and clothes washer replacement rebates, water audits, xeriscaping directives, low-interest loans for conservation upgrades, and wastewater reclamation and re-use.</p>	<p>In the past decade the LA Dept of Water and Power has invested \$100 million US in water conservation measures. It expects to invest a similar amount over the next ten years. Current per capita water use inclusive of all domestic and ICI uses is 155 US gal/d (587 L/cap/d).</p>
St. Petersburg, FL ⁸³ (Pop'n 250,000)	<p>City has universal metering, watering restrictions with a complaint hotline, requires rain sensors for automated sprinkler systems, distributes water conservation kits, has public and school-based education</p>	<p>In spite of population increases, total average annual water use dropped by 21% between 1998 and 2001. Current per capita water use inclusive of domestic and ICI uses is 131 million</p>

	programs, requires low-flow fixtures in new construction, operates a large wastewater reclamation and reuse system, and promotes gray water systems for outdoor lawn and landscape uses.	US gal/d (496 ML/d). The City's wastewater reclamation system treats and pipes 36.9 million US gal/d (140 ML/d) of reclaimed water to 10,483 residential and commercial customers. It is used solely for lawn and landscape watering.
Cary, North Carolina ⁸⁴ (Pop'n 100,000)	City initiated its program in 1996 with a goal of reducing overall per capita water use 20% by 2015. It includes wastewater reclamation and re-use (for irrigation and cooling), public education, toilet-flapper rebate, outdoor water-use ordinance, rain sensor ordinance, residential water audits, increasing block-rate pricing, and developer incentives for water-efficient building projects.	Water plant expansion has been deferred and City expects to comfortably meet its water savings goal.
Massachusetts Water Resources Authority ⁸⁵ (Pop'n 2.2 million in 46 cities, towns and water districts)	Prior to the late 1980s the MWRA was exceeding the safe yield of its water sources and was considering large scale water diversion and treatment plant expansion options. They ultimately decided to implement a comprehensive conservation program and only proceed with the capital works as required. The program included leak detection and correction, low-flow retrofits (730,000 homes), metering upgrades, conservation pricing, 6L toilet regulation (by the State), and public and business outreach and education.	Average daily system-wide demand was reduced by 24%. Treatment plant expansion did proceed but with a reduced design capacity. The river diversion plan was deferred for at least 20 years.
New York City, NY ⁸⁶ (Pop'n 18.6 million)	A 1992 study identified conservation as the preferred alternative in solving the City's problems of water supply shortages and excess flows at its wastewater treatment plants. These problems had been ongoing since the mid 1970s. The main elements of the program are completion of full metering, public outreach and education, free plumbing retrofits, leak detection and repair, and replacement of 1.3 million toilets with 6L models.	Water savings attributed to each element include: - Full metering: 200 mgd (US) - Leak repair: 40 mgd (US) - Toilet replacement: 75 mgd (US) Overall per capita water use declined 14% from 738 L/d in 1991 to 632 L/d in 1998. Customers received savings of 20-40% on their water and wastewater bills.

5.2.3 Engineered and Technology-Based Measures

Engineered or technology-based water efficiency measures are arguably the most effective tools for reducing total water demand and usage. These include full metering, leak detection and correction, scheduled watermain replacement, distribution-system pressure modulation, water efficient plumbing fixtures, water-efficient manufacturing and commercial processes, water-efficient turf and landscape irrigation systems, more-efficient backwashing of water treatment plant filters, and wastewater reclamation and reuse.

Canadian municipalities generally lag behind communities in other study jurisdictions in the promotion and use of engineered and technology-based solutions. Opportunities for expanding their use across the country appear less limited by feasibility and affordability than they are by the perception that the need, benefits and public acceptance are not there. Hopefully, the CMHC-sponsored conservation program-planning template referred to in the previous section will provide much needed assistance to water managers in responding to these roadblocks. Renewed outreach and education efforts will be important in convincing municipal councils and customers to take action.

Water recycling and wastewater reclamation and reuse can be used to supplement or replace the use of municipal drinking water or freshwater takings for certain applications. These range in scope from the household-level reuse of grey water for toilet flushing and outdoor uses to much larger schemes involving the use of wastewater treatment plant effluents for golf-course irrigation and industrial applications. Current building code regulations in most Canadian provinces prohibit wastewater and even rainwater use in situations where any possibility of a cross-connection to, or confusion with, the potable supply system exists. Limited use of treated wastewater in golf course irrigation is reported in a few provinces. The ongoing wastewater reuse research findings and guidance available from the WaterReuse Foundation in the U.S warrant monitoring. The organization is focused on expanding the beneficial use of reclaimed waters while addressing the concerns for public health and safety⁸⁷.

A survey of utility experiences as reported in the CWWA Water Efficiency Experiences Database, indicated that conversion to full metering was most frequently cited as the most effective measure undertaken for reducing overall water demand within their community or service area⁸⁸.

Municipal Case Studies: Engineered and Technology-Based Conservation Measures

Municipality	Description	Results
CANADA		
Various cities, BC ⁸⁹	Universal metering is common to many BC cities. The list includes the Capital Region District, Chilliwack, Kelowna, Nanaimo, Prince George (planned), and Vernon. The Greater Vancouver Regional District and Kamloops do not have mandatory metering for residential users.	
Kamloops, BC ⁹⁰ (Pop'n 77,300)	The City set a target of reducing peak period water use by 15% between 1992 and 1997 to be achieved mainly through outdoor watering restrictions. City sponsors an "aquonomics" course in elementary schools. Universal metering was rejected by city residents in an Oct 2001 referendum. This contradicted a city Water Use Efficiency Committee conclusion that universal metering was "the single most cost effective method of achieving more efficient water use..".	Average water usage in peak summer months has been reduced by 21%. Electrical energy savings = \$ 100K per year
Vernon, BC ⁹¹ (Pop'n 36,000)	Since 1977, the city's treated wastewater has replaced freshwater used in agricultural, forest nursery, golf course and playing field irrigation. System operates 125 days per year.	Wastewater reuse replaces 16,000 m ³ /day of freshwater supply. No effluent is discharged to Okanagan Lake when system is operating.
Whitecourt, AB ⁹² (Pop'n 8,000)	Installation of individual water meters in a 150-unit (500 persons) trailer park. The project was a response to data showing that the park development was using 25% more water per unit than the rest of the town.	Average water use declined by 24%. The trailer park's per capita water use dropped to approx. 175L/d.
Strathmore, AB ⁹³ (Pop'n 7,250)	Installation of a non-potable water system for lawn watering. The piped distribution system takes water from irrigation ditches adjacent to the town for delivery to 800 of 2,300 homes. All new development is required to install the	Conversion to non-potable water for outdoor use has deferred the need to expand the town's treated water system.

	necessary piping. Water use is charged at a flat rate.	
Gimli, MB (Pop'n 1,575)	In 1996, the Town installed water meters and carried out toilet retrofits in all residences at no direct cost to homeowner. Volumetric pricing was also introduced.	Water usage decreased by about 25% in the year following completion of the changes.
Rural Municipality of St Andrews, MB ⁹⁴ (Pop'n 10,000)	Water-efficiency measures pilot study. Project involved installation of dual-flush toilets and low-flow showerheads in 40 homes along with detailed before and after metering of actual water usage at various points in the home.	There was an average 46% (pre to post) reduction in total toilet flush volumes. While no savings were achieved through showerhead replacement it was noted that most homes were already using low-flow models. Clothes washers replaced toilet use as the largest indoor water use after toilet replacement. Homes already using front-load washers were using 20-30% less wash water than those using top-load machines. Water used in the regeneration of water softeners (found in 80% of the homes) accounted for 16% of total indoor use. Outdoor water uses accounted for half of overall household water use during the summer monitoring period. Domestic per capita water use declined from 174 L/day prior to the improvements to 149 L/day after, i.e. by about 15%.
Saugeen Shores, ON ⁹⁵ (Pop'n 6,500)	Former Town of Port Elgin installed metering on all 2,400 residential and commercial units. There was also a 70-80% voluntary installation of low-flow showerheads and faucet aerators . The cost of meters was recovered through a 2-year levy on property taxes.	Water plant expansion (est. to cost \$5.5 M) has been deferred indefinitely. Annual cost savings at the town's water and wastewater plants amount to \$12K
Fredericton, NB (Pop'n 47,600)	In 2004, the City passed a bylaw requiring that water services to all premises be metered . The current volumetric charge is \$0.49/m ³ .	
Pasadena, NL ⁹⁶ (Pop'n 3,450)	A 1996 study led to the initiation of a pilot study involving metering , the installation of water conservation kits , and the distribution of educational materials.	Average household water demand dropped by 20% immediately following meter installation and was 43% lower after installation of the water-saving devices.
OTHER		
Gallitzin, PA ⁹⁷ (Pop'n 2,000)	During the early 1990s the Town was experiencing water losses of over 70%. In 1994 it initiated a leak detection and correction and corrosion control program . Town staff located 95% of the leakage and retained an outside contractor to find the remainder.	By 1998 water use had decreased by 60% and losses were reduced from 70% to 9% of total pumpage. Annual energy costs were reduced by \$20,000 and chemical costs by \$5,000.
Hillcrest Park Condominium Complex, Albuquerque, NM ⁹⁸	Modifications were made to the 268 unit apartment complex originally built in 1972. These included installation of ultra low flow toilets, low-flow showerheads, and xeriscaping. The automated sprinkler system sprayheads were converted to bubblers and misters.	Between 1994 and 1998, when the changes were completed, water use had declined by 31%.
Connecticut, Massachusetts,	These states now require or empower individual communities to require the	

Michigan, Minnesota, New Hampshire, Rhode Island, Vermont and most southern States	mandatory installation and use of rain sensor shutoffs on automatic lawn and landscape irrigation systems.	
Colorado, Florida, Idaho, Louisiana, Nevada, New Jersey, New York, North Dakota, Texas	These states have introduced mandatory training and certification requirements for irrigation-system designers and installers . Training includes exposure to information on BMPs for irrigation-system design, set-up and maintenance, on drought tolerant plant selection, and on xeriscaping.	
All New Mexico communities	Homeowners may use 946 L/d of their gray water for residential landscape irrigation. This includes water from baths, showers, bathroom sinks and clothes washers.	
Yarra Valley Water, Melbourne, AU (Served pop'n 1.5 million)	Yarra serves northern and eastern Melbourne and surrounding suburbs. In addition to implementing Stage 1 and 2 water-use restrictions imposed by the State of Victoria, Yarra has implemented leak detection and repair, pressure management and treated wastewater recycling programs.	Water use has been reduced by 21% since the mid 1990s. Yarra is recycling 20% of treatment plant effluent for reuse.

5.2.4 Bylaws / Ordinances

Municipal bylaws are an effective tool for regulating certain types of water use in the absence of or as a complement to provincial/state regulations. The most common conservation application is in restricting the timing, level and types of outdoor water use. Many Canadian municipalities have successfully (i.e. with broad public acceptance and voluntary compliance) enacted bylaws that restrict lawn watering to certain hours of the day and alternating days of the week. Some municipalities enforce these provisions throughout the entire summer season while others implement them on an as needed basis. The power to enforce an outright ban on all outdoor uses in the event of an emergency low-water situation is commonly included. While monetary penalties for non-compliance are also common, enforcement action is usually taken on the basis of complaints received. Good examples of such bylaws are available on the municipal websites of cities and towns in most provinces.

In provinces that have not yet enacted regulations governing the use of low-volume plumbing fixtures in new and retrofit construction, some municipalities, e.g. Victoria, BC, have introduced bylaws requiring their use. Sewer-use bylaws put in place by some Canadian communities to safeguard the sewer system and wastewater treatment facility can also have a positive impact on moderating water usage by industries and commercial establishments.

In the United States, the typical municipal conservation ordinance reaches well beyond its Canadian counterpart although the primary focus is still on restricting outdoor uses and reducing peak demands. Many communities have enacted ordinances regulating the efficiency of in-ground landscape irrigation systems. Specific provisions observed among the study jurisdictions and a sampling of other states include certification and conservation training requirements for systems designers and installers, mandatory use of rain sensors, and restrictions on the proportion of a lot that can be devoted to grass. A growing number of states including many in the temperate northeast have taken action to enact some or all of these provisions on a statewide basis. Given the growth in the use of in-ground irrigation systems by landowners in some Canadian municipalities, introduction of

bylaws requiring the use of rain sensors and possibly the certification/training of irrigation-system designers and installers may warrant consideration.

The (U.S.) Irrigation Association has developed a Water Action Guide to help state legislators introduce legislation aimed at statewide adoption of more efficient landscape irrigation practices. The guide contains model legislation dealing with system design requirements, designer and contractor certification, restrictions on days and hours of use, and conservation-oriented rate structures.

Municipal Case Studies: Water Conservation Bylaws

Municipality	Description	Results
CANADA		
Greater Vancouver Regional District, BC ⁹⁹ (Pop'n 2.1 million)	Outdoor watering restrictions . GVRD also uses extensive outreach and education efforts aimed at residential and ICI customers. Residential / domestic water use is <u>not</u> metered. Current average annual water use is 580 L/cap/d inclusive of all domestic and ICI usage.	Since watering bylaw restrictions were introduced in 1993, average annual water use has declined by 15% and peak usage by 25%.
Barrie, ON (Pop'n 115,000)	City bylaws establish a restrictive lawn watering schedule and use of an increasing block-rate structure for all residential users .	
OTHER		
City of Lompoc, CA ¹⁰⁰ (Pop'n 42,000)	The City of Lompoc has one of the most comprehensive sets of bylaws observed among the jurisdictions studied. City bylaws impose watering restrictions, prohibit the use of potable water use for washing driveways and sidewalks, require positive shut-off hose nozzles, prohibit serving water in a restaurant except upon customer request, require mandatory use of ultra low-flow fixtures in new construction; set rules for gray water re-use.	
City of Albuquerque, NM (Pop'n 472,000)	Water Conservation and Water Waste Ordinance: - defines water waste as any water, other than natural precipitation, that flows from one person's property to the public right-of-way or to an adjacent property - penalties can range from \$20 for a first offence up to \$1000 per occurrence - upon the 8 th violation, a flow limiter is installed on the water service allowing only enough water for basic drinking water and sanitation needs. Time-of-Day Watering Ordinance: - watering is not permitted between 10am and 6pm from April 1 to Sept 30.	
Melbourne, AU ¹⁰¹ (Pop'n 3.4 million)	Under permanent water restrictions in force since March 1/04, watering of private and public lawns and gardens is restricted to the hours 8pm-10am, all hoses must be fitted with a trigger nozzle, and no concrete or paved surface can be hosed.	The city's water use has been reduced by 19% since the mid 1990s.
(U.S.) Irrigation Association	The IA has developed a ' Water Action Guide ' to help state legislators enact laws requiring statewide adoption of water-efficient landscape irrigation practices . The guide contains model legislation on irrigation system design standards, designer and contractor certification, bylaw restrictions on days and hours of use, and conservation-oriented rate structures.	

5.2.5 Economic Instruments

To date, most Canadian municipalities have used a relatively limited range of economic instruments to support conservation efforts. The most commonly used tools are full or partial customer rebates for water meter installation and plumbing fixture conversion. Some larger municipalities have provided funding assistance to industrial, commercial and institutional water users for the implementation of comprehensive water audits.

Pricing strategies applied to water and wastewater services have generally targeted recovery or partial recovery of capital and operating costs rather than conservation objectives. Even in situations where increasing block-rate structures are being used, the cost differentials may not be of sufficient magnitude to significantly impact water demand. Concerns over public acceptance and business-sector impacts of increasing block-rate pricing appear to have caused some municipal councils to not go beyond uniform-rate structures in pricing reform. While the potential impacts of increasing block-rate pricing structures on low-income households requires further consideration, there appears to be little or no underlying rationale to support the continued use of flat-rate and declining block-rate pricing. The conclusions and recommendations of the Federation of Canadian Municipalities with respect to water conservation needs and directions support this view¹⁰².

Continuing the pursuit of full-cost accounting and full-cost recovery in connection with the long-term provision, protection and rehabilitation of water and sewage services may be a more significant and necessary undertaking than independent pricing actions taken in the more limited context of conservation. In this regard, legislative initiatives underway in Ontario warrant watching. When the final regulations are promulgated to bring the full-cost recovery provisions of the *Sustainable Water and Sewage Systems Act (2002)* into effect, consumer water prices imposed by Ontario municipalities are likely to continue the ascent seen in recent years. The Act includes provisions for the recovery of source protection planning costs. Under pending source protection planning legislation these costs will include all studies and monitoring needed to establish the sustainable level of water taking (i.e. a water balance) on a watershed basis. At some point, a price level may be reached where consumers find it necessary or worthwhile to take additional actions to reduce demand.

Municipal Case Studies: Achieving Conservation through Economic Instruments

Municipality	Description	Results
CANADA		
Nanose Bay, BC ¹⁰³ (Pop'n 4,500)	Residents requested increasing block rate pricing to discourage excessive summer outdoor use and bring equity in the distribution of water service costs. Pricing program is supported by staged watering restrictions.	Water-use rates are: -\$0.49/ m ³ for first 0.88 m ³ -\$0.98/ m ³ for 0.98-2.22 m ³ -\$1.47/ m ³ for use >2.22 m ³ /day
Nanaimo, BC ¹⁰⁴ (Pop'n 72,000)	City has had full metering and an Increasing block rate since 1978.	Water-use rates are: -\$0.31/ m ³ for first 0.66 m ³ /d -\$1.41/ m ³ for 0.67-1.00 m ³ /d -\$1.65/ m ³ for use >5.0 m ³ /d
Greater Vancouver ¹⁰⁵ Water District (Pop'n 2.1 million)	GVRD has initiated a study to examine the feasibility and implications of introducing seasonal water rates at the wholesale and retail levels.	
Barrie, ON (Pop'n 115,000)	The City uses an increasing block-rate pricing structure for all residential users.	

OTHER		
Albuquerque, NM (Pop'n 472,000)	In the mid 1990s the City set a goal of reducing total water usage by 40% by 2014. The program focuses largely on indoor and outdoor retrofits supported by sizeable rebates . Rebates ranging from \$100 to \$800 US (up to \$5000 for businesses) are available for conversions to low-flow toilets, low-use dish and clothes washers, rain barrels, hot-water recirculation units, sprinkler timers and xeriscaping. Free water audits for homes and apartments are also offered along with free installation of low-flow showerheads, faucet aerators, auto-shutoff hose nozzles, and toilet fill-tube diverters or toilet dams . City also provides xeriscaping design templates and conducts regular conservation seminars.	Total (i.e. inclusive of all domestic and ICI usage) per capita water use dropped by 23% between 1995 and 2003. Current use is about 193 US gal/cap/d (730 L/cap/d). Residential water use declined by 32% over the same period
Los Angeles, CA ¹⁰⁶ (Pop'n 3,800,000)	LA uses a seasonal pricing structure. Volumetric rates are 20% higher in summer	
Yarra Valley Water, Melbourne, AU (Served pop'n 1.5 million)	Yarra serves northern and eastern Melbourne and surrounding suburbs. In 2004, Yarra implemented increasing block-rate pricing .	Water rates are: -\$0.75/m ³ for up to 40m ³ /quarter -\$0.88/m ³ for 40-80m ³ /quarter -\$1.30/m ³ for use >80m ³ /quarter The other 2 public water retailers serving Melbourne have similar rates.
New South Wales, AU	Water efficiency improvements are provided free of charge to low-income households.	

5.2.6 Outreach and Education

Education and outreach are important in a political environment that generally favours voluntary over regulatory approaches as a means of influencing public attitudes and actions on sustainable resource use.

All across Canada, federal, provincial/territorial and local governments have been active for some time in informing homeowners and businesses about water-use efficient technologies and practices. The missing piece in most of these efforts is stronger messaging around the need for and benefits of action. Attention should be drawn to locally and regionally relevant examples of water shortages experienced over recent years, water resources threats posed by climate change, impending conflicts associated with projected/desired population growth and economic development, threats to the health of aquatic ecosystems, and the role of water conservation in reducing energy costs.

Municipal Water Conservation Case Studies: Outreach and Education Measures

Municipality	Description	Results
CANADA		
BC Power Smart Program ¹⁰⁷	Comprehensive multi-municipality \$15M program focusing on reducing gas, electricity and water use in the home. Water savings target was 3.8 million m ³ annually. Trained contractors offered free one-hour in-home audits ending with recommendations for action. Each inspected home was provided with a free toilet-flow reducer or low-flow showerhead. The communications program included ads on TV, radio and buses, ads in newspapers and magazines, and bill inserts. Promotion was also done in shopping malls and at special events.	Neighbour to neighbour and friend to friend word-of-mouth was found to be the most effective tool for getting people to enroll in the audit program. \$ 0.9 M or 6% of total program cost was spent on advertising and promotion.

Greater Vancouver Regional District, BC ¹⁰⁸ (Pop'n 1,800,000)	GVRD conducts annual water-use efficiency seminars for landscape and irrigation professionals . Partners include the BC Nursery Trades Association, Irrigation Assoc'n of BC, Western Canada Turfgrass Assoc'n and BC Society of Landscape Architects.	
Regina, SK (Pop'n 178,000)	With the intent of deferring expansion of its wastewater treatment facilities, the City introduced a summer water conservation public awareness campaign in 1988. It promotes a plan of voluntary watering restrictions and includes information and demonstrations on xeriscaping. Homeowners are also provided with tips on indoor efficiency measures.	Mean annual water usage has been reduced by 20% and peak usage by 25% since the late 1980s. A 1998 survey indicated that ¾ of city residents had initiated some level of conservation. Infrastructure expansion was successfully deferred.
Winnipeg, MB ¹⁰⁹ (Pop'n 600,000)	The City initiated its "Waterfront" outreach and information program in the early 1990s. It has also made home water conservation kits available, conducted water audits on industrial uses, and implemented a school program for middle year students. For several years, the City has also been imposing added water charges to create a funding reserve for construction of a treatment plant and for aqueduct improvements. The City continues, however, to use declining block-rate pricing.	The combination of actions has deferred indefinitely the need to proceed with previously planned expansions to the city's aqueduct and distribution system.
Montreal, QC ¹¹⁰ (Pop'n 1.82 million)	The City has identified inefficient water use as a concern specifically as it relates to the cost of water and wastewater services. City initiated a study to investigate measures for encouraging conservation within each of the domestic and ICI sectors .	
Halifax, NS ¹¹¹ (Pop'n 359,000)	A cooperative city-provincial " Home Tune-Up " program is helping homeowners improve energy and water efficiency. Involves a comprehensive environmental assessment and individualized information and recommendations . A water conservation kit is provided.	Data for 2002 showed that the city-wide water demand had declined by 6%.
Resort Municipality of Cavendish, PEI (Permanent pop'n 270)	Cavendish's large influx of tourists in the summer period puts a burden on local water and wastewater services. The municipality has initiated an education and awareness program aimed at expanding use of water efficiency measures and practices.	
OTHER		
Albuquerque, NM (Pop'n 472,000)	The City provides xeriscaping design templates and conducts regular conservation seminars .	
U.S EPA Water Star® Labeling Program	EPA has initiated the Water Star® product-labeling program aimed at informing and encouraging Americans to purchase water-efficient plumbing fixtures, appliances and other products.	
Phoenix, AZ; Los Angeles, CA; Lompoc, CA	These cities and many others among the U.S. study jurisdictions incorporate comprehensive, multi-media and ongoing outreach and education as an integral part of obtaining sustained public and business commitments to water conservation.	

5.2.7 Land Use Controls and Stormwater Management

Conservation of water resources can be assisted through land use planning and other measures not typically considered as part of the demand management spectrum. Planning controls such as the designation and protection of greenbelt areas, wetlands and woodlots and the placement of upper limits on the creation of impervious areas within a watershed, help to safeguard groundwater recharge mechanisms as well as reducing runoff rates. Stormwater infiltration augments shallow groundwater systems that are important for the protection of summer baseflows in rivers and streams. Such measures are now being successfully applied in urban and urbanizing watersheds in many parts of Canada particularly where provincial and local governments have adopted the integrated watershed approach.

5.3 NORTHERN COMMUNITY CONSIDERATIONS

5.3.1 Background

Municipal water services in Canada's more northern communities often differ markedly from those of their southern counterparts. This can impact on water usage patterns and conservation opportunities. Colder climates, shorter summer seasons, a smaller ICI customer base, along with the physical challenges and costs of constructing, operating and maintaining water treatment and distribution systems are contributing factors. The challenges are not unique to the Yukon, Northwest and Nunavut Territories. They are also felt in the northern regions of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Newfoundland and Labrador.

Residential/domestic per capita water use can be either higher or lower than in southern municipalities depending largely on the mode of water distribution. Communities are often served by a combination of above-ground, in-ground and trucked distribution systems. Household water usage in the range of 80-200 L/cap/day is common within those communities where water is trucked in bulk rather than being supplied through piped systems. Much higher domestic per capita demands, sometimes in excess of 500 L/day, have been observed in other areas where 'bleeders' are used to protect individual services and the distribution system from frost damage.

While source-water availability does not appear to be a major issue, conservation and efficient use are ongoing concerns primarily because of the high costs of treatment and delivery. With the range of delivery systems and limited metering, it is not surprising to see a range of pricing approaches. Flat rate pricing with quarterly billing is common among customers served by piped systems. Bulk-rate volumetric pricing is common where water is delivered by truck. The cost of water services along with constraints in storage capacity likely play a role in moderating demand among bulk users.

5.3.2 Current Approaches and Opportunities

The following discussion and guidance on water servicing practices in northern communities essentially represents a distillation of the most innovative of what is happening in the Canadian north. None of the other jurisdictions selected for comprehensive review offered useful parallels in terms of physical conditions. Nevertheless, some information and observations have been drawn from a quick review of current and emerging practices in Scandinavian countries. While not specifically discussed, more generic conservation practices seen in southern communities also have application in the north. This would include the use of low-flow plumbing fixtures, continuing outreach and education, water audits for ICI uses, and distribution system maintenance.

To date, the most commonly observed conservation efforts in Canada's northern communities include promotion of and support for water-efficient plumbing fixtures, customer education on ways

to avoid water wastage, and conversion of some customer services from continuous-flow to thermostatically controlled bleeders.

Municipal Water Conservation Case Studies: Northern Communities

Municipality	Description	Results
CANADA		
Fort Nelson and Northern Rockies RD, BC ¹¹² (Pop'n 4,700 in Fort Nelson only)	The RD uses flat-rate pricing tailored to the type of use. Bulk customers pay volumetric charges on a declining block-rate structure.	Sample quarterly rates are \$67 for a single family dwelling or apartment unit, \$308 for a restaurant seating over 40 people, \$427 minimum for a coin laundromat. Bulk rates range from \$10 per 1000 gallons down to \$5 / 1000 gals.
Iqaluit and Cape Dorset, NU ¹¹³ (Pop'n: Iqaluit 6,000, Cape Dorset 1,150)	Demonstration projects are underway in pilot households to examine the feasibility of reclaimed grey water for use in toilet flushing and laundry facilities. Objective is to reduce water demand and wastewater flow. Funding assistance is being provided by the Federation of Canadian Municipalities.	In Iqaluit, the objectives are to reduce water use by 50%, to cut the frequency of bulk water deliveries, and save the city \$34K per year.
Whitehorse, YK ¹¹⁴ (Pop'n 19,060)	Replacement of free-flowing bleeders with thermostatically controlled bleeder devices on some water services. Low-flow toilets required in new construction. With only partial metering there is a mixture of flat-rate and volumetric water charges.	Significant decrease in total demand after changes. Metered customers pay a uniform rate of \$ 0.91/m ³ . Flat rate customers pay \$35.20/month.
RM of Wood Buffalo, AB ¹¹⁵ (Pop'n 56,000, Fort McMurray only)	Uses an increasing block-rate structure	Residential rates are: - \$0.7887/ m ³ up to 11.5 m ³ /month - \$1.0494/ m ³ for next 11.5 m ³ - \$1.0771/ m ³ for use >23 m ³ /mo.
Yellowknife, NT ¹¹⁶¹¹⁷ (Pop'n 18,000)	The City has eliminated use of bleeders and implemented leak detection and repair . These efforts are supported by a public awareness program . It reduces its normal residential customer water rate from \$1.31 to \$0.66/m ³ during the months of June, July and August to "encourage citizens to maintain their lawns and gardens".	Bleeder elimination from approx 400 services created savings of \$600 K/yr. Leak repair has saved an additional \$150K/yr.

5.4 CONSERVATION PRACTICES WITHIN THE ICI SECTOR

Collectively, the commercial, institutional and industrial sectors served by municipal water utilities normally account for less than 30% of total municipal water usage. They can, however, represent an important water savings opportunity. There are also situations, particularly in more rural areas, where a single industry such as a food processor can account for 50% or more of municipal water usage and wastewater discharge.

5.4.1 Commercial and Institutional

Most commercial and institutional establishments and facilities are significant users of water. This includes schools, hospitals, office buildings, hotels, commercial laundries, automatic car washes and water theme parks. Water is used for drinking and sanitation and for a variety of operations such as cleaning, rinsing, heating and cooling. Many of these facilities are situated on sizable landholdings that include large landscaped areas served by in-ground irrigation systems.

Municipally Supplied Commercial / Institutional Water Conservation Case Studies

Enterprise / Municipality	Description	Results
CANADA		
Fairmont Hotels Canada ¹¹⁸ (Formerly CP Hotels) – 26 properties across Canada	Program involved equipping 15,000 hotel rooms with water-efficient fixtures . Ongoing guest and employee education program is included.	15% water saving was achieved at Royal York in Toronto. Annual cost savings equal \$250 K at this hotel alone.
C.K Choi Building Vancouver, BC	Building uses waterless composting toilets , waterless urinals , rainwater collection (used in the combined and automated sprinkler and drip irrigation system) and xeriscaping .	Entire 3-story building was designed to use less than 500 L of potable water per day. This water is used only in kitchen and washroom sinks. This represents a 93% water saving over a more conventional design.
St Mary's General Hospital, Kitchener, ON ¹¹⁹	St Mary's was only the second hospital in all of North America to develop and register its Environmental Management System to conform to ISO 14001 standard. Its 'green landscaping' initiative is based on use of drought tolerant native plants and a " no chemicals " policy.	
Diocese of Charlottetown Enviro Church Conservation Project	The Diocese is undertaking environmental assessments of church properties in 56 parishes. The program aims to reduce energy use, water consumption and wastewater production by 10%. Parishioners are being encouraged to undertake similar efforts in their homes.	
OTHER		
Marriott Hotel, Albuquerque, NM ¹²⁰	Water and energy efficiency improvements were made In keeping with the hotel chain's corporate commitments. Changes at the 411 room hotel included installation of toilet dams and low flow faucet aerators in guest rooms, replacement of laundry machines with high efficiency models, and improved maintenance to detect and correct leaks . Outside, existing trees and shrubs were replaced with drought tolerant species and the irrigation system was revamped to eliminate leaks, improve scheduling, and convert to drip methods wherever possible.	Water usage declined by 36.5% after the improvements.
Presbyterian Healthcare Services, Albuquerque, NM ¹²¹	The healthcare corporation operates a main hospital campus covering 16 city blocks and more than 20 other facilities in the area. Starting with an intensive internal water audit in 1995, the company has made a series of targeted changes. Largest savings have come from improvements to grounds irrigation including replacement of inefficient spray heads, improved scheduling, and automatic shutdown if a leak is detected . Indoor changes have included recycling of autoclave condensate and cooling water, replacement of water-cooled vacuum pumps with oil-cooled models, required shutoffs on x-ray developers, and water-efficiency retrofits of all public washrooms.	The cost of Irrigation system improvements was paid for with one year's water savings. Between 1994 and 1998 water usage declined by 19% and further improvements are expected.
International Car Wash Association	The association has prepared an in-depth manual on conservation measures for both new and	

	retrofitted automatic car wash facilities. Topics include design and operation of wash-water recycling systems, leak correction, efficient spray nozzle design, pressure control.	
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5.4.2 Industrial

Most value-added or secondary manufacturing industries locate in cities and towns where they have access to a steady workforce, their major markets and suppliers, and to municipal water and sanitation services. Canada's largest manufacturing interests including the transportation equipment sector (\$121 billion in 2003 shipments), food and beverage processors (\$75 billion), consumer products manufacturers (\$46 billion), the high-tech industry (\$19 billion), and machinery makers (\$25 billion) are typically situated within urban settings¹²².

Urban-based manufacturers often use significant amounts of water for cooling, steam production, processing, cleaning and rinsing and, in some cases, as a fundamental component in final products. They have similar interests to the self-supply water user in relation to the conservation of energy, the more productive use of raw materials, and the reduction of wastewater collection and treatment burdens. Since they pay directly and transparently for the water they use and for the treatment of wastewaters there is a more obvious incentive to use water more efficiently. The importance of this incentive is, however, often negated by the municipal use of decreasing block-rate structures or other preferential pricing for large volume users.

Municipally Supplied Industrial Water Conservation Case Studies

Municipality	Description	Results
CANADA		
Daimler Chrysler Windsor Assembly Plant, Windsor, ON ¹²³	Water-efficiency improvements included modification of paint sludge pit purge rates and an increase of cooling tower cycles.	Total annual water savings are estimated to be 12 million L from the paint sludge pit changes and 42 million L from the cooling tower improvements. Net cost savings are expected to be \$78,500 annually.
General Motors of Canada Oshawa Truck Plant, Oshawa, ON ¹²⁴	Water used for humidity addition in paint booths is being recycled for reuse rather than sewered.	Truck plant water use has been reduced by 45% resulting in a water savings of 700 million L annually.
Kingsway Eco-Industrial Park, Sudbury, ON (proposed)	Project to be developed on a 112-acre site calls for process water recycling and reuse for irrigation and potentially other non-potable uses.	
Humpty Dumpty, Brampton, ON ¹²⁵	Snack food producer's annual charges for water, wastewater and energy were approx \$1 million, 60% from over-strength wastes. Efficiency improvements focused on installation of in-house process and wastewater centrifuge systems, starch recovery and water recycling.	The water recycling capability alone has resulted in annual cost savings of \$100,000.
OTHER		
Industry-Specific Water Efficiency Fact Sheets, North Carolina	The NC Dept of Pollution Prevention and Environmental Assistance has developed water efficiency guides for the textiles, food processing and metal finishing industries.	
Intel Corp. ¹²⁶ U.S.	Recycling of treated process water and other control measures at a micro-chip production plant.	Annual water savings of 35% were achieved.

5.5 SYNTHESIS OF MUNICIPAL PRACTICES

The following represents a compilation of practices constituting a highly comprehensive municipal conservation and efficiency program. As discussed at the beginning of the chapter, such a far-reaching program might be considered where circumstances warranted it. Regardless of the appropriate scope of individual programs, municipal decision-making should begin with the evaluation of a full range of alternatives and ensure that the preferred solution adheres to the principles of effectiveness, efficiency and equity.

Best Practices: A Municipal Water-Use Efficiency Opportunities Checklist

Component	Description
Planning and Monitoring	<ul style="list-style-type: none"> • Make water conservation and efficiency municipal council and department priorities • Approach conservation planning and implementation in a comprehensive and systematic manner; seek and identify opportunities for continuous improvement • Prioritize water conservation and efficiency alternatives based on the expected returns on investment. • Commit to water savings targets, budgets and implementation timelines • Implement water-use audits and conservation planning for large-volume users • Monitor progress and report on accomplishments • Monitor conservation initiatives and best practices in other municipalities for adoption or adaptation
Technology	<ul style="list-style-type: none"> • Implement universal metering for all customers; commit to regular meter inspection and calibration • Minimize distribution system losses <ul style="list-style-type: none"> ◦ Leak detection and correction ◦ Pressure modulation ◦ Scheduled watermain replacement • Improve water-use efficiency in filter backwash cycles • Implement residential, commercial and institutional plumbing-fixture retrofits • Implement conservation measures at all municipally-owned facilities and properties • Seek opportunities for approved uses of reclaimed wastewater
Bylaws	<ul style="list-style-type: none"> • Select, as appropriate, from bylaws that: <ul style="list-style-type: none"> ◦ Require use of water-efficient plumbing fixtures, i.e. in the absence of jurisdiction-wide building code requirements ◦ Restrict lawn watering and other outdoor uses ◦ Require use of rainfall sensors and soil-moisture sensors for regulating the timing and duration of watering in automatic landscape irrigation systems ◦ Limit the creation of impervious areas ◦ Require use of xeriscaping and/or limit grassed area ◦ Impose pre-established, automatic demand reduction measures on all customers in the event of drought-related or other supply shortages
Economic Instruments	<ul style="list-style-type: none"> • Implement pricing for water and wastewater services based on full-cost accounting and full-cost recovery • Use an increasing block-rate pricing structure • Consider subsidies for upfront costs of metering, plumbing retrofits, water audits, etc
Outreach and Education	<ul style="list-style-type: none"> • Implement outreach and education initiatives aimed at improving customer awareness and acceptance of conservation needs and opportunities • Tailor programs to customer interests and capabilities

6.0 CONSERVATION PRACTICES IN THE POWER GENERATION, RESOURCE EXTRACTION AND MANUFACTURING SECTORS

6.1 INTRODUCTION

Canada's wealth in forest, mineral, energy, water and other natural resources results in stronger business ties among its resource extraction, manufacturing and power generation sectors than what is typical of other developed nations. Economic growth and development prospects and plans within all three sectors are closely connected. The previous chapter examined the practices and opportunities of industries such as automotive production, metal finishing and food processing which are primarily served by public water systems. This chapter examines water use and conservation practices within all three sectors with a focus on self-supply water users.

6.2 THERMAL POWER GENERATION

According to the 1996 Environment Canada industrial water-use survey, freshwater withdrawals by thermal electric power production facilities amounted to some 26,900 million m³ annually or about 63% of all self-supply water withdrawals¹²⁷. Annual withdrawals increased by about 13% between 1986 and 1996. The size of the increase was tempered by the fact that water-recycling rates within the sector increased from 18% to 41% over the same period.

A majority of Canada's installed thermal-power production capacity is located adjacent to major lakes or river systems and typically features once-through cooling systems. Once-through cooling necessitates large water withdrawals but involves relatively small consumptive losses, i.e. in the range of 1-2%. The alternatives to once-through cooling are the closed-loop water-cooled and air-cooled systems. Arguments for moving away from once-through systems where water availability is not a limiting factor focus on other environmental concerns such as the role of large cooling-water intake flows in the entrainment or entrapment of fish and other aquatic organisms and the impact of discharged heat on fish habitat and migratory behaviour.

Cooling Towers used in Thermal Power Production



Cooling practices within the U.S thermal power generation sector have shifted dramatically away from once-through systems in the past three decades even though once-through cooling still accounts for 91% of sectoral water withdrawals¹²⁸. Power plants operating in arid states such as Arizona, New Mexico, Nevada and Utah are exclusively based on closed-loop systems or air-cooled systems. These systems also see extensive use in many other states including Delaware, Kentucky, Minnesota, Pennsylvania, South Carolina and Texas. A number of closed-loop power plants are also found in western Canada.

The conversion of older plants and design of new plants in the U.S. is a response to stricter federal water quality requirements on return flows and/or local water shortages. Sixty percent (60%) of total installed thermal power capacity in the U.S. is now based on closed-loop or air-cooled technology. Water-use productivity in U.S. thermal-electric power generation has improved from 63 US gallons per kWh in 1950 to 21 US gal/kWh in 2000.

Ongoing restructuring in Canada's electricity sector supports the construction of smaller thermal plants in locations where they can take advantage of alternative energy sources and co-generation opportunities. The trend is supported by a variety of factors including the emergence of more-efficient production technologies, the availability of natural gas, uncertainties surrounding expansion of nuclear, coal and hydropower production, and increased private-sector investment interest. Such facilities are good candidates for closed-loop and air-cooling technologies.

Water conservation actions taken by individual residential, commercial, institutional and industrial electricity consumers within a municipality or region can significantly reduce the overall demand for electrical power. This in turn reduces the volume of water that otherwise would be required in the production of that power.

6.3 RESOURCE EXTRACTION

Canadian resource-extraction industries including oil and gas extraction, metal mining and non-metallic minerals mining, had total shipments estimated at \$ 84 billion in 2001 (most current reporting)¹²⁹. Metal and/or non-metallic mineral production activities are found in most provinces and territories. Many of these operations, especially those involving hard-rock, metal mining, are situated in more remote areas where there is generally less competition over access to and withdrawal uses of water. Basic fuels production is concentrated mainly in Alberta, British Columbia and Saskatchewan.

Total Canadian freshwater withdrawals by the mining / resource extraction sector (excluding upstream oil and natural gas production) in 1996 were estimated to be 475 million m³¹³⁰.

6.3.1 Metal Mining

Canada's metal mining industry is concentrated in Ontario, Quebec and British Columbia. They account for 33%, 21% and 14% respectively of total Canadian shipments by value. A further 23% is associated with mines in Manitoba, Newfoundland and Labrador, and Saskatchewan¹³¹.

The mining of metal-bearing ores often involves water quantity management issues that have less to do with the deliberate withdrawal of fresh water and more to do with the handling of natural and incidental surface and groundwater flows. Watercourses sometimes may have to be diverted around the operating site. In other cases, surface runoff and groundwater seepage may require collection and discharge so that they don't interfere with mining and processing operations or add to the volumes managed in the tailings disposal facility.

A portion of the incidental water flows are typically used in the production process. They may be required in drilling, in ore-crushing, screening, grinding and mineral-recovery operations, and for dust control.

Since most jurisdictions treat the watercourse diversions and the impoundment of surface runoff and groundwater discharge as water takings requiring licensing, gross water-withdrawals by the metal mining sector can be a misleading point of comparison with water usage in other sectors. Consumptive losses are typically limited to evaporation from impoundments and areas where water is used for dust suppression and are moderated by the cooler climates found in most metal-mining regions of Canada.

The above suggests that the metal-mining sector is not a primary target for water conservation initiatives. On the other hand, ongoing attention is warranted in connection with the potential adverse environmental impacts of water-diversion and impoundment activities and tailing-pond operations. Water reclamation and recycling are important components in minimizing wastewater discharges.

Case Studies: Water Conservation Practices in Metal Mining

Mine, Location	Description	Results
CANADA		
Falconbridge Raglan Mine, Nunavik, QC ¹³²	Process water recycling.	Between 1998 and 2001, freshwater withdrawals were reduced by 19% at the same time that mine production was increasing by 50%. 2001 water usage amounted to 0.57 m ³ / tonne of ore processed. Wastewater emissions were also reduced. A further 10% reduction in water usage is targeted.
Placer Dome ¹³³	Company reports that "the objective at each mine is generally to minimize the amount of fresh surface or ground water used at the mine by re-using, or recycling and capturing impounded water on site as much as possible".	In 2003, water use productivity at its three Canadian mining operations was Campbell, Red Lake - 4.1m ³ / tonne, Musselwhite - 2.0 m ³ / tonne, and Porcupine, Timmins - 0.2 m ³ / tonne of ore production
OTHER		
Teck Cominco ¹³⁴	Company reports that "initiatives to conserve water are considered at all sites to ensure that water usage is optimized". At its Red Dog mine in Alaska, the company is using reclaimed tailings pond water in process applications . At its refinery operations in Peru, treated wastewaters are used in agricultural irrigation .	Fresh water withdrawals at the Red Dog mine account for less than 4% of total water usage.

6.3.2 Non-Metallic and Industrial Minerals Mining (and Processing)

This sector includes the broadly based aggregates and building materials (sand, gravel and stone) industries and more geographically limited operations involving mining/processing of potash, phosphate rock, gypsum and similar minerals. The processing side is normally considered separate from the mining side in economic analysis and reporting but has been included here because of its importance from a water-use perspective.

Canada's non-metallic mineral mining industry has a much broader provincial/territorial representation than that of metal mining. It is primarily shared among Ontario (28% of total Canadian shipments), British Columbia (21%), Quebec (17.5%), Northwest Territories (11%), Alberta (7.5%), and British Columbia (7%)¹³⁵. Nunavut is the only jurisdiction with no reported production.

As in the metal mining sector, most water quantity management issues tend to relate to the handling of naturally occurring surface and groundwater flows. The construction aggregates industry uses significant amounts of water in materials washing and sorting. This water can come from a combination of ground water inflows or surface water takings and is often reclaimed and recycled. Secondary processing operations including the creation of products made from gypsum, lime and calcium carbonate, the manufacturing of ready-mix concrete, or the production of table salt use freshwater as a reagent or carrier and often results in the incorporation of water into the final product. Solution mining and water recycling is also in use at some potash mining operations.

Case Studies: Water Conservation Practices in the Non-Metallic Mineral Mining and Processing Industry

Mill, Location	Description	Results
CANADA		
PotashCorp SK and NB ¹³⁶	Water recycling	Company reports that its "water-intensive mining operations recycle 92-96% of the water used".
OTHER		
National Gypsum Company, Shippingport, PA ¹³⁷	NGC's wallboard plant uses byproduct gypsum produced during scrubber (flue gas de-sulphurization) operations at a nearby coal-fired power generating station. The plant also recycles all of its process water for reuse . Other NGC plants are using reclaimed wallboard and recycled papers .	Use of the byproduct gypsum eliminates freshwater usage that would otherwise be required in producing an equivalent amount of mined gypsum. It also saves on the landfill capacity otherwise needed to dispose of the scrubber waste. The NGC plant is a zero wastewater discharge facility.
Lafarge Cement Plant, France, France ¹³⁸	The company replaced its once-through-cooling water system with a closed-loop recycling system in 2000 at a cost of 415,000 Euros.	The volume of water withdrawals from and wastewater discharges to the Armançon River were reduced by 75%.

6.3.3 Oil and Gas Extraction

Canada's crude-oil equivalent production amounted to almost 2.4 million barrels per day in 2003¹³⁹. Natural gas production was 16.9 billion cubic feet per day. Alberta producers alone account for 64% of national oil production and about 78% of natural gas production. Other oil producing provinces include Saskatchewan at 17.5%, and Newfoundland and Labrador at 14% of total national output. British Columbia (15%) and Nova Scotia (3%) were Canada's other significant natural gas producers.

The most intensive water usage in the upstream petroleum production sector is that associated with enhanced oil recovery (EOR) and oil sands operations. Most enhanced oil recovery processes (EOR) use waterflooding or steamflooding to extract petroleum not recoverable by conventional pumping. In the first case, water is injected into the oil-producing reservoir to replace or enhance the natural pressures that cause the oil to flow to and up the production well. In the second, steam is injected into the reservoir where it reduces the viscosity of heavier crudes thereby enabling them to be drawn to the production well for recovery¹⁴⁰. Oil sands production uses water to produce steam used in the separation process. Because of government pressure and public concern over water shortages

and associated environmental impacts, the Alberta industry is continuing to move toward higher water-recycling rates and increased use of saline ground waters¹⁴¹.

In 2001, reported takings from surface freshwater sources for conventional oil production in Alberta amounted to 26.9 million m³. Takings of non-saline ground water amounted to 10.1 million m³. Freshwater use in oil sands production was 60 million m³ or 1.86 m³/ m³ of bitumen production¹⁴². Smaller takings for other purposes such as hydrostatic testing of pipelines, water used in drilling operations, and water used for drinking, sanitary and fire protection uses are not included.

The Canadian Association of Petroleum Producers (CAPP) has recently identified freshwater usage per unit of production as one its stewardship benchmarking categories. All conventional oil, oil sands and natural gas producers will be expected to report their facility data on an annual basis for CAPP compilation and reporting.

Increasing government and industry interest is being shown in the expanded use of CO₂ injection in EOR production. It is used as an adjunct to water injection to enhance oil recovery rates. The main environmental benefit of CO₂ injection may come from its potential role in the capture and geologic sequestration of CO₂ that otherwise would be released to the atmosphere as a byproduct of gas processing or other industrial operations. A number of anthropogenic CO₂-EOR operations are underway in the United States. A similar project started at EnCana Energy's Weyburn, SK operations in 2000 using CO₂ piped in from a gas processing plant in North Dakota¹⁴³.

Case Studies: Water Conservation Practices in the Oil and Gas Extraction Industries

Facility, Location	Description	Results
CANADA		
Petro-Canada MacKay River, AB ¹⁴⁴	Company uses only saline groundwater sources in steam production. Recycling of recovered water eliminates wastewater discharges as well.	No freshwater is used.
Suncor Energy: Oil Sands Fort McMurray, AB ¹⁴⁵	The company "is undertaking a company-wide assessment of internal water management practices to identify opportunities for improvement".	Company reported that freshwater withdrawal per unit of production decreased from 7.66 m ³ /m ³ in 2001 to 5.52 m ³ /m ³ in 2002. Of the 67 million m ³ of water withdrawn from the Athabasca River in 2002, 12% was returned.
Imperial Oil Cold Lake, AB ¹⁴⁶		Freshwater use has dropped from 3.0 m ³ / m ³ of oil produced to < 0.5 m ³ / m ³ .

6.4 MANUFACTURING

Water use and conservation practices were examined for all manufacturing sectors having a strong national or regional presence in Canada. Sub-sectoring was undertaken in cases where within-sector differences in the magnitude and form of water usage and conservation opportunities warranted finer evaluation. The description of water use practices and analysis of conservation opportunities draws extensively on a 2003 U.S. Department of Energy study of integrated water and energy conservation strategies within several key industry sectors¹⁴⁷.

Prior to examining individual sectors it is helpful to look at strategic or higher-level approaches being taken to address broader issues of resource use and environmental protection at the national, state and inter-state level. The European Union's Integrated Pollution Prevention and

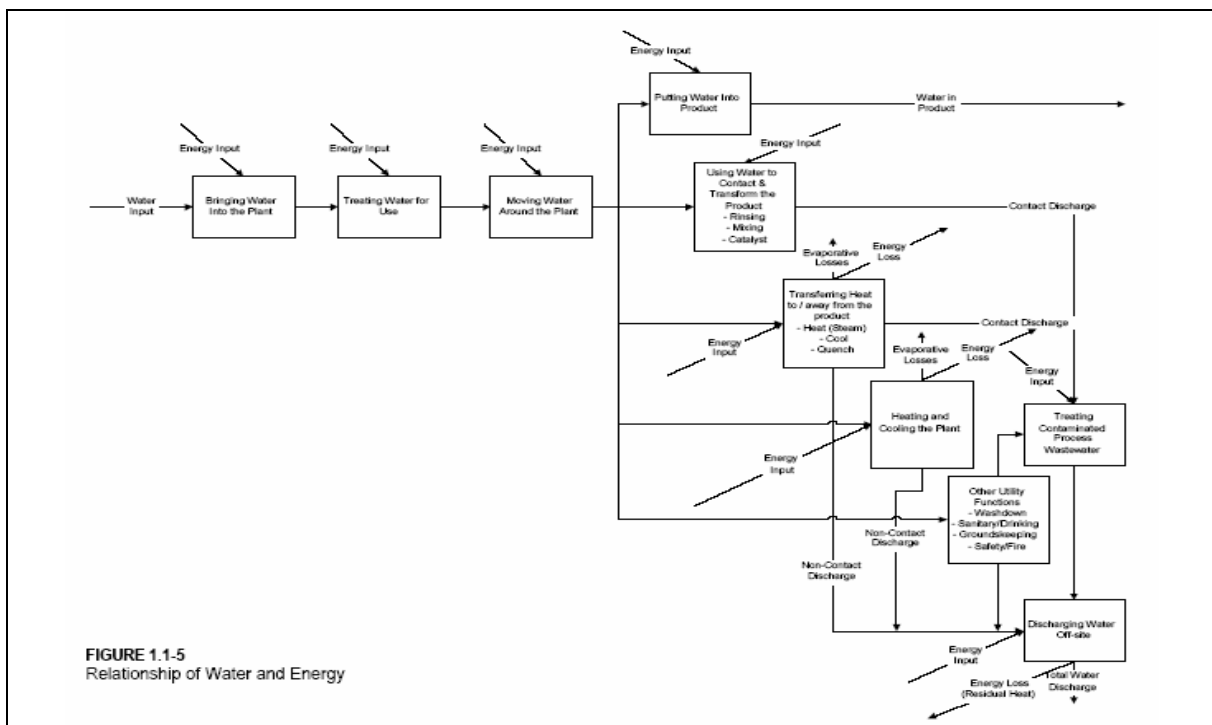
Control (IPPC) Directive which came into force in 2000 establishes a phased regulatory system that encompasses major industries and businesses and crosses all media¹⁴⁸. The directive represents the integration, broadening and deepening of previously existing regulatory regimes and measures operating in and impacting on EU member states¹⁴⁹. It is intended to take into account all of the environmental impacts of an operation, including efficient use of raw materials, energy efficiency, waste minimization, reduction of accidents and noise, and end-of-process issues such as waste disposal, site-closure and site restoration.

The IPPC directive operates around the application of production-process based raw material usage and environmental emission standards developed through government-industry technical committees. Water-use efficiency is addressed in the standards for some manufacturing sectors, e.g. pulp and paper, in the form of limits on water withdrawals per unit of production. New and significantly altered operations are required to comply immediately with the standards while existing facilities are to be phased in over a seven-year period. Some extensions to the compliance timetables have been granted particularly for those countries receiving accession into the EU.

The International Standards Organization (ISO) environmental management system provides another example of a higher-level integrated approach to environmental protection. The ISO approach has been endorsed by many Canadian industry associations and member companies with many reporting certification at the ISO 14,000 level. It is less prescriptive than the IPPC directives, i.e. it does not include quantitative targets for water-use productivity.

Current water conservation and water-use efficiency initiatives within the Canadian and U.S. manufacturing sectors have been less-directive than in Europe. They are largely driven by government tightening of wastewater discharge requirements and by industry recognition that reductions in water usage result in significant energy savings and lower other input costs. The close relationship between water and energy use is illustrated in the following figure.

The Water Use - Energy Use Relationship in Manufacturing¹⁵⁰



US Department of Energy. (2003). *Water Use in Industries of the Future*. Report prepared by CH2M HILL.

The process complexity characteristic of large industrial operations requires in-depth study of water, other raw-material and energy flows throughout the facility and careful planning of how changes in one area can affect other operations. Such audits or “plant-wide assessments” usually require in-depth facility knowledge and often require months of information collection and analysis. The following table outlines a generic process for developing and implementing an industrial water conservation program in combination with energy conservation and other process improvements.

Best Practice: Generic In-House Approach for Industrial Conservation Initiatives¹⁵¹

Principles and Actions	Rationale
Be thorough and systematic	<ul style="list-style-type: none"> • Sound water management involves a commitment to continuous improvement facilitated through the ongoing transfer of knowledge and experience within individual facilities and company-wide. • It requires the recognition and support of corporate executives.
Look at total water-use	<ul style="list-style-type: none"> • Maximizing conservation opportunities requires that the facility's entire water flow and balance system be evaluated and understood.
Institute rigorous water-use measurement.	<ul style="list-style-type: none"> • An accurate picture of how much water is being used within and between different process areas is fundamental to understanding where savings can be found.
Take a watershed perspective	<ul style="list-style-type: none"> • Broader understanding of water availability and variability and of shared resource interests is important to acting responsibly.
Reduce once-through cooling	<ul style="list-style-type: none"> • Other forms of cooling may be more practical and desirable in water-short areas.
Educate and involve employees	<ul style="list-style-type: none"> • Employees respond better to conservation initiatives if they are well informed and see them as a corporate priority.
Eliminate leaks and other inefficiencies.	<ul style="list-style-type: none"> • Repairing leaks and reducing other water wastage offer high rates of return on investment.
Identify water-reuse opportunities	<ul style="list-style-type: none"> • Water recycling and reuse become more attractive when energy savings and other opportunities are factored in. • Focus first on changes that will also reduce energy consumption and recover process chemicals.
Expand research into improved production methods	<ul style="list-style-type: none"> • Ongoing research and development is aiding in the discovery and refinement of production processes once thought impractical. • Focus on low energy and low water-use processes.

According to the 1996 national survey data, Canada's manufacturing industries were second only to the thermal power generation sector in terms of water withdrawals¹⁵². Total manufacturing withdrawals amounted to 6,038 million m³ that year. This was down 24% from the levels observed in the 1986 survey. Information compiled in this analysis suggests that industrial water withdrawals have continued to fall in all major manufacturing sectors and among most sub-sectors. These reductions have likely narrowed the gap between manufacturing and agricultural water use in terms of total water takings on a national scale.

6.4.1 Pulp and Paper

The Canadian pulp and paper industry is a major contributor to national, provincial and local economies. Manufacturing shipments totaled \$ 33.2 billion in 2003¹⁵³. Mills are found in all provinces except Prince Edward Island. The most common production methods found in Canada are the Kraft, thermomechanical and the chemi-thermomechanical process. There are also a few sulphite chemical mills and ground wood mills.

Water usage in pulp and paper mills serves four main functions - chemicals make-up, transport and management of material flows throughout the production process, materials separation and cooling¹⁵⁴. The industry exhibits the highest process water usage to total water use ratio of all industrial sectors. Freshwater withdrawals by Canadian mills amounted to some 2,350 million m³ annually in 1996¹⁵⁵. This represented about 44% of the combined self-supply water withdrawals by all manufacturing sectors making it the largest single industrial user.

Industry studies indicate that water usage by North American bleached Kraft mills using once-through cooling generally falls in the range of 55-90 m³ per air dried tonne (adt) of product. Water use in unbleached-Kraft production, which is less common in Canada, is in the range of 35-55 m³/adt. A North American ground wood-mechanical mill normally exhibits water use in the 6-20 m³/adt range. The following table illustrates the industry's current water-use productivity compiled at the global level.

Global Water-Use Productivity in the Pulp and Paper Industry (circa 2000) ¹⁵⁶

Mill Process Type	Water-Use Productivity (m ³ /adt) at Selected Percentiles				
	10%	30%	50%	70%	90%
Bleached Kraft	35	56	75	92	122
Unbleached Kraft	15	22	32	45	68
Ground Wood	10	23	35	48	77
Non-Integrated	5	13	24	45	85

The Forest Products Association of Canada (FPAC) reports that total water usage by Canadian mills decreased by 32% between 1989 and 2003 while total pulp/paper production was increasing by 30%¹⁵⁷. Total water usage has declined by 67% since the 1960s. FPAC also indicates that further incremental water savings are anticipated in coming years. Reductions are being achieved through adoption of new technologies and manufacturing processes that permit recovery and reuse of process waters and through tighter process controls and improved maintenance. The growth in used-paper recycling has also played a part. Water-saving measures also contributed to an 11% improvement in energy efficiency on a per tonne basis at Canadian mills in the period 1990-99¹⁵⁸.

While modernization of certain equipment and processes has been ongoing in most Canadian mills, continued use of some original infrastructure and production technology is not uncommon. This in turn can limit the scope of potential water savings. The older mills of eastern Canada have generally not achieved the same level of water use and waste discharge improvements seen in their western counterparts¹⁵⁹.

Significant process advancements have made construction of a “zero liquid effluent” (ZLE) mill based on the use of a modified bleached chemi-thermomechanical (BCTMP) process a reality. The world's first successful ZLE mill is reported to be the Millar Western Meadow Lake mill in Saskatchewan¹⁶⁰. Since some water losses are unavoidable in the production process, a ZLE mill may require a small amount of make-up water (+/-2 m³/adt) on an ongoing basis. The synergies involved in eliminating water quality impacts, reducing water use, recovering and recycling chemicals,

increasing wood-fibre recovery, and conserving energy make this an attractive option in the construction of new mills.

The following table summarizes the broad range of industry opportunities to reduce freshwater requirements, reduce operating costs and achieve other environmental objectives within existing mills.

Best Practice: Water Conservation Opportunities for Existing Pulp and Paper Mills¹⁶¹

Process Type	Suggested Improvement Measures	Water Productivity Targets (following improvements)
Chemical pulping	<ul style="list-style-type: none"> • Dry debarking • High efficiency brown-stock washing and screening • Improved spill controls • Steam stripping and reuse of all pulping condensates • Cooling water collection and reuse • Improved countercurrent flow of paper machine waters back to the bleaching and pulp washing processes • Digester-extended and/or oxygen delignification prior to bleaching • Elemental chlorine free or total chlorine free bleaching with alkaline filtrate recycle 	<ul style="list-style-type: none"> • Bleached: 30-50 m³/adt • Unbleached: 15-25 m³/adt
Mechanical and chemi-mechanical pulping	<ul style="list-style-type: none"> • Dry debarking • Segregation and countercurrent reuse of paper mill process waters • Use of thickeners or presses prior to pulp drying • Segregation of non-contact cooling and process waters for reuse • Enhanced liquid storage to balance process water requirements and prevent intermittent overflows of process waters • Installation of more efficient pulp-washing equipment in BCTMP and CTMP mills 	<ul style="list-style-type: none"> • Integrated mills producing newsprint, light-weight coated and supercalendered papers: 12-20 m³/adt • BCTMP and CTMP market pulp mills: 15-20 m³/adt • ZLE BCTMP mills: 2 m³/adt
Recycle pulping	<ul style="list-style-type: none"> • Separation and countercurrent reuse of less contaminated process waters • Internal filtration, gravity clarification or flotation and reuse of process waters • Segregation and reuse of non-contact cooling water • Enhanced liquid storage to balance process water requirements and prevent intermittent overflows of process waters • Internal biological treatment of process waters and partial recycle and reuse of treated effluents 	<ul style="list-style-type: none"> • Corrugated-medium and linerboard mills: <7 m³/adt • Deinked newsprint and writing paper mills: 8-15 m³/adt • Tissue product mills: 8-25 m³/adt
Papermaking	<ul style="list-style-type: none"> • Whitewater filtration and filtrate reuse for paper machine showers and chemical dilution • Enhanced whitewater recirculation to displace freshwater make-up during upset conditions • Segregation, collection and reuse of cooling waters • Clarification of whitewaters for reuse in pulp mill • Countercurrent washing of incoming pulp 	<ul style="list-style-type: none"> • Paper-product dependent: • Ranges from 4-10 m³/adt for corrugated medium to 15-25 m³/adt for high quality tissues

Case Studies: Water Conservation Practices in the Pulp and Paper Industry

Mill, Location	Description	Results
CANADA		
Howe Sound Pulp and Paper Ltd., BC ¹⁶²	Process-water recycling and reuse.	Between 1990 and 2000, the company reduced total water usage while production tripled. Over the same period, energy consumption per tonne of product was reduced by 40%. An in-house Water Conservation Committee has identified measures for reducing water use by an additional 10%.
Millar Western, Meadow Lake, SK	The 280,000 tonnes/yr zero-liquid effluent Meadow Lake mill constructed by Millar Western Forest Products in 1992. It is jointly owned by the company and the SK Government. It uses aspen feedstock.	The mill is reported to be the world's first successful zero liquid effluent (ZLE) mill. It is also chlorine free.
Weyerhaeuser Company ¹⁶³	Weyerhaeuser's Environmental Policy sets a company goal of "conserving natural resources through recycling and waste reduction ".	The company's 32 pulp and paper mills combined have reduced water use by 40% since 1980. The amount of water required to produce a tonne of pulp or paper has declined by 58% and is currently 45.9 m ³ / tonne. The Flint River pulp mill in Oglethorpe, GA, is currently operating at 36.7 m ³ /tonne.
Hinton Forest Products Hinton, AB ¹⁶⁴	In 2002, company diverted heated cooling water for re-use in the mill's bleaching plant. Further water use reduction opportunities are being pursued.	Re-use of heated cooling water reduced water usage by 900 gal/min or about 4% of average daily withdrawals..
Tembec Company has pulp and paper mills in QC, ON, MB and BC and in France ¹⁶⁵	Under its Impact Zero® environmental management program, Tembec has set water-use productivity targets of 50 m ³ /tonne for its Kraft mills, 20 m ³ /tonne for its high-yield pulp mills, and 30-40 m ³ /tonne for its newsprint-groundwood papers mills. The targets are to be achieved by 2008.	Average water-use productivity by mill type in Canada in 2002: Kraft (3 mills): 90-130 m ³ /tonne High Yield Pulp (2 mills): 30-53 m ³ /t Newsprint-Groundwood (2 mills): 43-55 m ³ /t
OTHER COUNTRIES		
European Union IPPC Directives ¹⁶⁶	IPPC Directives require the immediate use of best available techniques for water-use efficiency in all new mills. Best Available Techniques (BAT) adoption within existing mills must be in place by 2007. BAT requirements vary according to mill process and product type.	Water-use productivity requirements are: <u>Integrated P & P Mills</u> -Bleached Kraft: 40-65 m ³ /adt -Unbleached Kraft: 25-40 m ³ /adt -Bleached sulphite: 50-70 m ³ /adt -Mechanical: 12-20 m ³ /adt -Recovered paper: 8-15 m ³ /adt <u>Paper-Only Mills</u> -Coated/uncoated papers: 10-15 m ³ /adt -Tissues: 10-25 m ³ /adt
Bowater Incorporated South Carolina and	Water recycling and process-efficiency improvements.	The company's Catawba Mill in South Carolina has reduced its water usage by

Alabama mills ¹⁶⁷	Bowater's 'Good Neighbor' Policy states that "the company has been entrusted with the stewardship of extensive renewable natural resources and accepts the responsibility of managing those resources on a sustainable basis..."	30% and expects to reduce it by a further 15%. The Coosa Pines Mill in Alabama reduced its water use by 40% over a 2-year period. Both mills also experienced energy savings as a result of the improvements.
International Paper ¹⁶⁸ IP operates 36 pulp, paper and packaging mills in the U.S. Canada (BC and AB), Europe, Russia and New Zealand	In 2002, IP initiated "an effort to identify water supply concerns at each of our mills." The company has been using ' water reuse loops ' to conserve water.	The median water-use productivity measured across all IP mills is: Bleached Kraft - 65 m ³ /tonne Unbleached Kraft - 40 m ³ /tonne Ground Wood - 35 m ³ /tonne Non-Integrated - 22 m ³ /tonne
Netherlands mills ¹⁶⁹		Netherlands mills are reported to have reduced total water usage by 90% since the late 1970s.
StoraEnso The company has mills in Nova Scotia, the U.S. and Europe		StoraEnso's current global average water-use productivity is 55 m ³ /tonne of pulp, paper and packaging board. An improvement of about 5% was reported for the period 1999-2003.

6.4.2 Chemical Industries

For the purposes of this discussion, the chemicals and chemical products sectors were considered to include all of the organic chemicals, inorganic chemicals, fertilizers, and plastics and rubbers sub-sectors. In 2003, Canadian manufacturing shipments from the combined industry totaled \$65.9 billion¹⁷⁰. Industrial production is concentrated in Ontario, Quebec and Alberta, which respectively account for 50%, 25% and 20% of total Canadian shipments¹⁷¹.

Environment Canada's 1996 industrial water use survey showed the chemicals sector as having total annual freshwater withdrawals of 1,015 million m³ ranking it behind the pulp and paper and primary metals sectors in total withdrawals¹⁷². More recent reporting by the industry, suggests that many Canadian companies have since reduced their process-water usage¹⁷³.

Outside of the inorganic chemicals and fertilizers sub-sectors, water is not commonly used as a feedstock or reactant but is extensively used in cooling, steam production and washing/rinsing operations¹⁷⁴. As in many other industry sectors, cooling requirements account for the largest portion of freshwater withdrawals. Notwithstanding the limited process usage, contaminated wastewater streams are not uncommon because of system leaks and incidental contact of water with both raw and intermediate materials and final products. Total water usage per unit of production rankings (highest to lowest) among North America's largest chemical producers are as follows: nitrogen, ethylene, ammonia, phosphoric acid, propylene, polyethylene, chlorine, sulfuric acid and oxygen.

Consumptive losses can involve evaporative losses to the atmosphere (particularly where cooling towers are used), deep-well disposal of contaminated wastewaters and, in the case of the inorganic chemical and fertilizers industries, the incorporation of varying amounts of water into final products shipped throughout North America. While global industry estimates suggest that less than 5% of total water usage ends up in final products the percentage can be significantly higher and may result in locally significant environmental impacts in some cases

The Canadian industry has made significant progress in reducing overall process water usage through extensive recycling. These initiatives have been driven by pressures to eliminate or significantly reduce wastewater emissions and lower energy consumption.

Case Studies: Water Conservation Practices in the Chemical Products Industry

Facility, Location	Description	Results
CANADA		
Ethyl Canada Inc. ¹⁷⁵ Corunna, ON Manufacturer of diesel and gasoline additives	Prior to 1997 the company operated water and energy conservation programs on the basis of acting on 'individual targets of opportunity'. The company then established a cross-functional Water Team to monitor and address all aspects of water use.	Compared to 1996, water use has been reduced by 91%. Water use per tonne of production is down 94% and energy use per tonne of production has decreased by 76%.
Celanese Canada ¹⁷⁶ Edmonton, AB Manufacturer of petrochemicals and industrial products	Internal at source reductions and recycling have allowed the company to eliminate its discharge of storm water runoff, non-contact cooling water and utilities blowdown waste streams to the North Saskatchewan River.	Internal recycling has offset 30% of the river water intake.
ERCO Worldwide ¹⁷⁷ Saskatoon, SK Manufacturer of chlorine dioxide precursors	Recycling of cooling water and better water use.	Water requirements and discharge volumes decreased by 67% from 1997 to 2003.
OTHER		
DuPont ¹⁷⁸	Company produces a glycolic acid compound for use in cleaning power plant cooling towers and other industrial heat exchangers, condensers and boilers.	Enhanced cleaning effectiveness was shown to reduce the typical volume of cooling water make-up by 6%. Cost savings for water and wastewater fees are reported to far outweigh the cost of cleaning treatments.

6.4.3 Petroleum Refining

Canadian shipments of refined petroleum products were valued at \$ 35.5 billion in 2003 with most of that production coming from refineries in Ontario, Alberta and Quebec¹⁷⁹. At 228,600 m³/day crude throughput was up 6.3% from 1999 levels¹⁸⁰.

Total freshwater withdrawals by Canadian refineries in 1996 were 255 million m³¹⁸¹. Current withdrawals are believed to be lower as a result of ongoing leak detection and correction efforts and the recycling/reuse of process waters. Canada's petroleum industry associations do not currently compile and document total water use and water-use productivity data in sector-wide environmental reporting¹⁸².

The principal uses of water in petroleum refining are in steam production and cooling. Smaller amounts are used for the removal of water soluble inorganic compounds from hydrocarbon streams¹⁸³. Most Canadian refineries use once-through cooling systems making overall withdrawals markedly higher than that found in refineries using closed-cooling circuits and cooling towers. Process wastewaters originate mainly from the crude distillation and fluid catalytic-cracking units where there is direct contact with hydrocarbons and, to a lesser extent, from flushing and cleaning activities and runoff from process or product handling and storage areas. The dissolved solids content of some wastewater streams renders them too expensive to treat for surface water discharge. They are

typically disposed of through deep-well injection assuming that a suitable bedrock formation is located nearby. Consumptive losses of water are primarily a result of evaporation to the atmosphere.

Since cooling and steam production dominate refinery water demands, it follows that these areas represent potential targets in seeking further reductions in withdrawals. The decision to move from once-through cooling to closed-circuit cooling involves the combined considerations of water and energy conservation, environmental benefits and costs. With cooling towers there is still a sizeable make-up water requirement some of this can be obtained from other sources such as boiler blowdown, storm water runoff or treated sanitary wastewater¹⁸⁴. Some portion of any non-contact cooling water flow may be reusable in process operations or in utility functions. The more temperate climate that Canadian refineries operate in compared to conditions found in the southern U.S. suggests that selected air-cooling applications could also be examined¹⁸⁵. On the process side, oily condensates might be reusable as desalting wash water and stripped sour water from the hydrotreaters might be used for desalter-water makeup¹⁸⁶. Recent and ongoing refinements of reverse osmosis and other membrane technologies have increased the opportunities associated with treating wastewaters for recycle and reuse.

A 2003 study of water conservation practices in the petroleum refining industry, undertaken for the U.S. Dept of Energy, concluded that the most promising strategies for tightening up the water balance within a refinery include:

- Internal treatment and recycle/reuse of process waters
- Conversion to closed-circuit cooling
- Cooling tower design modifications that increase heat transfer and reduce evaporative losses
- Treatment of cooling-tower makeup waters to minimize the required blowdowns
- Use of treated wastewater obtained from external sources

Case Studies: Water Conservation Practices in the Petroleum Refining Industry

Refinery, Location	Description	Results
CANADA		
Suncor Energy: Sarnia Refinery Sarnia, ON ¹⁸⁷ 70,000 barrel/day refinery	In 2002, the refinery withdrew an average of 78.6 mgd of water from the St Clair River using 99% of it for process cooling. Most of it was returned to the river after treatment.	Water withdrawal per unit of production (at the combined Sarnia and Denver, CO refineries) improved from 7.35 m ³ /m ³ in 2001 to 6.61 m ³ /m ³ in 2002.
OTHER		
Chevron-Texaco Corp., Richmond and East Segundo, CA ¹⁸⁸	Treated municipal wastewater is being used to replace freshwater used in cooling at both oil refineries. This is the largest industrial water reuse project in California.	Freshwater withdrawal savings equal 1.8 billion US gallons/yr (6.8 million m ³ /yr).

6.4.4 Primary Metals Manufacturing

The primary metals sector includes primary production of basic iron and steel and associated products along with the smelting, refining, rolling, casting and extruding of non-ferrous metals. Total Canadian shipments from all sub-sectors combined in 2003 were \$ 37.6 billion¹⁸⁹. Primary iron and steel and steel products operations account for some 55% of total shipments. Smelting and refining of non-ferrous metals (e.g. aluminum, copper, and nickel) account for a further 25%.

The most recent national survey of water usage shows primary metals producers with combined annual freshwater withdrawals of 1,350 million m³ in 1996¹⁹⁰. This places the industry behind the pulp and paper sector and ahead of the chemical and chemical products sector as the most water-use intensive manufacturing industries in Canada. Water is primarily used in cooling, material conditioning, dust suppression, and cleaning and in the control of air emissions (i.e. wet scrubbers)¹⁹¹. Within a typical North American integrated steel mill approximately 12% of water use is devoted to material conditioning, 13% to air pollution control and most of the remainder to heat transfer or cooling. Consumptive losses result from evaporation in the blast furnace, basic-oxygen furnace, coke oven, and casting areas.

The Canadian Steel Products Association (CSPA) reports that closed-loop cooling systems along with treatment and reuse of process waters have helped to reduce water demand to the point where 95% of the water used by the industry is recycled¹⁹². The industry's ongoing interest in reducing energy consumption and related costs along with the increased availability and use of recycling steel products have also played an important part in the realization of improved water-use and energy-use. Some 9.5 million tonnes of steel scrap were recycled in 2002

Water requirements in the production of aluminum, copper and other non-ferrous metals are less intensive than those of the iron and steel industry. Promising conservation opportunities in aluminum and copper processing include reusing non-contact cooling water in other areas, converting to closed-circuit cooling, and internal treatment, chemical recovery and reuse of water used in surface treatment (finishing) baths.

Case Studies: Water Conservation Practices in the Primary Metals Industry

Mill, Location	Description	Results
CANADA		
Dofasco Hamilton, ON ^{193 194}	Company began construction of a state-of-the-art Acid Regeneration Plant (ARP) in 2003. The plant will use a closed loop system to recover and reuse spent acid and rinse water . The project is the final stage of several process water recirculation initiatives dating back to 1990..	The ARP will eliminate the need for water intake from and sodium chloride discharge to Hamilton Harbour. Since 1990, the company reduced water intake and effluent discharge volumes by 58.4 million m ³ /yr at a cost of \$34 M.
Algoma Steel Inc. Sault Ste Marie, ON ¹⁹⁵	Water recirculation systems have been installed in the Direct Strip Production Complex (built in 1995) and blast furnace.	Company reports that water demand has been "significantly reduced".
OTHER		
International Steel Group Inc. Sparrows Point Mill Baltimore, MD ¹⁹⁶	Treated effluents from a nearby municipal wastewater treatment plant are used to meet some of a mill's water demands.	
Alcoa Inc, Lafayette, IN ¹⁹⁷	Ingot cooling water recirculation system (proposed)	A one-time capital cost of \$10,000 US, is projected to result in energy savings of \$18,000 annually. No estimate of the expected water savings was given.

7.0 AGRICULTURAL SECTOR CONSERVATION PRACTICES

7.1 CANADIAN AGRICULTURAL PRODUCTION AND WATER USAGE

Canada's agricultural industry exhibited gross farm receipts (excluding agri-forest products) of \$38.3 billion in 2000¹⁹⁸. Alberta's \$9.92 billion, Ontario's \$9.12B, Quebec's \$6.14B and Saskatchewan's \$5.89B accounted for 81% of the total. Manitoba contributed \$3.53B, British Columbia \$2.31B, the Atlantic Provinces \$1.18B, and the Yukon and Northwest Territories a combined total of \$8.13 million. Out of 230,000 reporting farms within the 2001 Canada-wide Census of Agriculture, 118,000 were identified as primarily involved in livestock production and 112,000 in crop production. Livestock operations accounted for 55% of total farm receipts in 2000.

Total annual freshwater withdrawals by Canadian agriculture were estimated at 4,100 million m³ in 1996 (most recent survey)¹⁹⁹. This represented about 9% of total withdrawals among all water-use sectors combined. Crop irrigation accounts for 85% of agricultural withdrawals with the remaining 15% going to livestock watering, and other uses including cleaning, washing, preparation of fertilizer and pesticide applications, and dilution of manure. Overall consumptive usage or loss amounts to about 67% of withdrawals but can be higher depending on prevailing climate and weather conditions, operating systems and producer practices.

7.1.1 Provincial Profiles

British Columbia^{200, 201, 202}

- British Columbia had gross farm receipts of \$2.31 billion in 2000. These were split almost equally between crop production (48%) and livestock production (52%).
- Estimated freshwater use by BC's agriculture industry in 1996 was 763 million m³ for crop irrigation and 14.7 million m³ for livestock production²⁰³.

Alberta^{204, 205}

- Alberta's gross farm receipts totaled \$9.92B in 2000. Livestock and livestock products accounted for two thirds of the total.
- Estimated freshwater use by Alberta's agriculture industry in 1996 was 2,609 million m³ for crop irrigation and 61.5 million m³ for livestock production²⁰⁶.

Saskatchewan^{207, 208, 209}

- Gross farm receipts totaled \$5.89B in 2000 with crop production accounting for almost 70% of the total.
- Estimated freshwater use by Saskatchewan agriculture in 1996 was 271 million m³ for crop irrigation and 40 million m³ for livestock production²¹⁰.

Manitoba^{211, 212}

- Manitoba's gross farm receipts totaled \$3.53B in 2000. Crop production accounted for about \$1.8B (51%) and livestock production for \$1.6B (49%).
- Estimated freshwater use by Manitoba's agriculture industry in 1996 was 24.7 million m³ for crop irrigation and 23.6 million m³ for livestock production²¹³.

Ontario^{214, 215, 216, 217}

- Ontario's gross farm receipts were \$9.12 billion in 2000. Receipts were split rough equally between livestock (53%) and crop production (47%).

- Estimated freshwater use by Ontario's agriculture industry in 1996 was 114 million m³ for crop irrigation and 59.2 million m³ for livestock production²¹⁸. More recent (2000) estimates put total withdrawals at 202 million m³/yr divided among crop production at 121 million m³/yr (60%), livestock production 53 million m³ (26%) and aquaculture 28 million m³/yr (14%).

Quebec^{219, 220, 221}

- Quebec had gross farm receipts of \$6.14B in 2000. Livestock and livestock products accounted for more than 70% of total receipts.
- Current annual water requirements for agricultural production are estimated at 174.1 million m³. This includes 73.5 million m³ for aquaculture, 56.0 million m³ for livestock and 44.6 million m³ for crop production. The Environment Canada 1996 water use survey estimated annual irrigation usage to be 58.4 million m³ and livestock usage to be 45 million m³.

Nova Scotia^{222, 223, 224}

- Nova Scotia had gross farm receipts of \$0.41B in 2000. Livestock and livestock products accounted for 66% of receipts.
- Nova Scotia's agricultural water usage in 1996 was estimated to be 5.47 million m³; 3.2 million m³ in livestock production and 2.27 million m³ for crop irrigation.

New Brunswick^{225, 226, 227}

- New Brunswick had gross farm receipts of \$0.37B in 2000. Receipts are almost equally divided between crop and livestock production.
- New Brunswick's agricultural water usage in 1996 was estimated to be 3.81 million m³; 2.37 million m³ in livestock production and 1.44 million m³ for crop irrigation.

Prince Edward Island^{228, 229, 230}

- PEI had gross farm receipts of \$0.32B in 2000. Crop production accounted for 61% of total receipts.
- PEI's agricultural water usage in 1996 was estimated to be 3.62 million m³; 1.9 million m³ in livestock production and 1.72 million m³ for crop irrigation.

Newfoundland and Labrador^{231, 232, 233}

- Newfoundland and Labrador had gross farm receipts of \$0.074B in 2000. Livestock and livestock products accounted for almost 80% of total receipts.
- The province's agricultural water usage in 1996 was estimated to be 0.63 million m³; 0.48 million m³ in livestock production and 0.15 million m³ for crop irrigation.

Yukon and Northwest Territories²³⁴

- Gross farm receipts (2000) are roughly the same in the two territories at approx. \$4 million annually.
- There were no data available on agricultural water withdrawals.

7.2 CROP IRRIGATION FUNDAMENTALS

7.2.1 General Principles

Crop-irrigation needs and practices reflect production settings and crop types. The amount of water required for plant growth varies significantly among crop types and species. The need and decision to supplement natural precipitation are influenced by soil type, topography, climate, weather, production objectives and economic considerations. Irrigated production may be under cover, e.g. in

greenhouses, or involve field crop and rangeland production. It is not surprising, therefore, to see that a range of irrigation technologies and practices are in use within the industry and across Canada.

While crop irrigation accounts for a large percentage (67%) of consumptive water usage in Canada, as it does in most countries, it is important to consider agricultural water management from the broader perspective of water-use productivity. How can the benefits of crop irrigation be realized while using minimum and sustainable water withdrawals?

Irrigation is used to supplement natural precipitation in order to sustain crop health and productivity. In some areas it is also used on an as needed basis for frost protection. In its primary use, the objective is to deliver the right amount of water, at the right time and at the right cost particularly to the root zone where it is available for uptake by the plant. Some of the applied water evaporates from the soil surface, some is stored in plant tissues and some is transpired. Both storage and transpiration are essential processes for plant growth. In a perfectly designed and operated system, all of the irrigation water would be consumed through one of these processes. To approximate such a system, conservation efforts need to address issues of water waste throughout the system and fundamental questions regarding the type and value of irrigated agricultural production in an area. This includes understanding:

- Evaporative and exfiltration losses from primary irrigation infrastructure such as storages and irrigation ditches often found in regional systems
- Evaporative losses attributable to the design and operation of irrigation equipment
- Water rights and allocation provisions
- Irrigation scheduling
- Moisture holding capacity of soils
- Return on total system investment as influenced by the economic and social choices in choosing to irrigate and choosing to grow particular crops
- Environmental and other consequences including excessive return flows, soil erosion, transport/leaching of agricultural chemicals and other pollutants into surface and ground waters, and increased soil salinity
- Competition with other water users including the need to protect aquatic systems and maintain environmental flows
- Opportunities and implications in using reclaimed municipal and other wastewaters as supplements or replacements for freshwater use

7.2.2 Irrigation Systems

There are four basic types of irrigation systems used in crop production:

- Gravity Flow or Surface Flood
- Spray or Sprinkler
- Drip or Trickle
- Micro-irrigation

Gravity-flow systems are most often operated at the regional scale by irrigation districts. Water is conveyed to the farm and farm field through open ditches and then applied through surface flooding. The system is used to some extent in Saskatchewan and Alberta. It is used more extensively in some southern U.S. states including California, Arizona and New Mexico and in Australia. Overall water-use efficiency is lowest among all system types because of extensive surface evaporation and exfiltration losses throughout the lengthy conveyance network. While labour and capital costs are low, use of the system is limited to flat terrain and may even necessitate precision-leveling of the irrigated fields. A higher proportion of applied waters may be returned (via runoff or percolation to

ground water) for use on the same acreage or by others but the trade-off is the much-increased risk of pollutant transfer to both surface and ground water sources.

Irrigation of Row Crops using Gravity Flow



Sprinkler systems typically offer higher water-use efficiencies than gravity or flood systems but actual efficiency can vary widely depending on configuration and operating pressures. These may draw upon a large regional water supply system or may take from an on-farm source. There are four basic categories of sprinkler systems²³⁵.

- Solid Set: These systems may be put permanently in place or may be hand moved. They can be used on a wide variety of field and row crops and are suitable over a range of terrains.
- Mechanized Centre-Pivot / Linear Systems: These are most often used in large-scale applications on flat to moderate topography. They can be fitted with overhead sprinklers or sprinklers mounted closer to the ground on drop tubes. They are less labour intensive than hand move sets but are not suited to smaller square or rectangular field applications.
- Wheeline: These systems use medium-sized sprinklers. They are suited to smaller rectangular fields having flat to moderate topography growing lower value field crops. They are less labour and capital intensive than centre-pivot / linear systems.
- Travellers: Travellers are most often fitted with large spray guns and are used on crops that are less sensitive to the uneven application of water. Like the wheeline, they are less labour and capital intensive than centre-pivot / linear systems.

High pressure (>60 psi) sprinklers and spray guns are widely used across Canada on a variety of crops. Their water efficiency can be quite low because of high evaporative and drift losses particularly under windy conditions.

Low to moderate pressure (<50 psi) centre-pivot and linear sprinklers are used in parts of southern Alberta and Saskatchewan in the production of forage, cereal and oilseed crops and pulses. Independent studies have demonstrated the higher water-use efficiencies and lower energy requirements of these systems^{236,237}. They have been found to be highly effective (98% in winds under 5 km/hr) in delivering water to plant and soil surfaces. The low-pressure, drop-tube sprinkler system has been described as “the biggest single advancement [among mechanized-irrigation systems] towards increasing irrigation efficiency...”²³⁸. Lower pressure systems are particularly suited to flat terrain and lighter soils. In regional supply systems, evaporative and exfiltration losses from storage reservoirs and open conveyance channels can still limit overall project efficiency.

Low-Pressure Drop Tube Sprinkler System



Drip or trickle irrigation systems involve the use of small diameter tubing or piping placed above or below the field surface in proximity to plant rows or, in some cases, individual plants. Holes along the length of the pipe deliver water directly to the root zone minimizing evaporation. These low-flow high-efficiency systems are most often used in nursery, tender fruit, berries and vineyard operations. They are receiving increasing interest in the production of vegetables and other field crops particularly in perpetually water-short areas. In addition to their efficiency in delivering water directly to the plant, drip and trickle systems can increase crop yield and quality, reduced energy costs, and avoidance of diseases²³⁹. They are also suited to some ‘chemigation’ applications, i.e. the co-delivery of water soluble fertilizers and pesticides, and minimize the potential transfer of pollutants into ground or surface waters.

Drip Irrigation in Strawberry Production



Micro-irrigation systems are used extensively in greenhouse production and in some open-field production of high-value vegetable, berry and floriculture crops. Water is delivered directly to the individual plants through small tubing or micro sprays. These systems are both water and energy-use efficient. Chemigation may also be incorporated subject to the avoidance of clogging problems with the small orifices.

Micro Irrigation in Greenhouse Floriculture



7.3 CANADIAN CROP IRRIGATION PRACTICES

7.3.1 National Overview

Successful crop production relies on availability of land, suitability of soils and temperatures, stability in commodity demand and prices, and having enough precipitation when it is needed. Irrigation is needed when precipitation is not sufficient to maintain soil moisture. In some parts of the country this is an ongoing need rather than an occasional requirement. As can be seen in the following table, growing areas in the Atlantic Provinces receive 3.0-3.5 times the precipitation received in the Southern Prairies and in the southern interior of British Columbia. As much of the precipitation in the western provinces comes in the form of snow, annual averages tend to even inflate the picture of what is truly available during the growing season.

Average Annual Precipitation in Selected Agricultural Areas (1971-2000)

Location	Average Annual Precipitation (mm)
Kelowna, BC	340
Medicine Hat, AB	334
Swift Current, SK	377
Souris, MB	516
Delhi, ON	1010
Vineland Station, ON	875
Joliette, QC	1006
Greenwood, NS	1127
Fredericton, NB	1124
Summerside, PE	1078

The following table summarizes the area under irrigation and major irrigated crops grown within each province as reflected in the 2001 Census of Agriculture²⁴⁰.

Irrigated Crop Area by Province: 2001 Census

Province/ Territory	Irrigated Area hectares x 1000		Major Irrigated Crops (by value)
	1995	2000	
BC	115.4	111.2	Floriculture/nursery, greenhouse, vegetables, fruits
AB	516.6	499.2	Forages, potatoes, vegetables, floriculture/nursery
SK	97.4	68.5	Oilseeds, cereals, pulses, forages
MB	22.2	28.1	Potatoes, greenhouse, vegetables
ON	66.1	49.3	Floriculture/nursery, vegetables, greenhouse, tobacco, fruits
QC	33.6	22.6	Vegetables, greenhouse, nursery
NB	1.4	1.1	Potatoes, floriculture/nursery
NS	2.2	3.5	Fruits, floriculture/nursery, vegetables
PE	1.1	0.7	Potatoes
NL	0.1	0.2	Floriculture/nursery, vegetables
Totals	856.1	784.5	

Canada's greenhouse production comprises only 1,835 ha or 0.2% of total irrigated area but is responsible for \$570 million in gross annual (2000) receipts. High commodity values relative to overall water requirements make under cover crops along with nursery, floriculture, vegetable and tender fruit crops prime candidates in the allocation of water supplies. Greenhouse production encompasses 914 ha (50% of national total) in Ontario, 464 ha (25%) in British Columbia, 251 ha (14%) in Quebec, and 103 ha (6%) in Alberta.

7.3.2 Provincial Summaries

British Columbia^{241, 242, 243, 244}

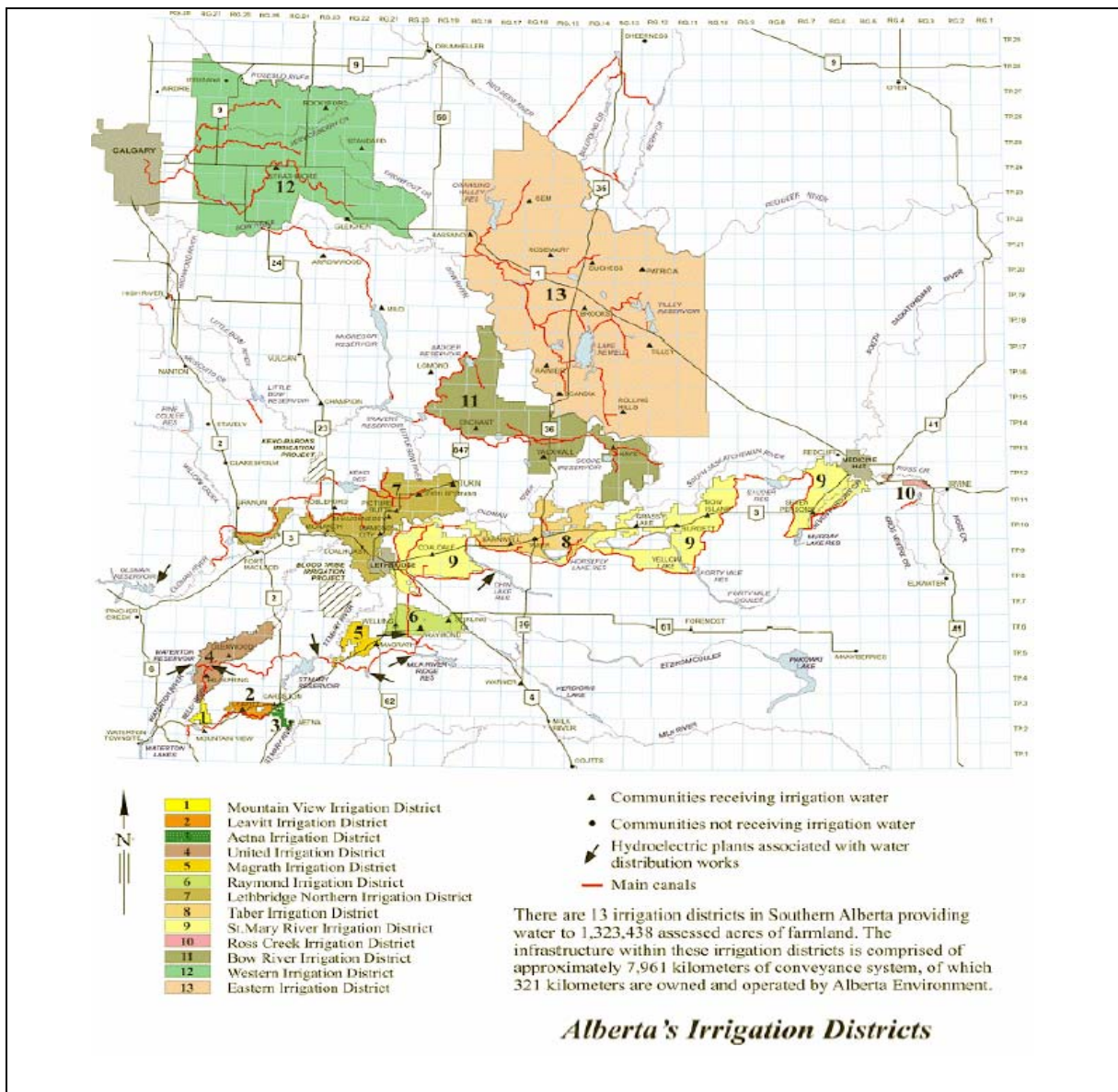
- BC's irrigated crop acreage amounted to 111,000 ha in 2000 placing it second to Alberta in provincial totals. Forages constitute 85% of irrigated area, followed by tree fruits at 5.5% and vegetables and berries at 2.7% and 2.5 % respectively.
- 85% of crop area under irrigation is self-supplied (i.e. private licences) with the remainder being served by a local irrigation district or a combination of private and communal systems.
- Estimated freshwater use in 1996 was 763 million m³. Surface water withdrawals dominate at 97.5% of overall usage.
- The largest contributors to gross farm receipts were floriculture and nursery 32%, greenhouse and field vegetables 21%, and fruit 15%.
- Primary producing areas include the Thompson (forages and ginseng), Okanagan (forages, tree fruits, nursery and grapes), Caribou (forages), Kootenays (forages) and Fraser Valley (berries, vegetables, forages and nursery).
- Sprinkler systems are used on 71% of irrigated acreage, surface flood on 18%, spray guns on 7%, and trickle/drip on 3%.

Alberta^{245, 246, 247}

- The province has 13 irrigation districts all of which are located in the South Saskatchewan River Basin (see accompanying map). Water storage and distribution networks owned and operated by the districts often serve municipal water supply and recreational needs in addition to crop irrigation uses.

- The districts serve a total assessed irrigable area of 526,000 ha. The 4 largest districts account for almost 78% of the total. These are St Mary's River 28%, Eastern 22%, Bow River 16%, and Lethbridge Northern 12%.
- Freshwater withdrawals for crop production in 1996 were 2,609 million m³.
- Forage crops occupy 43% of land served by irrigation districts. This is followed by cereals 36% and oilseeds 12%.
- While irrigated acreages represent only 4% of Alberta's arable land base, they are responsible for 20% of agricultural production. Among irrigated crops, the largest contributors to gross farm receipts are forages, potatoes, vegetables, and floriculture/nursery crops.
- Sprinkler systems are used on approximately 76% of Alberta's irrigated acreage. Most of the remainder (i.e. 20%) uses surface flood systems.

Water Irrigation Districts in Alberta



Alberta Agriculture, Food and Rural Development. *Irrigation: Industry Overview*. See online at www.agric.gov.ab.ca/app21

Saskatchewan^{248, 249, 250}

- While only 68,500 ha were reported as irrigated in 2000, provincial records indicate there were 137,000 irrigated ha in 2001.
- Estimated freshwater use by Saskatchewan crop producers in 1996 was 271 million m³.
- There are 30 irrigation districts, the majority of which are located within a 150km radius of Lake Diefenbaker on the South Saskatchewan River. In addition, there are many thousands of private irrigators located outside the districts.
- On a province-wide basis, the distribution of irrigated acreages is forages 46%, cereals 35%, oilseeds 8%, pulses 8% and floriculture 3%.
- Irrigation in the Southwest Development Area centred around Swift Current is focused on alfalfa and other forages (83% of irrigated area) and cereals (13%). Total irrigated area equals 59,000 ha.
- In the Lake Diefenbaker Development Area currently irrigated acreage is apportioned 47% to cereals, 26% to forages and 11% each to pulses and oilseeds. Total irrigated area equals 40,000 ha. There is considerable opportunity for expansion because of consistent water supplies, good soils and a favourable climate.
- The Southeast and Northern Development areas together contain a total of 35,000 ha most of which is irrigated from private sources. The focus tends to be on high value crops including turf grass, Saskatoon berries, market gardening, tree nurseries, potatoes and hybrid canola.
- Among irrigated crops, the highest contributors to farm receipts were oilseeds, cereals, pulses and forage crops.
- Primary irrigation systems used in Saskatchewan include sprinkler 51%, backflood 29% and surface flood 21%. Drip irrigation is used on some high value low acreage crops.

PFRA's Val Marie Dam and Storage Reservoir (11, 528 dam³) in Southwest Saskatchewan

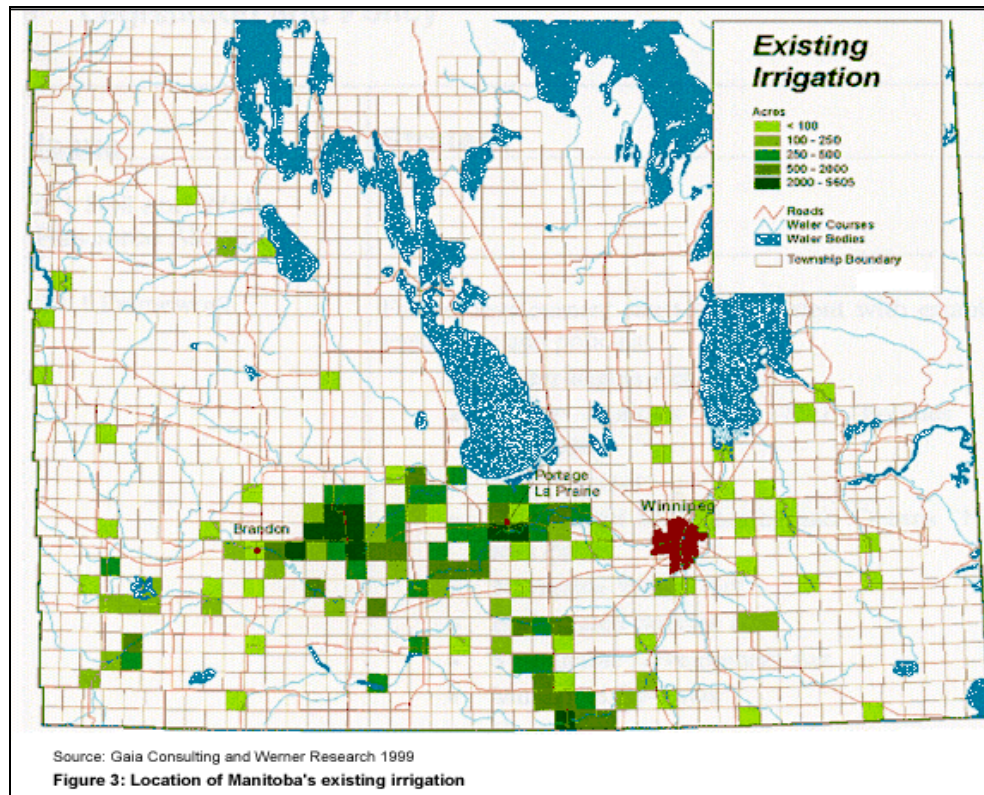


Manitoba^{251, 252, 253}

Most of Manitoba's irrigated acreage (28,000 ha in 2000) lies in an area running east from Brandon to Portage La Prairie then south to the Canada-U.S border (see figure).

- Potato production accounts for 69% of irrigated land area. Lesser irrigated crops include cereals at 16%, vegetable crops 5%, and forages 4% of irrigated land.
- Highest contributors to farm receipts among irrigated crops are potatoes, greenhouse and vegetables crops.
- Freshwater use for crop irrigation in 1996 amounted to 24.7 million m³.
- Most irrigated lands are served by sprinkler systems.

Irrigated Crop Lands in Manitoba



Manitoba Agriculture, Food and Rural Initiatives. *Manitoba Agricultural Yearbook 2002*

Ontario^{254, 255, 256, 257}

- Ontario farmers irrigated some 50,000 ha in 2000. Major production areas include Norfolk County (tobacco, floriculture and nursery and vegetables); Hamilton, New Tecumseth and Georgina (vegetables, sod and nursery); Niagara (greenhouse vegetables and flowers and tender fruit); and Leamington-Essex (greenhouse vegetables and floriculture and nursery). The New Liskeard area of north-central Ontario is regionally important for vegetable production.
- With more than 900 ha under cover (plastic and glass) the province is home to 50% of Canada's total greenhouse area.
- Crop irrigation withdrawals were estimated at 114 million m³ in 1996 and 121 million m³ in 2000.
- Highest receipts among irrigated crops come from floriculture and nursery, greenhouse vegetables and tobacco.

Quebec^{258, 259, 260}

- The major irrigated crop-producing areas include the Montérégie region (vegetables); and the Lanaudière and Central Quebec regions (vegetables and cranberries).
- The Montérégie region is home to 40% of the province's irrigated croplands followed by Lanaudière at 25%.
- Among irrigated crops, the highest contribution to gross farm receipts came from vegetables, greenhouse and nursery crops.
- Current water requirements for irrigation are estimated to be 44.6 million m³/yr. Environment Canada's 1996 Industrial Water Use survey estimate was 58.4 million m³/yr.
- Water usage is broken out as follows: field crops 75%, cranberries 18%, and greenhouse production 7%. Field crop production draws 41% of its water from farm ponds, 35% from a river or lake, and 14% from private wells.
- Greenhouse production of vegetables and ornamentals encompasses a total of 230 ha. Twenty-seven percent (27%) is in Montérégie, 20% in the Laurentians Region, and 10% in the Central Quebec region. Total greenhouse water usage amounts to 3.34 million m³/yr. Sixty percent (60%) of this water comes from private wells and 23% from public water systems.
- Sprinkler systems are used by 50% of irrigating producers, spray guns by 23%, and drip systems by 20%.
- Water supply shortages where they occur have mainly affected the vegetable production sector.

Nova Scotia^{261, 262, 263}

- Nova Scotia's primary crop producing areas are located in the Annapolis Valley and Cape Breton.
- Irrigation is common on blueberries, apples, strawberries, vegetables and horticultural crops.
- Among irrigated crops, the highest contribution to gross farm receipts came from fruits (32%), floriculture and nursery (25%), and vegetables (14%).
- Irrigation withdrawals were estimated at 2.27 million m³ in 1996.
- The occurrence of 4 record-setting dry summers since 1997 has increased interest in irrigation systems development.

New Brunswick^{264, 265, 266}

- Crop irrigation is found mainly in the Fredericton-Sussex area with 20% of agricultural lands under irrigation. Primary crops include vegetables and cranberries.
- Other areas with more limited irrigation include the Upper Saint John River valley (potatoes), Kent and Westmoreland (vegetables) and Northeast (blueberries).
- Among irrigated crops, potatoes (56%) and floriculture/nursery crops (26%) were the highest contributors to total farm receipts.
- New Brunswick's irrigation water usage in 1996 was estimated to be 1.44 million m³.

Prince Edward Island^{267, 268, 269}

- Primary irrigated crops include potatoes, blueberries and cole crops.
- Only 3-4% of producers irrigate and only on occasion.
- Potatoes account for more than 83% of crop receipts.
- PEI's agricultural water usage in 1996 was estimated to be 3.62 million m³; 1.9 million m³ in livestock production and 1.72 million m³ for crop irrigation.

- About 8,000 ha have been identified of potential interest for expanded irrigation.
- Potato processors are promoting irrigation to increase potato size.

Newfoundland and Labrador^{270, 271, 272}

- There are only some 180 ha currently irrigated and it's mainly for frost protection.
- Floriculture/nursery and vegetable production account for 88% of crop receipts.
- The province's irrigation water usage in 1996 was estimated to be 0.15 million m³.

Yukon and Northwest Territories²⁷³

- The Yukon had 2,840 ha in crops with 565 ha under irrigation. Total crop area in NWT was 91 ha with 7 ha irrigated. Tame hay, oats and alfalfa occupy most of the Yukon cropped area.
- Greenhouse vegetables and flowers are the largest contributors to crop receipts in both territories.

7.3.3 Programs, Issues and Obstacles

Further expansion of irrigated-crop production in Canada is a virtual certainty. The pressure will come not only because of increased domestic and foreign demand for Canadian-grown products but also because producers will act to minimize the impact of climate change and variability on crop yield and quality.

A recent study by the Prairie Farm Rehabilitation Administration (PFRA) considered Canada's expected role in meeting the global demand for agricultural commodities²⁷⁴. It focused on the prairies and examined existing proposals which call for the development of an additional 380,000-1,830,000 ha of irrigated land within Alberta, Saskatchewan and Manitoba²⁷⁵. The proposed expansions include an additional 78,180 ha in Alberta, 50,850-1,500,000 ha in Saskatchewan and 250,000 ha in Manitoba. The higher end of the range reported for Saskatchewan is dependent on diverting 780,000 dam³ of water from the North Saskatchewan to the South Saskatchewan River Basin. These expansions represent a 65-300% increase in irrigated prairie lands.

A 2003 report by the Saskatchewan Dept of Agriculture, Food and Rural Revitalization also examined irrigation opportunities and concluded that, "the full economic benefit of irrigation projects are only realized when high value, non-traditional crops such as potatoes, timothy hay and dry beans are grown in conjunction with in-province agricultural processing, intensive livestock production or similar value added activity."²⁷⁶

Given the natural water deficits that exist throughout much of the southern prairies the viability of the proposed irrigated-area increases assumes continued use of supply management measures including major inter-basin diversions and constructed storages along with improved regional and farm-level irrigation practices. The PFRA report acknowledges the likelihood that environmental concerns, competing water uses and economic constraints are likely to moderate the scope and form of future development.

Diversification of irrigated production into higher-value crops on lower acreages and matching crop types to local soil and climate conditions can reduce overall water demands and withdrawals in watersheds where water availability on a sustained and equitable basis is a problem. Maintaining soil health through addition or retention of organic matter, avoidance of compaction and reduced tillage are also effective in reducing water demand and increasing irrigation efficiency.

Agriculture and Agri-Food Canada recently (2002-03) completed an in-depth survey of water supply and management issues facing Canada's agriculture industry²⁷⁷. The survey included extensive and separate regional consultations in British Columbia, the Prairies, Ontario, Quebec and the

Atlantic Provinces. It was intended to provide direction and support to the existing 4-year (2002-06), \$60M National Water Supply Expansion Program (NWSEP).

The survey illustrates that some constraints are widespread in nature and impact on the industry in six or more provinces (see table). These include the lack of information on water availability and demand, seasonal shortages of supply, limited uptake of conservation measures, and limited local capacity to fund regional water supply development. Constraints were described as “most widespread in location and type in the Prairies and British Columbia” and “primarily related to irrigation supplies” in the central and eastern provinces.

The study concluded that, in many areas of the country, constraints to agricultural water use and agricultural expansion could be accommodated through improvements in water-use efficiency without the need to expand supplies. It also suggests that deficiencies in current practices are often a result of the limited education, extension and technical assistance opportunities provided to producers.

The final study report suggests that the NWSE Program should be guided by the following priorities:

- Improving knowledge of surface and ground water resources in terms of the availability of supplies and the imposition of demands by all sectors
- Encouraging more efficient use of available water
- Improving planning and communication among all parties involved in water resource development and water withdrawals
- Facilitating further development of water supply and distribution infrastructure needed to support agricultural industry sustainability and growth.

The report cautions that the existing timeframe and funding commitments under NWESP are considered insufficient to address identified issues and constraints facing the industry.

Constraints to Agricultural Water Supply Development and Use in Canada
(Main constraints are identified in **bold**)

Constraint	BC	AB	SK	MB	ON	PQ	NB	NS	PEI	N/L
Fully allocated supplies	x	X			x					
Limited supply	X	X	x	x						
Lack of information on groundwater resources	x	x	X	X	x	X	x	x		
Lack of information on supply/demand	X	X	X	x	X	X	X	X	x	X
Seasonal water shortages	x				X	x	X	X	X	
Regulatory/Licensing issues	x				X		X	X	X	
Poor quality			X	x		x				x
Lack of infrastructure	x	x	X	X		X				
Limited uptake of water conservation	X	x	x		x	x	X	X	X	
Limited local capacity	x	X	X	X	x		x	x	x	
Competition	X	x			X		x	x		
Lack of technical assistance	x					x	x	X	x	

It remains unclear what portion of NWSEP funding might be available to assist existing crop irrigators in becoming more water efficient vs. what is intended to go toward investment in water supply development and expansion. In this regard, the NWSEP constraints analysis differs from a related survey of U.S. crop irrigators (see discussion in the following section) in that the Canadian study did not specifically explore what could be done to enhance the productivity of existing water usage and thereby create growth opportunities without expanding withdrawals. Given the current economic climate for agricultural production in Canada and elsewhere, it is hard to imagine producers investing in more efficient water use practices and technologies without the increased cost-share assistance from governments.

7.4 CROP IRRIGATION PRACTICES IN OTHER COUNTRIES

7.4.1 United States

Overview of Irrigated Crop Production

Crop irrigation accounts for 40% of all freshwater withdrawals in the U.S. and 64% of all withdrawals when thermal power generation usage is excluded. Total agricultural water withdrawals amounted to 197 billion m³ in 2000 of which 96% (189 billion m³) was used for crop irrigation²⁷⁸. The 25 million ha of irrigated cropland represented only 16% of the country's harvested lands, but accounted for 49% of total crop sales. Crop irrigation is responsible for 90% of all consumptive water use in the western states and 80% nationwide.

In terms of overall area under irrigation, the most extensively irrigated crops (from highest to lowest) are corn for grain, alfalfa hay, wheat, cotton, soybeans, orchard crops, rice and vegetables²⁷⁹. Corn for grain and alfalfa dominate irrigated acreage in the U.S. West where they form the main feedstock for the \$45 billion US livestock industry.

Greatest concentrations of irrigated cropland are found in California, Texas and Nebraska²⁸⁰. California accounts for about 22% of total irrigation use on 16% of nationally irrigated land. It along with the Pacific Northwest, Colorado, Texas Gulf, Great Basin and Rio Grande regions are responsible for about two-thirds of all irrigation usage.

Irrigated lands in the American West produce 72% of all crop sales on only 27% of total harvested acreage²⁸¹. High-valued orchards, berries, vegetables and nursery crops account for 60% of the West's crop sales on 15% of irrigated lands. Field and forage crops account for most of the remaining 40% while occupying more than 70% of total irrigated area. Average crop sales (1997) per harvested acre were \$950 US on irrigated land and \$120 US/acre on dry land²⁸².

In the eastern U.S., only 7% of harvested lands are irrigated²⁸³. The largest acreages are in rice, soybeans and corn for grain, however, overall sales value is dominated by nursery crops, orchards, vegetables and grains other than corn. Average sales per acre were \$1,200 US irrigated and \$200/acre dry land.

Irrigation Acreages, Water Usage and System Types in Selected U.S. States (1998)²⁸⁴

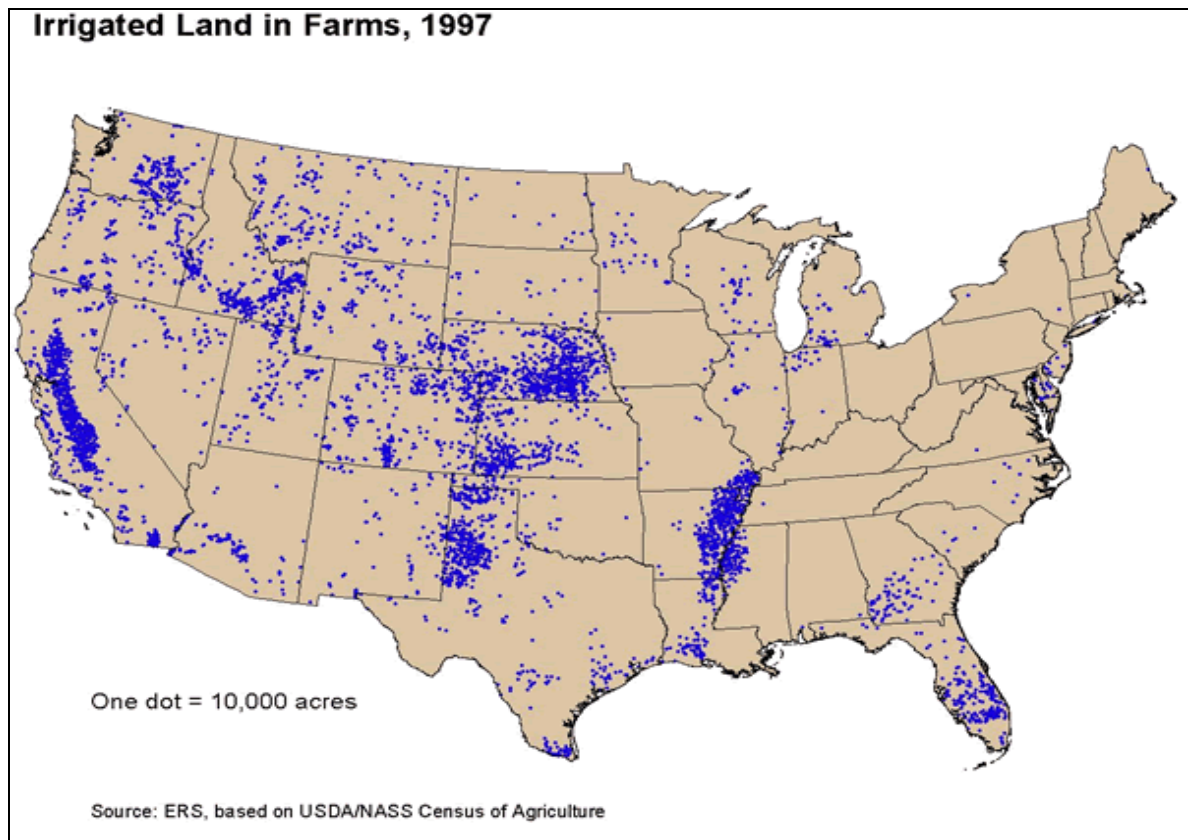
State	Annual Usage (million m ³)	Irrigated Area (ha x 1000)	Irrigated Area by System Type (ha x 1000)		
			Sprinkler	Micro-irrigation	Gravity/Surface
Arizona	7.460	395	74	6	315

California	42,140	4,087	672	1,201	2,214
Florida	5,925	834	208	285	340
New Mexico	3,950	404	187	3	214
Total (U.S)	189,000	25,043	11,453 (45.7%)	1,692 (6.8%)	11,898 (47.5%)

On a national basis, the average annual rate of water use in irrigation is 7,560 m³/ irrigated ha. This compares to a rate of 5,220 m³/ irrigated ha in Canada. The higher U.S rate can be attributed to a combination of factors including climate, relative distribution of crop types, water availability, and irrigation practices.

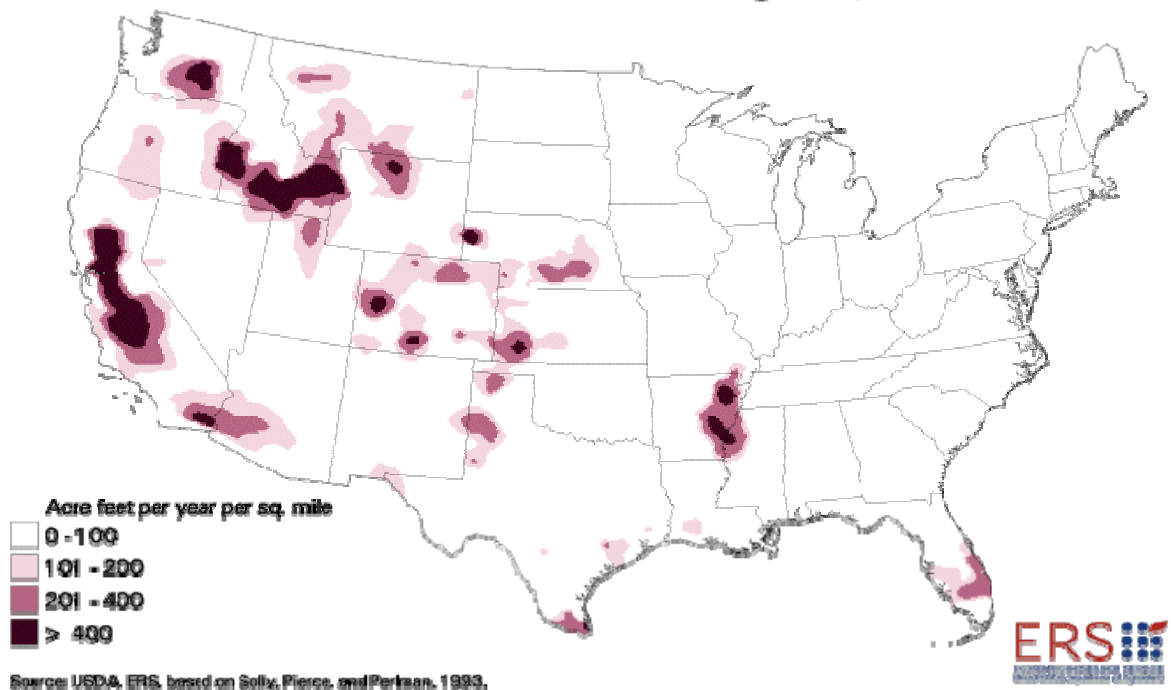
There has been a 20% decline in the use of gravity or surface flood systems since 1979 but they are still used on almost half of all irrigated cropland nation-wide²⁸⁵. Gravity flow systems dominate the irrigation of pastureland, wild hay and rice and significantly outweigh the use of sprinklers on alfalfa, mixed forages, cotton, soybeans and orchard lands. Partial conversion away from gravity systems has contributed to a 12% decline in overall irrigation water use since the peak of the early 1980s. Gravity methods still account for 63% of all crop irrigation usage in the country.

A Utah State University extension service study concluded that the average efficiency of surface flood systems is only about 50% of that of a well designed and operated sprinkler system²⁸⁶. The same study also reported that crop yields in alfalfa and wheat were 40-50% higher using sprinklers for the same amount of applied water. Sprinklers began replacing gravity systems in Utah beginning in the early 1950s, but are currently in use on only 40% of the state's 1.3 million acres (0.526 million ha) of irrigated cropland.



Economic Research Service, US Department of Agriculture. See online at www.ers.usda.gov/data/maps

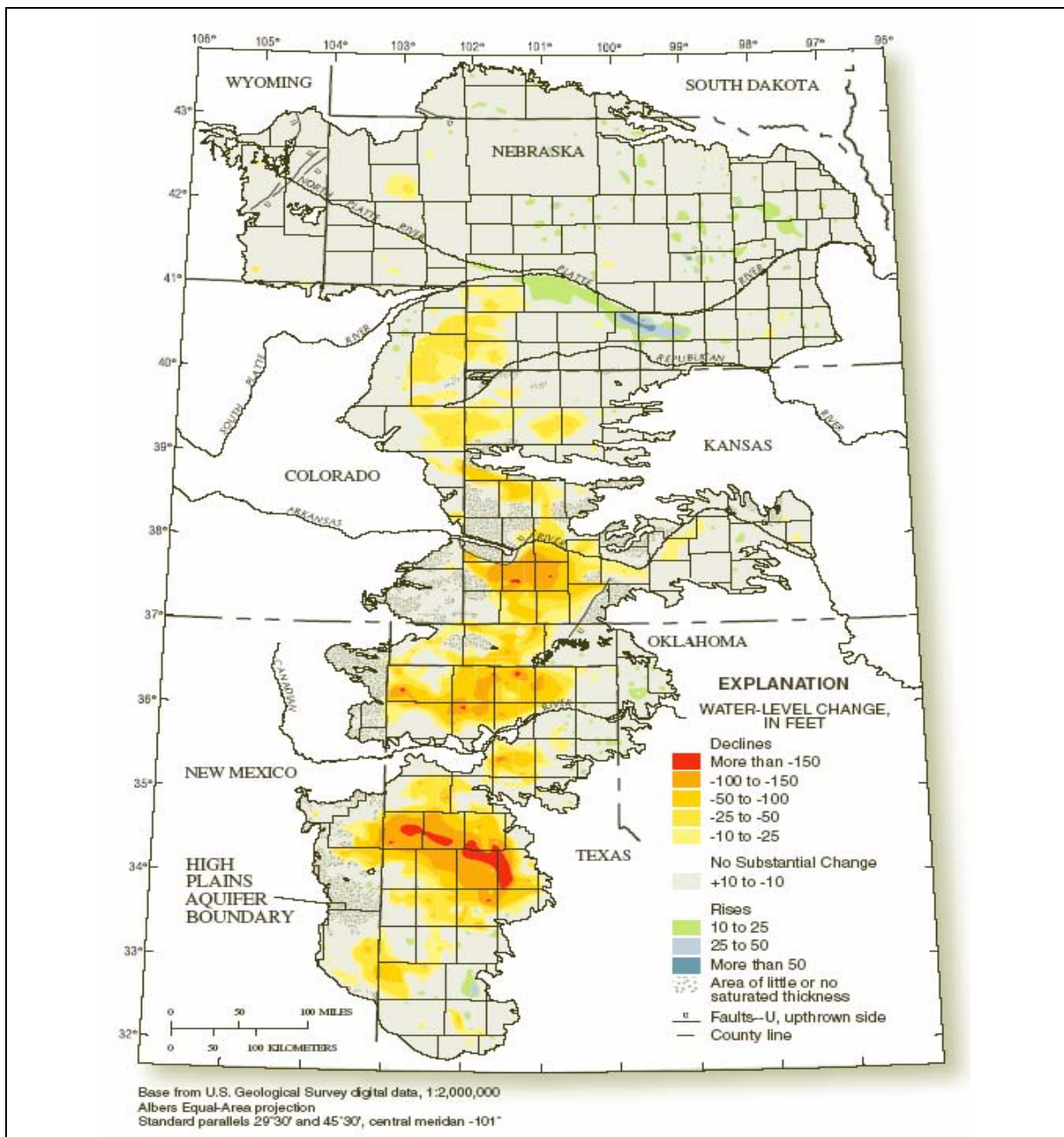
Fresh Water Withdrawals for Irrigation, 1990



Economic Research Service, US Department of Agriculture. See online at www.ers.usda.gov/data/maps

The case of the High Plains aquifer has received international notoriety with respect to the impacts of crop irrigation on ground water and in turn on surface water resources. The immense aquifer, which underlies parts of 8 states (see figure), was first developed for irrigation usage in the early 1940s. Irrigation withdrawals began to expand rapidly after 1950. Data from 3,860 observation wells indicate that over the period 1950-2002 the mean water level across the entire aquifer has fallen about 12 feet (3.7m)²⁸⁷. Large areas with water table declines of more than 50 feet (15.2m) are evident in southwest Kansas, east-central New Mexico, the central part of the Oklahoma Panhandle, and the western part of the Texas Panhandle.

Water Level Changes in the High Plains Aquifer from Pre-Development (circa 1950) to 2002



US Geological Survey. (2004). *Water Level Changes in the High Plains Aquifer, Predevelopment to 2002*. Fact Sheet #2004-3026. See online at <http://infotrek.er.usgs.gov/pubs>

U.S. Water Conservation and Use-Efficiency Initiatives

U.S. agriculture's conversion to more water-efficient irrigation technologies and practices has been a slow and evolving process²⁸⁸. This is particularly true in the West with its historic roots in guaranteed water rights and massive supply management schemes. In the absence of an efficient water-rights trading system or other mechanisms for reassigning rights, the prior appropriation doctrine provides little incentive for existing rights holders to reduce their water usage through

investing in capital improvements. These and other obstacles were assessed as part of the 1998 Farm and Ranch Irrigation Survey (FRIS)²⁸⁹. The following table explores those barriers for the four states focused on in this report.

Barriers to Making Water and Energy Conservation - 1998 Farm and Ranch Survey
(% of respondents reporting)

Reported Barrier (based on total farms reporting a reason)	Arizona	California	Florida	New Mexico	U.S. Wide
Risk of lower crop yield or quality	20	48	27	13	29
Physical limitations of crop or field conditions	21	18	7	22	26
Savings will not cover costs	56	62	15	35	52
Unable to finance improvements	56	34	11	47	52
Landlord won't share in cost	19	4	2	7	18
Uncertainty over future water rights	15	20	8	28	21
Won't be farming long enough to justify making improvements	27	24	13	10	25
Other reason	8	4	5	34	13
Percentage of farms that have not investigated improvements	55	30	45	33	36

Some general observations that can be drawn from the survey include:

- One third or more of producers in all four states had not bothered to investigate making any type of improvements. Lack of interest in investigating improvements was highest in Arizona at 55% of those surveyed
- Cost or financing issues (i.e. return on investment and ability to finance) were seen as the largest barrier in Arizona, California and New Mexico but less of an issue in Florida. The nation-wide average price paid for off-farm surface water supplies was \$16 US per acre-foot or \$41 per acre. The price is generally based on the operation and maintenance costs of the delivery system. One third of respondents felt that water-cost reductions through conservation improvements would not cover the costs of those improvements.
- Less than one quarter of respondents in all four states and only 7% of Florida respondents saw physical limitations of crop or field conditions as an barrier to making improvements
- Uncertainty over future water rights was highest in New Mexico and California and lowest in Florida. This issue was of greatest concern in states facing rapid urban growth and escalating environmental demands.
- The potential for reduced crop yield or quality is a concern to almost half of California producers but to less than one quarter of producers in the other states. They were, however, still the largest single area of concern to Florida growers.

Without direct government assistance or the forced incentives of water shortages and/or higher prices for purchased water, producers using gravity systems are not as likely to convert to more efficient sprinklers. On the positive side, those with large acreages who did make the change to sprinklers have found the benefits of centre-pivot low-pressure technologies in reducing both energy and labour costs²⁹⁰. Since 1979 in the Plains States there has been an ongoing shift away from big gun, solid set and hand move high pressure systems to more water, energy and labour-efficient centre-pivot sprinklers.

The survey found that 46% of sprinkler-irrigated acreage in the U.S West was served by low-pressure (<30 psi) systems and an additional 32% was served by moderate pressure systems (30-60

psi)²⁹¹. For gravity flow systems, FRIS determined that only about 40% of irrigated cropland was subject to some form of ‘conserving’ practice including use of above or below ground pipe, lined-ditches and laser-leveled basins.

FRIS concluded that, “significant potential exists for improvement in irrigation water-use efficiency”. For farms served by pressure or sprinkler systems this potential was determined to range from 52% for larger farms to 66% for smaller farms. Smaller farms are defined as those with annual farm sales of less than \$250,000 US. For those using gravity systems the conservation improvement potential was 36% on larger farms and 57% on smaller farms. Realizing these improvements can depend on parallel initiatives to upgrade the delivery system to ensure that water is available to the farmer when it is most needed.

Over the years, the United States Department of Agriculture (USDA) and the Interior Department’s Bureau of Reclamation have had a variety of cost-share and technical assistance programs in place to assist farmers in converting to more water-efficient practices with a focus on smaller farms. An estimated 21,000 irrigated farms (8 million acres) received USDA cost-share funding for irrigation or drainage improvements in the period 1994-98. Other federal programs provided cost sharing to 12,000 farms (3 million acres) while state, irrigation district and local cost-share initiatives included 13,000 farms (4 million acres). Currently approved multi-year federal funding (2002 Farm Act) for irrigation and drainage-related program initiatives is scheduled to increase from \$400 million US in 2004 to \$ 520 million US in 2007. Several states including Arizona, Colorado, Kansas, Montana, Texas, Utah and Washington also provide financial support for water conservation.

The small-farm focus, predominant in existing programs, is under review since it is apparent that this approach does not get at larger conservation objectives intended to “support environmental policy goals as well as Native American trust responsibilities”²⁹². Program improvements being considered include expanded use of water banks, water markets and conserved-water-right programs²⁹³. Changes in federal water prices including higher rates, per unit charges and block-rate pricing are being examined as a possible complement to other initiatives.

Improved irrigation scheduling has been identified as another area where significant water-efficiency gains can be made²⁹⁴. Over 70% of western U.S farmers use observed plant condition or soil feel as their means for determining when to irrigate. Only 8% use soil-moisture sensing devices, 4% use commercial scheduling services, and 1% use farm-calibrated computer simulation models. Operators of smaller farms were found to be less likely to use more sophisticated scheduling methods.

An irrigation success story is that of the Eastern Oregon Farming Company, which uses field-level monitoring and computer simulation to direct daily irrigation operations on 10,500 acres (4,250 ha) of cropland. The system paid for itself in energy savings alone in its first year of operation²⁹⁵. It is said to be accurate to 3%± in predicting and meeting actual crop water requirements.

Use of reclaimed municipal and food-processing wastewaters for crop irrigation is receiving increased interest but has seen relatively limited application to date. The main challenges in expanding the application arise from producer and public concerns over the possible risks to plant and animal health and food safety and uncertainties over the financial aspects of putting the system in place. While use of reclaimed water can produce mutual benefits for the farmer and wastewater utility, the opportunities are essentially confined to lands in close proximity to a major urban area.

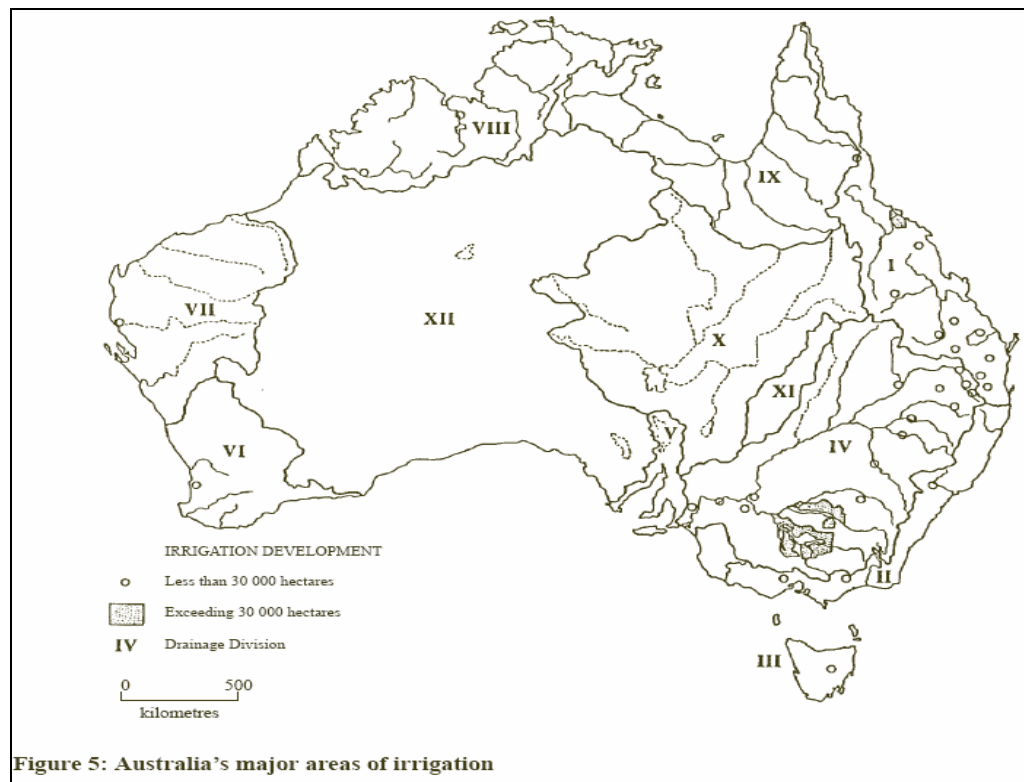
7.4.2 Australia

Overview of Irrigated Crop Production^{296, 297}

Australia's arid climate does not easily support intensive crop production. It is, therefore, not surprising that water management practices within the irrigated crop sector have become a focal point for national and state water reforms.

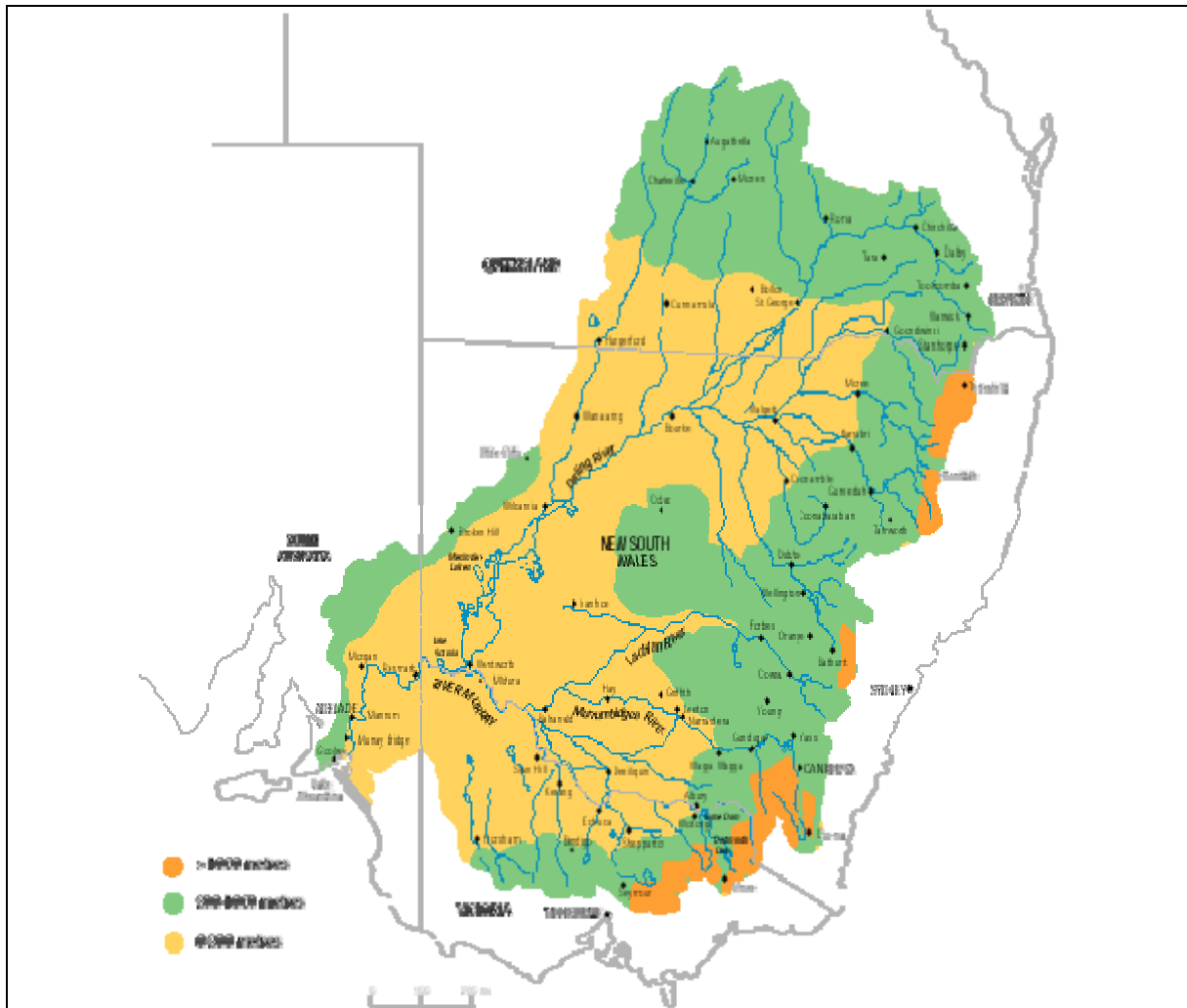
- Australia's agriculture industry had gross receipts of \$39.6 billion AU in 2001-02. Receipts from irrigated crop production accounted for 25% of that output.
- By order of (decreasing) value, the major economic contributors among irrigated crops are cotton, fruit and grapes, sugar cane, and vegetables.
- Total land under irrigation amounted to 2.545 million ha. This represents only 0.5% of all production lands. Irrigated acreages were distributed among pastures 38.3%, cereals 20.7%, cotton 16.4%, sugar cane 9.3%, grapes 5.4%, fruit 4.6%, vegetables 4.3% and other 3.2%.
- Irrigation water withdrawals for the year were 15.5 billion m³, accounting for 75% of total freshwater use by all sectors. The country-wide mean water-use productivity in irrigated crop production is 6,090 m³/ha/year.
- Water use in crop irrigation is the leading cause of unsustainable abstractions from both surface and ground water. The 2000 National Water Resources Assessment showed that 26% of Australia's river basins and 34% of its groundwater management units were nearing or exceeding their sustainable extraction limits.
- Because of the country's dry climate, irrigation is used on 91% of all cotton producing lands, 84% of all vegetable lands, 79% of fruit and 43% of sugar cane.
- The majority of Australia's irrigated lands lie in the 1.06 million km² Murray-Darling Basin, which spans parts of 4 states, i.e. New South Wales, Victoria, Queensland and South Australia. Annual precipitation over much of the basin averages 600-700 mm except for a small band along the eastern perimeter, which receives in the range of 700-800 mm.

Areas of Concentrated Irrigated Crop Production in Australia



Australian Bureau of Statistics. (2004). *Water Use on Australian Farms 2002-03*. See online at www.ausstats.abs.gov.au/ausstats

Murray-Darling River Basin in Australia



Murray-Darling Basin Commission. (2004). *Annual Report 2003-2004*. See online at www.mdbc.gov.au/subs/annual_reports

Australian Agricultural Water Reforms

Under Australia's ongoing water reforms package, commonwealth and state governments have identified improving agricultural water use efficiency as a major priority. "Irrigation water is becoming less available, more tradable and more expensive. The irrigation industry is facing restrictions, and in some cases reductions, in water availability and entitlements. Future growth in irrigation now depends on efficiency gains in existing enterprises, rather than further use of scarce water resources"²⁹⁸.

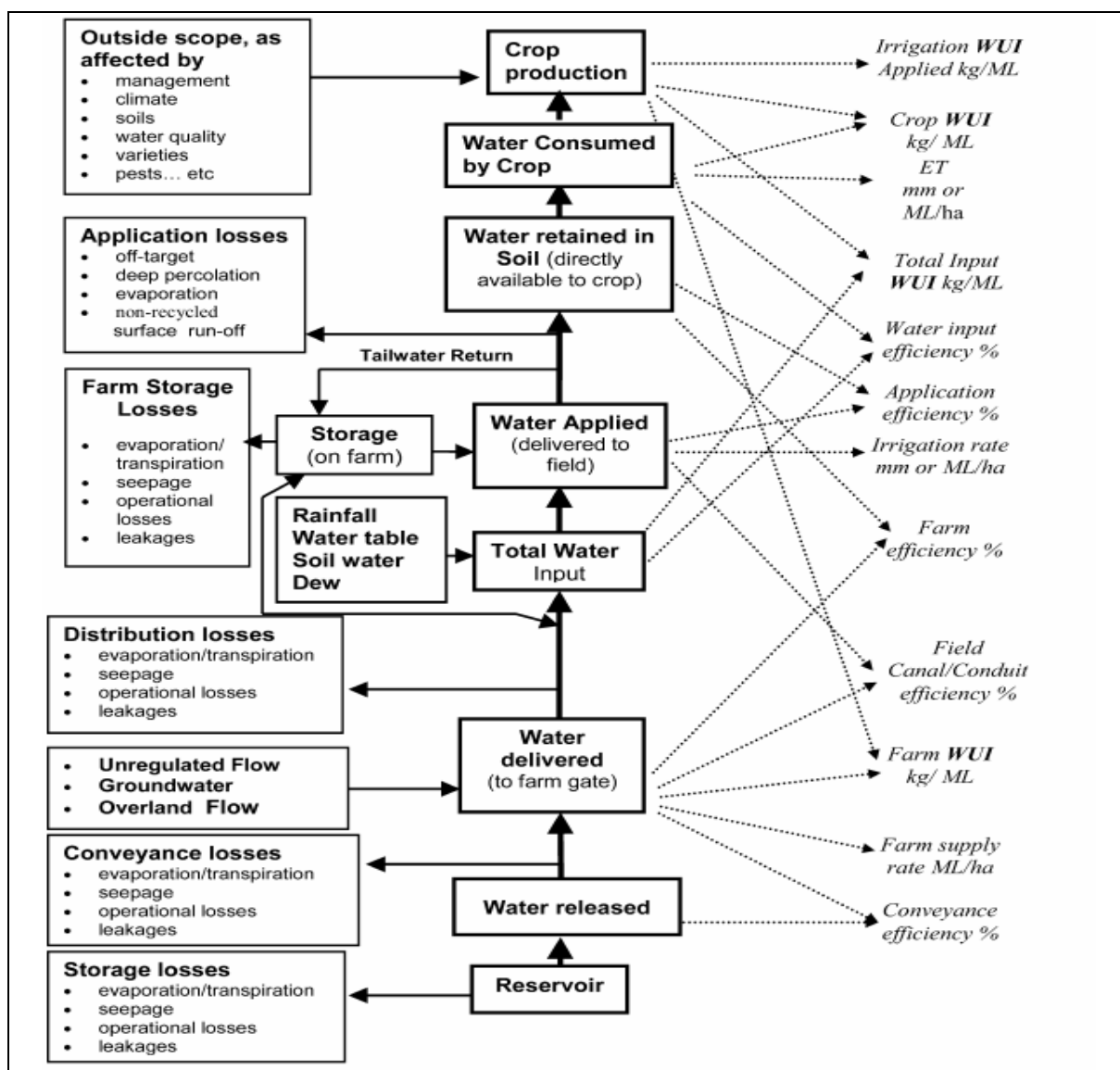
Since 1997, the Murray-Darling has had a 'cap' in place that restricted total water withdrawals to levels as they existed in 1993-94. The net effect is that in order for any new water-related development to proceed, there must be a corresponding decrease through efficiencies in existing development or the transfer/purchase of an existing water right. Each state is responsible for implementing the provisions.

Improved water-use efficiency in the irrigation sector is to be achieved through a combination of four mechanisms:

- Full-cost pricing including environmental costs
- Water-use monitoring as part of water administration and water allocation processes
- Progressive implementation of volumetric metering and reporting with a priority on heavily and over-allocated watersheds and aquifers
- Establishment of water-use efficiency targets.

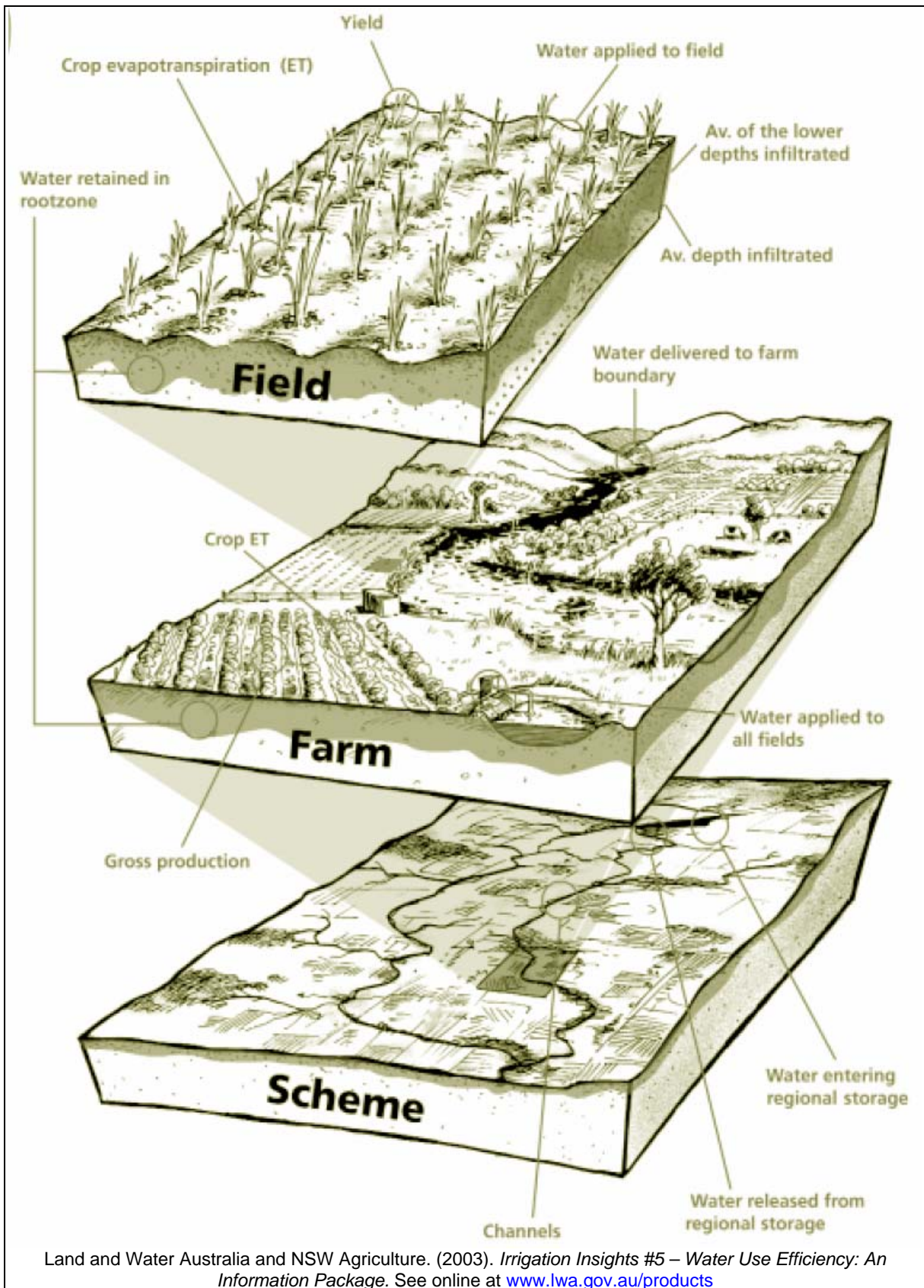
Research and field trials are underway to look at ‘water-use efficiency’ and water balances at multiple scales from the basin-level down to the field-level and to factoring in the economic return or ‘water-use productivity’ as depicted in the following figures. Efforts are focused on identification and quantification of major water loss pathways and examination of alternative measures to reduce these losses. The goal is to improve and coordinate the capabilities of water management agencies and individual producers in managing water-use efficiency throughout entire water withdrawal and delivery systems.

Framework for Evaluating Water-Use Efficiency in Crop Irrigation



Land and Water Australia and NSW Agriculture. (2003). *Irrigation Insights #5 – Water Use Efficiency: An Information Package*. See online at www.lwa.gov.au/products

Nested Approach for Performing Water Balance Calculations



Crop Irrigation Case Study: State of Victoria, AU Agricultural Water-Use Reforms

Background	
<ul style="list-style-type: none"> One third of Victoria's rivers are in poor condition. Two-thirds of wetlands have dried up or are severely degraded. The state has had 8 consecutive years of below normal precipitation. More than 200 communities are on permanent water restrictions. Water shortages and conflicts among urban and rural water users are commonplace. The state's population is expected to grow by 30% by the year 2030. Crop irrigation accounts for 77% of total water withdrawals. Irrigated crops contribute 30% of all agricultural output Authorized national and state water reforms prohibit expanded withdrawals, require roll backs of some entitlements, and require irrigation system operators and individual irrigators to become more efficient in using water. Victoria's multi-faceted reform package 'Securing Our Water Future Together' contains the following elements targeted at the crop- irrigation sector. 	
Program Element	Actions
Improved Water Trading	<ul style="list-style-type: none"> Water entitlements are being 'unbundled' from land ownership Enables individuals to lease water to and from other people Someone can own shares of available water without having to own land to use it on
Preventing 'water barons'	<ul style="list-style-type: none"> Government regulations limit non-water user ownership to 10% of available supplies in each system to prevent price gouging All water trading will be publicly registered, tracked and reported
More secure entitlements	<ul style="list-style-type: none"> Ongoing entitlements or 'sales' water in excess of a user's needs may be traded The government will return 20% of all sales water to rivers \$100 million AU is being invested in transitional assistance to farmers and in modernizing irrigation channels
Smarter water delivery	<ul style="list-style-type: none"> A \$320 million trust will allow the state to invest in new channel automation technology that will save up to 30% of water currently lost in open channel delivery Metering will be required of all 'significant' water users with subsidies for existing users not currently metered Unused, uneconomic and environmentally problematic irrigation channels will be closed through a negotiated process
Better on-farm practices	<ul style="list-style-type: none"> Smarter delivery is expected to assist farmers in adopting more efficient irrigation technologies \$15 million is being made available to farmers for conversion to improved practices Performance standards will be raised to ensure that poor practices are gradually phased out.

7.4.3 Europe

European Union (EU) Policy and Program Directions for Irrigated Agriculture

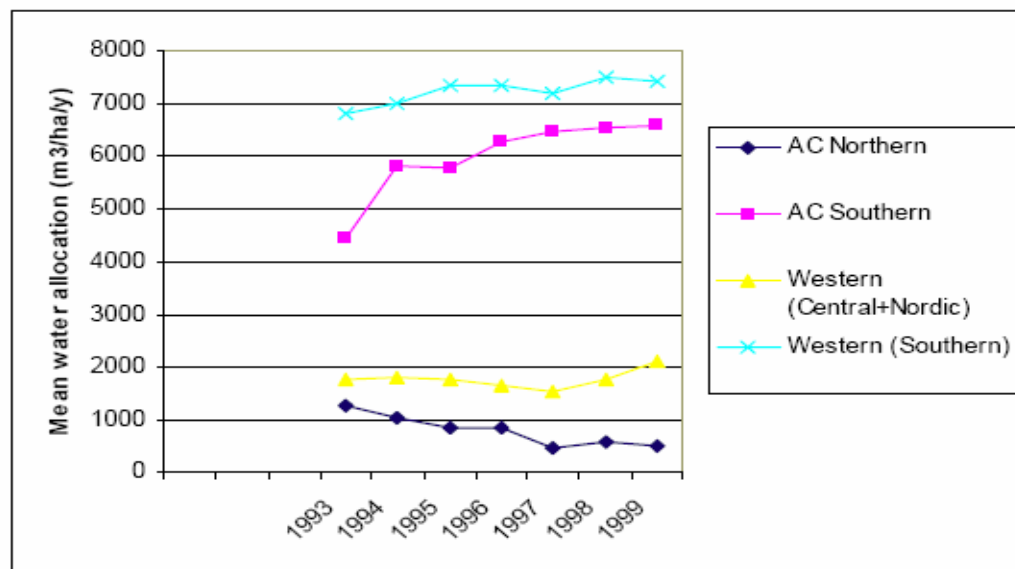
The European Union's Common Agricultural Policy provides the basis for guiding necessary improvements to European irrigation practices²⁹⁹. Crop irrigation has been identified as a major user of water and a significant contributor to widespread environmental concerns. Irrigated production accounts for 30% of overall EU water withdrawals and as much as 60-70% of total withdrawals in some western and southern countries.

The European Commission Water Framework Directive requires EU member countries to apply cost accounting and pricing mechanisms that provide adequate incentives for all users to use water resources efficiently and that will ensure that each economic sector contributes to the cost of water services including those related to the environment and resource sustainability. The goal is to have these mechanisms fully operational by 2010.

All farmers are expected to maintain minimum ‘good farming practice’ standards. Where it is considered necessary for a farmer to take additional measures in order to “protect the environment and maintain the countryside” he/she is to be compensated for the added costs. This financial assistance, referred to as an ‘agri-environmental scheme’, requires the farmer to make a minimum 5-year commitment to implement and maintain the additional measures. As of 2001, more than 27% of all EU agricultural land area was covered by such schemes. The Common Agricultural Policy makes ‘cross-compliance’ a condition for assistance.

There is currently a broad range of irrigation technologies in use across Europe with less-efficient gravity systems still being fairly common in the south. In the face of the Common Agricultural Policy requirements, many European countries are looking to the results of ongoing improvements in neighbouring EU countries as well as evaluating emerging crop irrigation practices in Australia and the United States (California) in deciding the most appropriate direction to take.

Mean Water Allocation for Crop Irrigation among EU Regions



European Environment Agency. (2004). *Indicator Fact Sheet: Water Use for Irrigation*. See online at www.eea.eu.int/indicators/all_factsheets_box

Notes:

- Western (Southern) region consists of: **France**, Greece, Italy Portugal, Spain
- Western (Central+Nordic): Austria, Belgium, Denmark, Finland, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Sweden, Switzerland, **United Kingdom**
- AC (South): Cyprus, Malta, Turkey
- AC (North): Bulgaria, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia

England and Wales³⁰⁰

With only 108,000 ha or 0.6% of all agricultural lands being irrigated and much of that on a relatively infrequent basis and for higher-value crops, the UK's agricultural crop-water usage component is the smallest among the countries included in this study. Surface water withdrawals account for 80% of crop water usage.

The 2003 Water Resources (EIA) Regulations require the proponent of a crop irrigation project that could have 'significant environmental effects' to complete an environmental impact assessment or statement prior to approval.

The UK Environment Agency's 2003 document 'Best Farming Practices: Profiting from a Good Environment' offers non-prescriptive guidance to farmers on a range of environmental matters³⁰¹. It is premised on preventing and solving environmental problems in a manner that should also be profitable to the farmer. In the area of water management, the focus is on planning and monitoring water use, detecting and repairing leakage, preventing surface and ground water pollution, monitoring crop-water needs, cooperatively scheduling irrigation operations, and exploring alternative sources, e.g. rainwater capture.

France³⁰²

France's agricultural sector has some 2.634 million ha of crop land under irrigation. This accounts for 9% of all arable land. Assuming that crop irrigation accounts for almost all agricultural water usage, the country-wide mean annual withdrawal rate is estimated to be about 12,000 m³/ha of irrigated land. More than 80% of withdrawals are obtained from surface water sources. Considerable expansion of irrigation acreage happened during the 1990s as a result of government assistance in the form of subsidized equipment purchases and low water prices.

More serious effects of irrigation over-abstraction on other water users and the environment are being felt in western France and in the Beauce region of the north³⁰³. The drought-like conditions experienced throughout large portions of Europe in recent years have, however, heightened concerns across many parts of the country.

7.5 SYNTHESIS OF CONSERVATION OPPORTUNITIES IN CROP IRRIGATION

Achieving a year-to-year and long-term sustainable balance among the interests of crop producers, other water users and the environment is one of the biggest water-related challenges facing land use planners and water managers in many parts of the country. Increasing productions demands, urban expansion within agricultural areas, water resource impacts of climate change, and resourcing constraints are sure to exacerbate that challenge.

It is clear from a wealth of Canadian and other experience that achieving success will require more innovative approaches to irrigation and more ingenuity in assigning responsibility and accountability. The role of global markets and competition in food commodities must also be addressed as they work to hinder the industry's ability to absorb the costs of making improvements in water-use efficiency. This innovation must integrate decision-making surrounding.

- Application of limits and priorities on water supply allocation
- Adoption of sound water management practices
- Selection and diversification of crops (i.e. water-use productivity)
- Use of economic instruments and legislative safeguards for enhancing the long-term security for producers, other water users and environmental health.

Best Practices for Water Conservation and Efficiency in Crop Irrigation

Component	Best Practices
Design	<ul style="list-style-type: none"> • Work collectively with other water users, other stakeholders and governments in developing a comprehensive watershed-based plan for developing, sharing and

	<p>sustaining the resource over the long term.</p> <ul style="list-style-type: none"> • Select the most water-efficient irrigation technologies and practices practicable • Choose sprinkler systems over gravity systems and low-moderate pressure over high-pressure systems to minimize conveyance and evaporative losses. • Use a mix of locally available water sources including surface, shallow ground water and deep groundwater where possible. • Assess water-use productivity; diversify production to include higher value and less water-use intensive crops. • Determine the legal aspects of water use; obtain all necessary permits and licenses
Operation and Maintenance	<ul style="list-style-type: none"> • Monitor the real-time water requirements of individual crops and plantings and irrigate only as is necessary to relieve or prevent water stress • Apply only as much water as the soil can hold; minimize runoff • Avoid irrigating under windy conditions and during hot periods of the day. • Monitor and maintain the irrigation system; repair leaks • Coordinate irrigation scheduling among users sharing the same resource
Policy Suggestions	<ul style="list-style-type: none"> • Require metering / monitoring and routine reporting of all significant water use • Establish water-use efficiency targets and guidelines; use incentives as needed • Periodically review allocations; implement reductions or reallocations as necessary to ensure water-use sustainability for combined extractive and in-stream interests. • Move toward full cost-accounting and cost-recovery on government investments in water infrastructure and services

7.6 LIVESTOCK PRODUCTION AND WATER MANAGEMENT

7.6.1 Canadian Livestock Production and Water Usage

Canadian agriculture's gross farm receipts from the production of livestock and livestock products amounted to \$21B in 2000³⁰⁴. Total freshwater withdrawals (1996) were approx. 600 million m³ or about one-sixth of that used in crop production³⁰⁵.

British Columbia^{306, 307, 308}

- British Columbia had gross farm receipts from livestock production of \$1.1 billion in 2000.
- Dairy accounted for 32%, poultry and eggs 29%, cattle and calves 28%, and hogs 4% of total receipts.
- Estimated freshwater use (1996) was 14.7 million m³.

Alberta^{309, 310}

- Alberta's gross farm receipts from livestock and livestock products totaled \$6.45B in 2000.
- Cattle and calves accounted for 74%, hogs 11%, and dairy 7% of total receipts.
- Estimated freshwater use (1996) was 61.5 million m³.

Saskatchewan^{311, 312, 313}

- Gross farm receipts from livestock production totaled \$1.8B in 2000.
- Estimated freshwater use (1996) was 40 million m³.

Manitoba^{314, 315}

- Manitoba's gross farm receipts from livestock production totaled \$1.6B in 2000.
- Estimated freshwater withdrawals (1996) were 23.6 million m³ for livestock production.

Ontario^{316, 317, 318, 319}

- Ontario's gross farm receipts from livestock and livestock products were \$4.84B in 2000.

- Estimated freshwater use was 59.2 million m³. More recent (2000) estimates put livestock withdrawals at 53 million m³ and aquaculture withdrawals at 28 million m³.

Quebec^{320, 321, 322}

- Quebec had gross farm receipts of \$4.3B from livestock and livestock products in 2000.
- Highest receipts came from dairy (43%), hogs (27%), poultry and eggs (15%) and cattle (13%).
- Current water requirements for livestock production are estimated at 73.5 million m³/yr for aquaculture and 56.0 million m³/yr for livestock. The Environment Canada 1996 water use survey estimated livestock usage to be 45 million m³/yr.
- Dairy, beef cattle and hog production are responsible for 92% of livestock water requirements.

Nova Scotia^{323, 324}

- Nova Scotia's livestock production farm receipts were \$0.27B in 2000.
- Highest receipts from livestock production were dairy 35%, poultry and eggs 30%, hogs 13%, and cattle and calves 13%.
- Livestock related water withdrawals (1996) amounted to 3.2 million m³.

New Brunswick^{325, 326}

- New Brunswick had gross farm receipts from livestock of \$0.18B in 2000.
- Highest receipts were from dairy 37%, poultry 24%, and hogs 21%.
- Livestock water usage in 1996 was estimated to be 2.37 million m³.

Prince Edward Island^{327, 328}

- Gross farm receipts from livestock totaled \$0.12B in 2000.
- Receipts were shared among dairy 43%, hogs 25%, and cattle and calves 23%.
- PEI's livestock water usage (1996) was estimated to be 1.9 million m³.

Newfoundland and Labrador^{329, 330}

- Newfoundland and Labrador's gross farm receipts from livestock were \$0.06B in 2000.
- Dairy, poultry and eggs account for 93% of livestock receipts.
- Livestock water withdrawals (1996) were 0.48 million m³.

The daily volume requirements for watering and cleaning vary considerably by animal as reflected in the following table. Agriculture Canada estimates put the distribution of livestock water use as watering 80%, sanitation and washing 10% and spillage 10%³³¹.

Livestock and Poultry Water Requirements^{332, 333, 334}

Animal	Water Requirement (L/day)
Dairy cattle	90
Calves	20
Beef cattle	45
Hogs	9
Sheep	7
Poultry: mature pullets, hens and chickens	0.2-0.6
Poultry: mature turkeys	1-1.8

7.6.2 Water Licensing Requirements and Conservation Practices

Water withdrawals for livestock watering are generally exempt from license or permit approvals in most provinces unless the water is being taken into storage prior to use. Like domestic supply needs, livestock watering normally takes precedence over irrigation and other uses in the event of water shortages. In most years, reports of producers not having sufficient supplies to water their livestock are rare. On the other hand, livestock operations have been hit hard when insufficient water is available to produce the corn and forage crops they depend on for feed.

The European Commission has established non-quantitative Best Available Techniques (BAT) directives for the poultry and pork industries³³⁵. The directives are applicable to operations involving more than 40,000 poultry, 2000 production pigs (>30kg) or 750 sows. Their focus is water-efficient cleaning practices and the elimination of waste in watering operations. Livestock producers are expected to:

- Clean animal housing and equipment with high-pressure cleaners after each production cycle or batch with the objective of “finding the balance between cleanliness and using as little water as possible”
- Carry out regular calibration of drinking-water systems to avoid any spillage
- Meter and keep records of water use
- Detect and repair leakages

The use of ‘mains’ water is not unusual in smaller livestock watering operations in the U.K. where costs for water are the equivalent of about \$1.63 / m³ Cdn.

Most Canadian jurisdictions offer a range of best practices guidance materials and workshops for livestock producers covering water management in relation to environmental and animal health issues³³⁶. A synthesis of available information from across Canada and from other countries suggests the following as appropriate best practices and policy considerations:

Best Practices for Livestock Water Management

Component	Best Practices
Design	<ul style="list-style-type: none">• Site intensive livestock operations in areas with adequate water supplies and minimal long-term risk of interference with and from other users/uses• Consider the need for water storage to ensure continued adequacy of supply in the event of low-water conditions.• Understand the legal aspects of water use; obtain all necessary permits and licenses.
Operation and Maintenance	<ul style="list-style-type: none">• Monitor water needs, water use and water waste throughout the operation; target areas where efficiency can be improved.• Maintain watering equipment floats and seals to prevent leakage, spillage and overflows• Install watering facilities that reduce livestock competition• Reduce water needs by reducing animal exposure to heat stress in summer months.
Policy Suggestions	<ul style="list-style-type: none">• Require metering / monitoring and routine reporting of all significant water use• Establish water-use efficiency targets and guidelines; use incentives as needed

8.0 RECREATIONAL SECTOR CONSERVATION PRACTICES

8.1 INTRODUCTION

While recreation industries are not traditionally seen as important contributors to water-use concerns at the national and provincial/territorial levels, the rapid growth of industry segments such as golf courses is causing local, regional and some provincial governments to express concern over long-term resource sustainability in selected urban or near-urban area watersheds. A cross-jurisdictional analysis of water-use issues associated with the recreation industries sector identified both golf courses and ski resorts as sub-sectors warranting attention.

8.2 GOLF COURSES

The increasing popularity of golf has seen the number of courses grow to more than 2,200 nationally³³⁷. There are more than 200 courses within a one-hour drive from downtown Toronto and several new courses are opening within the Greater Toronto area each year. Other areas with a high concentration of golf courses include the Greater Vancouver / Lower BC Mainland area with 88 courses, the Greater Montreal / Eastern Townships' area with 84, and the Greater Calgary area with 51.

Irrigation demands can vary considerably from course to course based on factors such as soil and turf types, climate, irrigation practices and system design. They may also vary significantly from year to year. A typical 18-hole course with irrigation coverage of all fairways, greens and tee boxes may use as much as 34 million litres of water in an average season³³⁸.



Industry associations and affiliates such as the Royal Canadian Golf Association (RCGA), Canadian Golf Superintendents Association, the U.S Golf Association and the American Society of Golf Course Architects have adopted environmental codes of practice and endorsed conservation action programs. Under programs like the Audubon Cooperative Sanctuary Program for Golf, course developers and operators receive guidance on best practices and have access to numerous case studies

demonstrating their application³³⁹. Topics addressed include water quality and quantity management, pest management, fertilizer use, wildlife and habitat protection. Uptake of the Audubon program is voluntary and in spite of its promotion by the RCGA and others, only 52 Canadian courses have so far received certification.

Europe's Committed to Green Programme for Golf is similar but ecologically broader than the Audubon Program³⁴⁰. Formally established as a charitable trust in the UK in 2000, there are some 500 participating courses in 17 countries. Twenty courses in six countries have received full accreditation. The programme, which has been extended to encompass other sports played on turf addresses the following elements:

- Nature conservation
- Landscape and cultural heritage
- Water resources management
- Turfgrass management
- Waste management
- Energy efficiency and purchasing policy
- Education and the working environment
- Communications and public awareness

A broad range of water conservation measures were observed among study jurisdictions including:

- Restricting normal watering to tee boxes, greens and primary landing areas on fairways.
- Further restricting watering to tees and greens during low-water conditions
- Constructing storages to hold water collected during spring runoff
- Irrigation-water recapture and re-use
- Use of clubhouse gray water and treated municipal wastewaters
- Use of drought-tolerant turf grasses and soil conditioners

Case Studies: Water Conservation Practices for Golf Courses

Location	Description	Results
CANADA		
Manitoba Golf Superintendents' Association ³⁴¹	With the aid of Manitoba Conservation and a grant from the federal government MGSA has developed a self-assessment checklist to help interested clubs implement a Safety and Environmental Management System (SEMS) . A section of the checklist is dedicated to proper water management and conservation .	To date 47 golf courses have participated with follow-ups completed on 15. Participating clubs have seen improvements in water use.
Fairmont Hotels ³⁴² Canada and other countries	All courses must develop and implement a water conservation plan . Plans are expected to include use of weather monitoring, irrigated area restrictions, drought-tolerant vegetation, and improved irrigation scheduling .	
OTHER		

Florida ³⁴³	Use of reclaimed water for irrigation	Statewide in 2001, 419 golf courses reported using a total of 110 US mgd or 416 ML/d of reclaimed wastewater for irrigation. This represents 29% of all courses in Florida. Golf courses accounted for 19% of reclaimed water usage in the state. The use of reclaimed water now accounts for 37% of the total irrigation water requirements for all Florida courses combined. The Loxahatchee reuse system by itself provides reclaimed water to 12 courses.
Other U.S. States ³⁴⁴	Use of reclaimed water for irrigation	Extensive use of reclaimed water on golf courses is now ongoing in Arizona, California, Florida, Hawaii, Nevada, South Carolina and Texas. Less extensive usage is occurring in Alabama, Colorado, Georgia, Illinois, Maryland, Michigan, Missouri, Montana, New Jersey, New Mexico, Ohio, Oklahoma, Oregon, Pennsylvania, South Dakota, Tennessee and Wisconsin.

8.3 SKI RESORTS

The water-use practices of ski-resort operations may not warrant particular national attention or concern at this time. They are briefly discussed here because of their presence among a majority of provinces and evidence that they have raised local water management concerns. More and more Canadian ski resorts are evolving into year-round multi-purpose operations thus increasing the potential for competition with other water uses. Proper water-use planning during site design and sound operating practices can help ensure that conflicts are avoided.

There are more than 250 ski resorts in Canada with the greatest number being located in Quebec, British Columbia, Ontario and Alberta³⁴⁵.

Canadian Ski Area Facilities

Province / Territory	# of Facilities
Quebec	83
British Columbia / Yukon	62
Ontario	50
Alberta	32
Manitoba / Saskatchewan	14
New Brunswick	4
Nova Scotia	3
Prince Edward Island	1
Newfoundland and Labrador	3
Total	252

At a large resort, water used in snow making could amount to as much as 10 million L/day albeit on an as needed and short-season basis. The intensity of snow making operations is generally at its peak early in the ski season as resort operators are focused on building a strong base. It is then ongoing throughout the season as required to make up for a lack of fresh snow or to maintain good skiing conditions on steeper and more heavily used runs.

The National Ski Areas Association (NSAA) and its affiliated companies and organizations in the U.S. have endorsed a set of environmental principles dealing with water use and other issues. Beyond expecting member compliance with all federal, state and local requirements, NSAA promotes

the voluntary utilization of a variety of water-use efficiency and conservation measures including the use of:

- Constructed storages and runoff recapture to reduce the need for water withdrawals at times when they might interfere with other users/uses
- Water and energy-efficient snow guns
- Efficient landscape and golf course irrigation system designs and practices at year-round resorts
- Outreach and education in connection with water-use efficiency in area hotels, restaurants and other businesses³⁴⁶.

Water Use in Snow-Making



9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 ACKNOWLEDGING THE CURRENT AND PREPARING FOR THE FUTURE

Canadians (along with Americans and Australians) continue to use water less efficiently than peoples of other nations. Examples of inefficient and wasteful practices are pervasive among households, communities and all business sectors. Even where such practices may not have resulted in water shortages, compromised the availability of supply for other users, or adversely impacted on the aquatic environment, they are likely contributing to other concerns. Water-use inefficiencies are a factor in increasing the consumption of energy and other resources, in adding to the complexity and cost of managing wastewater emissions, and in driving unnecessary expenditures for expansion of water-related infrastructure.

While all governments have begun important actions to conserve water resources these actions do not appear to be as aggressive, broad-based and consistent as they need to be to ensure a sustainable future. Growing populations, expanding economies and climate change continue to drive increased water demands while simultaneously reducing or threatening the availability and suitability of supplies.

What lies ahead provides justification and support for strengthened government initiatives that would systematically encourage and facilitate adoption of comprehensive and harmonized water-use efficiency practices by Canadian businesses, communities and citizens. These initiatives should stress universal and early adoption of well documented ‘no regrets’ technologies and practices within all water-use sectors and pragmatically seek out and pursue progressively more aggressive solutions based on maximizing overall benefits. Priority attention should be directed to situations where existing practices have resulted in conflicts among users, are threatening environmental quality, or may be leading to wasteful expenditures on water servicing infrastructure.

9.2 SECTORAL OPPORTUNITIES AND APPROACHES

The review of conservation measures being applied within individual sectors indicates that many globally recognized ‘best practices’ are already in use within some Canadian communities and businesses. What distinguishes Canada from most other study jurisdictions is the lack of more comprehensive and uniform uptake or application of these measures. The following is a sector by sector overview of more apparent water efficiency opportunities, of the rationale for their broader adoption and of key considerations that need to be addressed in their implementation.

9.2.1 Municipal

Sustainability issues in the municipal water supply sector transcend the question of balancing between water availability and demand. This is especially so in the case of growth communities where water efficiency improvements can be the key to avoiding or limiting expensive investment in expanding both water and wastewater infrastructure.

Strong pressures to implement full cost accounting and cost recovery in the municipal sector favour implementation of universal metering and conservation-oriented rate structures. The first is fundamental in making all water users aware of the scope of their demands and in achieving greater equity in the distribution of costs. The latter offers an incentive to use water wisely. The case can also be made for minimizing distribution system losses and for capitalizing on the mutual benefits (to

community and consumer) of moving toward the mandatory use of water efficient plumbing fixtures, appliances and other devices in new construction as well as in retrofit and replacement.

Higher per-capita servicing costs faced by many small communities (<1000 residents) and northern communities may warrant more direct senior government involvement in helping to fund upfront implementation costs. Government intervention in seeking an appropriate level of water pricing harmonization among municipalities may also be warranted to restrict the destabilizing use of subsidies as a tool in attracting business development.

9.2.2 Agriculture

The agricultural sector and irrigated-crop production in particular is a common contributor to water sustainability concerns and user conflicts across Canada and in other countries. Addressing these concerns presents a major challenge in water management. Production activities tend to be concentrated within contiguous areas, water demands are intensive, cumulative and overlapping, and these demands typically coincide with periods of lowest water availability. Sectoral demands are also expected to grow as a result of pressures to expand production, to irrigate crop types not currently irrigated, and to counteract increasingly evident impacts of climate change, e.g. increased incidence and severity of drought and higher evapotranspiration rates.

Solving or preventing serious water management problems will almost certainly involve both demand management and supply management approaches. Demand management opportunities exist to minimize water losses in conveyance systems, to better coordinate the scheduling of irrigation use by individual farmers and groups of producers, to use more efficient application technologies, and to more carefully determine the net economic return in irrigating certain lower-value crops. The required investments, which could be substantial, pose tough issues for both producers and governments in determining appropriate rates of return and in arriving at a workable division of funding responsibilities. The basic issues of mandatory water-use monitoring and reporting, full-cost accounting and cost recovery need to be dealt with in these deliberations.

9.2.3 Thermal Power Generation and Cooling

In Canada more water is withdrawn for cooling purposes than for any other type of use. The majority of these withdrawals are used in thermal power generation. They also constitute a large component of water used in the raw materials processing and manufacturing sectors.

The dominance of cooling withdrawals within Canada's overall water use picture is made even more pronounced by the long-standing practice of once-through cooling. While use of closed-loop water cooling and air cooling has been growing in popularity, Canada has not as aggressively followed the regulatory lead of other countries that clearly favour their use in new and retrofit applications. A country-wide examination of environmental and financial arguments for and against continued use of once-through cooling appears warranted in light of what is happening elsewhere. Such a review is timely in view of the ongoing restructuring within the industry.

9.2.4 Industrial

The breadth of the industrial or manufacturing sector makes it complex and diverse in terms of water quantity management issues and opportunities. The interests and practices of self-supply water users are also often quite distinct from those who draw from municipal systems, i.e. self-supply users have a less obvious cost-driven incentive to conserve.

Evidence suggests that many Canadian companies within all major industrial sectors have voluntarily reduced water withdrawals as an adjunct to other objectives such as reducing energy

consumption or assisting with the management of wastewaters and reduction of emissions. Actual levels of achievement appear to be highly variable perhaps reflecting inconsistencies in the application of government pressure and/or incentives for dealing with these objectives.

Beyond taking more straightforward steps to reduce water waste through repairing leakages and to increase water recycling and reuse, companies within every sector can readily avail themselves of documentation involving same-sector companies who have successfully reengineered processes, replaced equipment or implemented other measures to directly or indirectly reduce water demands. As is being observed in the European Union, it may now or soon be possible to develop ‘best practices’ guidelines or standards that quantify acceptable industry performance with respect to water-use efficiency and productivity within individual sectors or sub-sectors.

9.2.5 Resource Extraction

With the exception of enhanced oil recovery operations, water quantity management concerns in the resource extraction sector generally focus on questions of diversions and impoundments rather than conservation and efficiency.

Process water recycling has been a common practice at metal and non-metallic mineral mining operations for many years as a means of minimizing wastewater discharge volumes. Evaporative losses are associated with tailings impoundments and use of water for dust suppression but these are generally minor particularly in the case of hard rock mining. Consumptive losses may be of greater concern in connection with refining of metallic ores (water may be used both as a coolant and as a reagent in byproduct recovery) and processing of non-metallic minerals that requires the creation of intermediate or final-product suspensions or slurries.

Enhanced oil recovery operations (EOR) involving the use of water or steam have raised public concerns over potential impacts on the availability of supplies used by other extractive interests and on the environment. Disposal of some of the contaminated water from these operations has involved the use of permanent deep well injection, which further adds to the consumptive nature of EOR water usage. These concerns have led governments, particularly in Alberta, to curtail the granting or scope of new freshwater withdrawal approvals and forced the industry to pursue other alternatives including the use of saline water sources along with increased water recycling and reuse. Since EOR and heavy bitumen operations are vital components in Canadian energy production the use of these and other alternatives for minimizing freshwater use can only grow in importance.

9.2.6 Recreation

Public concerns over the impacts of water usage by the recreational sector continue to grow in many parts of the country. The focus of much of this attention is golf course operations that, like agricultural and landscape irrigation, exert high water demands over short periods of time. Ongoing expansion in the number of courses being developed in close proximity to major cities and within city regions will increase pressure on governments and the industry to find water management solutions that stress water efficiency improvements over increased withdrawals. Indeed, many newer courses are being sited, designed, constructed and operated to make much more efficient and sustainable use of water than what is the norm for most existing courses.

9.3 STRATEGIC PRINCIPLES AND DIRECTIONS

The absence of a comprehensive federal/provincial/territorial strategic plan and approach to water conservation sets Canada apart from other countries examined as part of this study. Most of these countries have faced similar within-country variations in the nature of water resource concerns

and in the willingness and capacity of water users to deal with the problems. The design and implementation of purposeful and successful conservation initiatives should not be managed solely on the basis of local, regional and provincial undertakings. Such an approach would lead to delays and inconsistencies in achieving sustainable development goals. It could also result in unacceptable social and economic hardship in some areas, alter the competitive environment among businesses operating in the same sector, and escalate inter-jurisdictional tensions surrounding the use and sharing of transboundary waters.

The directions that follow are premised on the principle that water-resource sustainability solutions and outcomes are best arrived at through a continuum of intergovernmental and public-private collaboration from the national level on down to the local level. To be effective, they must have the buy-in and support of the businesses and communities they are intended to serve and protect.

Sustainable Resource Development and Use Policies

- Endorse and promote water conservation and water-use efficiency as components of broader sustainable development goals and commitments to be established within all jurisdictions. Factor in Canada's international undertakings with respect to global resource sustainability goals.
- Set water conservation and water-use efficiency targets that address watershed and service-area sustainability objectives while also ensuring inter-regional and cross-sectoral harmony.
- Integrate water conservation goal-setting, messaging and implementation with related initiatives targeting the efficient use and conservation of energy and other resources and the protection of water quality and aquatic systems.
- Integrate the use of regulatory and non-regulatory tools in a manner that effectively, efficiently and equitably achieves the desired conservation savings. Give due recognition to the capacity and responsibility of water-users and the benefiting public to share in the costs.
- Develop and support business-renewal strategies for the creation of new economic opportunities based on more-productive water uses. Give particular attention to areas where current and/or projected water demands are likely to pose unacceptable costs upon water-users, the public or the environment.
- Develop and support urban development standards and practices that encourage attenuation of stormwater runoff and protection of groundwater recharge.
- Endorse and promote full-cost accounting and cost recovery across all levels of government with regard to the management and delivery of water-related services. Have appropriate regard for the limited financial capacity of some smaller communities and within some business sectors. Factor in the projected costs of renewing and replacing failing and outdated infrastructure.

Legislation and Regulation

- Introduce regulatory measures that i) require self-supply water users to prepare water conservation/efficiency plans, ii) establish water-efficiency standards/guidelines for individual sectors, iii) protect in-stream uses and aquatic systems, and iv) implement cost recovery.
- Introduce or amend legislative mechanisms that will enable government agencies to address situations where reprioritization, redistribution and/or reduction in water use allocations are essential for the protection and advancement of the public good.

Monitoring, Reporting and Analysis

- Implement mandatory requirements for the accurate measurement and routine reporting of water usage by all self-supply water users. Harmonize data collection and reporting requirements as necessary to facilitate information compilation and analysis within and across sectors and among jurisdictions.
- Implement mandatory metering of water usage by all customers served by public/municipal water systems.
- Expand and intensify surface and ground water level and flow characterization studies and monitoring networks. Assign priority to areas of existing or emerging water-use conflict or concern.
- In known growth areas, compile information on potential increases in water demands for key sectors and watersheds. Assume 10, 20 and 50-year planning horizons.
- Enhance support for the development, refinement and use of watershed and aquifer-based water allocation and conservation planning tools, i.e. water budget models.
- Summarize and publicly report the above information and any associated analysis of it on a routine and frequent basis.

Outreach and Education

- Undertake a review of existing outreach and education initiatives at all levels of government. Ensure they are effective in reaching water users and in providing essential information on conservation benefits, options and implementation strategies. Tailor initiatives according to individual sector.
- Develop documentation of and/or links to the more detailed technical and cost information required by industry, agricultural producers, and other businesses.
- Expand and enhance the coverage of water conservation and stewardship goals and measures within the school curricula at all age levels.

Stakeholder Consultation and Involvement

- Engage municipalities, industry, business and other stakeholders in target setting, identifying alternative measures, formalizing commitments, finding innovative resourcing approaches, and assessing progress.
- Enlist the support of water conservation innovators and champions within each sector to spread the conservation message and knowledge to their colleagues. Document and disseminate information on progress made and challenges overcome, i.e. success stories.

Economic Instruments

- Accelerate the use of full-cost accounting and cost recovery approaches in the provision of water management services and activities including those pertaining to water conservation and efficiency.
- Require municipalities to phase out the use of flat-rate and declining block-rate pricing and the use of preferential pricing to large-volume water users. Investigate the relative merits of increasing block rate structures, seasonal pricing and similar measures in reducing total demand and peak demand. Provide appropriate forms of rate relief where needed for low income households.
- Make development of and commitment to a water conservation plan a condition of eligibility for funding assistance in connection with all water and wastewater infrastructure expansion and renewal projects.

- Develop and implement appropriate strategies for addressing the more limited implementation capacity of smaller and northern communities and of smaller business operators.

Research and Development

- Examine the benefits and drawbacks of encouraging or requiring the use of (conversion to) closed-circuit cooling systems in thermal power generation, industrial, commercial and institutional water-use applications. Assess the influence of different geographic/watershed and demographic settings.
- Investigate the feasibility of implementing national or regional water-use efficiency standards or guidelines based on best technologies and/or practices in major water use sectors and sub-sectors.
- Expand research into the anticipated impacts of global warming and climate change on water resource availability and demand with a focus on better regional-level quantification of these impacts.

Implementation

- Acknowledge that the attainment of water efficiency and sustainability goals will take longer to achieve in some areas and sectors than in others. Require that new growth and development be based on best practices and technologies and set realistic timeframes for attaining targeted improvements within existing development. Seek commitments to continuous improvement.
- Work toward devolving operational water management decision-making to the lowest practicable administrative level subject to the application of clearly defined policies and principles and the provision of appropriate over-sight. Devolution would be phased based upon the development and demonstration of the local capacity to assume responsibility.
- Integrate and harmonize conservation planning and implementation among all levels of government and between the public and private sectors.

9.4 ROLES AND RESPONSIBILITIES

The goal of ensuring that Canada and Canadians develop and use the nation's water resources to the sustainable benefit of all interests can only be realized if responsibilities and accountability are broadly shared. The following roles and responsibilities are suggested.

CCME

- Provide a forum for the discussion, analysis and harmonization of current and proposed federal and provincial/territorial water conservation initiatives.
- Encourage and facilitate sharing of conservation experiences across all Canadian jurisdictions
- Conduct periodic reviews of implementation progress and concerns.

Federal Government

- Encourage and facilitate cooperation among the provinces and territories and with federal departments.
- Continue and expand support for shared federal/provincial/territorial networks and programs designed to characterize and monitor streamflows, water-levels and groundwater-elevations.

- Continue to survey, analyze and report information on water use across all major use sectors and on a country-wide basis.
- Implement conservation measures at all federal facilities and properties.
- Seek US support and commitment to conservation initiatives impacting on boundary waters.
- Monitor conservation initiatives and practices in other countries.
- Provide coordination and support for evaluation, development, adaptation and demonstration of new or improved water-use technologies and practices, e.g. closed-circuit cooling.
- Coordinate and support development of sectoral best practices standards and guidelines for water-use efficiency.
- Examine the feasibility of introducing a national water-efficiency labeling program for plumbing fixtures, household and commercial appliances, and other water-use related devices.
- Adopt taxation policies and cost-share infrastructure eligibility criteria that encourage and facilitate adoption of water-efficiency measures by municipalities and businesses and discourage new or ongoing investment in the use of inefficient practices and technologies.

Provincial and Territorial Governments

- Use provincial building codes to require the mandatory use of water-efficient plumbing fixtures in all new residential, commercial and institutional construction and retrofits.
- Require self-supply water-use licence and permit holders (as a condition of approval) to:
 - Prepare water conservation plans and implement water efficiency measures
 - Accurately meter/monitor and routinely report daily water usage.
- Adopt criteria that make municipal and private sector eligibility for water-related infrastructure grants and other government funding conditional upon the preparation and adoption of an acceptable water conservation plan and practices.
- Support development and use of sectoral best practices water-efficiency standards and guidelines.
- Restrict new water takings and prioritize uses in areas subject to existing or impending conflicts between demand and supply.
- Require and facilitate the preparation of drought-response plans for areas subject to recurring water shortages.
- Implement conservation measures at all provincially owned facilities and properties.
- Use sectorally targeted outreach and education to promote and encourage conservation.
- Provide support for the evaluation, development, adaptation and demonstration of new or improved water-use technologies and practices.
- Establish economic incentives to encourage water users to adopt water-efficient practices and technologies and/or disincentives to discourage new and continued use of inefficient practices and technologies.
- Adopt permit fees and other water charges to cover the costs of water management programs and activities and to support conservation behaviours.
- Continue and expand support for cost-shared monitoring networks and programs used to characterize and measure streamflows, water levels and groundwater-elevations.
- Require and support the use of supply and demand forecasting and water budgets/balance analyses in all critical-use watersheds/aquifers.
- Monitor conservation initiatives and best practices in other jurisdictions for potential adoption or adaptation.
- Support interprovincial and national harmonization of conservation and sustainable use initiatives.

- Support coordinated conservation and sustainable use initiatives in Canada-US transboundary watersheds.

Municipalities

- Make conservation and water-use efficiency programs a municipal priority.
- Approach conservation planning and implementation in a comprehensive and systematic manner; seek continuous improvement.
- Set water savings targets and implementation timelines.
- Implement universal metering for all customer sectors; commit to regular meter inspection and calibration.
- Minimize distribution system losses through:
 - Leak detection and correction
 - Pressure modulation
 - Scheduled watermain replacement.
- Enact bylaws that do some or all of the following:
 - Require use of water-efficient plumbing fixtures and appliances
 - Appropriately restrict lawn watering and other outdoor uses as needed
 - Require the use of rainfall sensors and automated controls for regulating rates of flow and on-off cycles of landscape irrigation systems
 - Limit the impervious area portion of a building lot.
- Implement water pricing based on full-cost accounting and recovery.
- Use increasing block, seasonal use and other conservation-oriented rate structures.
- Encourage and subsidize residential, commercial and institutional plumbing-fixture retrofits.
- Promote xeriscaping and use of drought tolerant plants.
- Require or encourage (and subsidize) water-use audits and conservation planning among large-volume users.
- Use outreach and education to encourage good conservation practices.
- Implement conservation measures at all municipally owned facilities and properties.
- Monitor progress and report on accomplishments.
- Monitor practices in other municipalities for potential adoption or adaptation.

Business and Professional Organizations

- Adopt a water conservation and efficiency code of ethics and require member adherence to it.
- Stay current with advances in sectoral BMPs and disseminate this information to members through seminars, fact sheets, case study reviews, etc.
- Support and participate in pilot and full-scale BMP demonstrations.
- Support and participate with governments in the development of sectoral water efficiency standards and guidelines.
- Routinely monitor and report on sector performance.
- Represent member interests in provincial/territorial and national consultations on water management.

GLOSSARY OF TERMS

Aquifer: An underground geological formation or group of formations containing useable amounts of groundwater that can supply wells or springs for domestic, industrial, commercial, or irrigation uses and maintain seasonal baseflows / levels within a stream or lake.

Backflood: A system used to temporarily retain water at shallow depth over large areas of crop or pasture land. The system involves keeping a dam in place for a period of 2 weeks or more in order to build up soil moisture content.

Baseflow: The amount of water or rate of flow being carried in a stream in the absence of precipitation and its related runoff. During dry periods, baseflow is typically comprised only of groundwater discharge and any continuous inputs of water or treated wastewater from man-made sources and operations.

Best (Management) Practice: A practice or combination of practices (including the use of innovative technologies and processes) that embodies and optimizes the combined benefits of effectiveness, practicality and versatility in addressing the needs of the environment and the water user.

Business Renewal: The act of changing what is being produced or how it's being produced in order to become more productive and efficient in the use of raw materials, labour and other resources. In a water conservation sense, business renewal would be beneficial if it reduced the demand for water and/or increased the amount and/or value of what was produced relative to the amount of water required.

Closed-Circuit Cooling: A system used to extract unwanted heat from an industrial or commercial process wherein the water used is treated (e.g. in a cooling tower) to release some or all of the acquired heat and is then recycled for re-use in the same manner for which it was originally taken.

Consumptive Use / Loss: A use of water involving its removal from a source without its being returned or its being returned in a diminished amount to that source. Also, the quantity of water that has been 'consumed'. Some processes or practices that result in a consumptive use include evaporation, evapotranspiration, incorporation into a plant, animal or product, transfer and diversion.

Demand Management: A strategy involving actions taken to improve water-use efficiency, increase water recycling and re-use, minimize waste and conserve available water resources. Also any action or set of actions taken to reduce the amount of water required or used by an individual, business or community.

Drought / Low-Water Condition: A period of prolonged dry weather which leads to a marked depletion in stream flows, lake levels, groundwater tables or other measure of water resource availability.

Eco-Industrial Park: A planned co-location of industries (and other businesses) within a contiguous area for the purposes of sharing resources and byproducts in a manner that conserves overall use of water, energy and other resources, minimizes waste and leads to a healthier environment.

Economic Instrument: A monetary measure (e.g. fees, taxes, subsidies and grants) used to generate revenue or to influence the activities, practices and behaviours of the person or business to which it is directed.

Environmental Flows: The minimum amount of streamflow essential for the maintenance of ecological functions, the protection of aquatic life and habitat, and the assimilation of pollutant inputs. This amount will differ from reach to reach, watercourse to watercourse and season to season.

Evapotranspiration: Process by which water is transpired by plants and evaporated from plant and soil surfaces.

Extractive Uses: Uses of water in which it is removed from its source for use or application elsewhere. A use is still extractive even when all or a majority of it is returned altered or unchanged to its source at a later time. Water withdrawals serving municipalities, industry, agriculture, thermal and off-line waterpower production, commercial enterprises, and conservation projects, e.g. wetland creation, are extractive uses. Diversions of

water from one watercourse to another or from one point to another point in the same watercourse are extractive uses.

Instream Uses: Uses of water that don't require its removal or diversion from a river, stream or lake. Uses involving the temporary on-line storage of water, e.g. a run-of-the-river hydroelectric power dam and reservoir, are generally still considered instream uses. Notwithstanding their classification as instream uses, any use involving even the temporary on-line storage or retention of flow requires a water-taking licence or permit in most jurisdictions.

Irrigation Efficiency: The ratio of the average depth or quantity of irrigation water beneficially used to the average depth or quantity of irrigation water applied.

Natural Water Deficit: The amount of water lost through evaporation exceeds the amount of water gained through precipitation.

Once-Through Cooling: A system that uses ambient water to extract unwanted heat from an industrial or commercial process wherein the water is used only once and is then discharged, i.e. it is not reclaimed or recycled for re-use in the same manner.

Per Capita Water Use: *Total per capita water use* generally refers to overall water usage by all domestic, industrial, commercial and institutional customers on a municipal water system divided by the total population residing within the service area. *Domestic or residential per capita water use* is based only on that portion of the municipal supply that is used in and around dwellings. Unfortunately, much of available municipal water-use reporting neglects to clarify which of two measurements is being given.

Rain Sensor: A device for monitoring rainfall and the subsequent rate of moisture evaporation. The device is used to interrupt the normal on-off cycle of an automatic crop, lawn and landscape sprinkler system so as to prevent watering when it is not needed.

Return Flow: That portion of a water withdrawal that is returned from its point of use to a watercourse and becomes available for use by others. In the strictest sense, a returned flow should re-enter the same source or system from which it was drawn and should do so within a relatively short time after the initial withdrawal.

Supply Management: Any action or set of actions taken to meet the water demands of an individual, business or community by accessing and developing new or additional sources of supply.

Tail Water: Excess irrigation water that reaches the end of the field to which it was applied. This water may be available for irrigation use on an adjacent field or property or may return in whole or in part to a receiving watercourse.

Unaccounted-for-Flow: An expression used to describe that portion of municipally supplied water that enters the distribution system from the treatment plant but does not reach the utility's customers. It may also be referred to as '*non-revenue water*'. This unaccounted for flow or volume may include water lost through distribution-system leakages and watermain breaks, water taken from hydrants for fire-fighting and other unmetered purposes, deliberate water theft, and water delivered but not measured due to metering error.

Water Allocation: The process of determining who is given access to an amount of water from a surface or ground water source, how much that amount is, and when it may be used. Also, the amount of water authorized for use by someone.

Water Budget / Balance: A mathematical determination of how much water can be withdrawn from a ground or surface water source without interfering with other water users and uses including the water needed to protect ecological functions and protect aquatic biota and their habitats. The water balance takes into consideration current conditions and projected changes and variability in supply and demand.

Water Conservation Measure: A tool, process or practice intended to result in the more conservative and efficient use of water.

Water Conservation Plan: A document that details objectives, targets, specific measures and timetables for optimizing water use and conserving available supplies.

Watercourse: Any body of water (normally with a physical connection to another body of water) including a creek, stream, river or lake. Through legal definition, a watercourse may also be deemed to include ground water.

Watershed / Subwatershed: The total area of land and water that drains to a common outlet such as to a larger river, lake or ocean. The perimeter of a watershed or sub-watershed generally follows the height of land that divides water flowing toward one watercourse from water flowing to another.

Water-Use Efficiency: The targeted result of actions taken to bring about a beneficial reduction in water loss or water waste or to minimize the amount of water used in accomplishing a task or producing a product.

Water-Use Productivity: The ratio of the amount of water used in the production of a good or service to the level of production obtained, e.g. litres per tonne of pulp or litres per vehicle. The lower the water input required, the higher the productivity.

Water Withdrawal / Taking: The bulk or continuous removal of water from a surface watercourse or from ground water.

Xeriscaping: An alternative form of landscape design that emphasizes the use of drought resistant and, in particular, indigenous plants as a means of minimizing supplementary irrigation water demand and runoff.

COMMONLY USED UNITS AND EQUIVALENTS

ac = acre = 0.4047 ha

acre-foot = 1233.5 m³

BL = billion litres

dam³ = 1,000m³

ha = hectare = 10,000m²

m³ = 1,000 litres

ML = million litres

tonne = 1,000 kg = 1.102 tons

US gallon = 3.7854 litres = 0.8327 imperial gallons

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APPENDICES

- A: Jurisdictional Reviews
- B: Recommended General and Sectoral BMP Guides and Manuals
- C: Suggested Websites

APPENDIX A JURISDICTIONAL REVIEWS

A.1: Canada

A.2: United States

A.3: Other Countries

APPENDIX A.1 CANADA

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT (CCME)

Introduction

The Canadian Council of Ministers of the Environment is the major intergovernmental forum in Canada for discussion and joint action on environmental issues of national and international concern. The council is comprised of 14 environment ministers, one from each of the federal, provincial and territorial governments in Canada. The objective of the council is to achieve a high level of environmental quality across the country by means of collective intergovernmental cooperation and the development of nationally consistent environmental standards, strategies and objectives.

A Deputy Ministers Committee and a full-time Secretariat manage the work of the CCME between annual meetings of the Council of Ministers. The Secretariat provides support to the Council of Ministers and various CCME committees. Providing on-going advice to the Deputy Ministers Committee and coordinating specific CCME projects assigned to intergovernmental task groups, the Environmental Planning and Protection Committee is a permanent intergovernmental steering committee. Through task groups, CCME members work cooperatively to achieve specific goals, and to reach consensus on proposed national policies, programs, standards and guidelines. Over the years the CCME has addressed issues of water use efficiency and conservation through such task groups. Past and present task group initiatives are identified in the table below.

Water Conservation and Related Initiatives

Initiative, Lead Agencies and Partners	Sector(s) targeted	Description	Results and Effectiveness
National Action Plan to Encourage Municipal Water Use Efficiency (1994) Water Use Efficiency Task Group	Municipal	The action plan offers direction to governments and recommends what government departments and municipalities should do to achieve greater water efficiencies and decrease capital expansion and operating costs. Among other things, the Action Plan calls for governments to show leadership by reducing water use in their own facilities, as well as publicly funded facilities, and to adopt consistent policies, regulations and codes concerning water efficiency. Implementation of the plan is promoted by the CWWA.	
Analyses of Water Conservation Measures and Economic Instruments for Water Conservation (2005) Water Conservation and Economics Task Group	Provincial and territorial governments	Work is currently being carried out to develop a comprehensive source of information on water conservation measures, relevant to Canadian conditions. It is intended to facilitate information transfer and sharing of approaches for furthering conservation objectives in the nation. A second project analyzing economic instruments for water conservation is also currently under-way.	

FEDERAL GOV'T & OTHER NATIONAL INITIATIVES

Water and Related Legislation and Policies

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Constitution Act (1867)</i>		Gives direct responsibility for water management on federal lands, in the territories and on the reserves of Canada's aboriginal peoples to the federal government. Provinces are identified as the "owners" of the water resources and are therefore primarily responsible for their daily management. Other federal

		duties include transboundary management, fisheries and navigation.
<i>Canada Water Act (1970)</i>	Environment Canada	Calls for joint consultation between the federal and provincial governments in matters relating to water resources. Joint projects involve the regulation, apportionment, monitoring or survey of water resources, and the pre-planning, planning or implementation of sustainable water resource programs.
<i>International River Improvements Act (1955)</i>	Environment Canada	Provides for licencing of activities that may alter the flow of rivers flowing into the United States;
<i>Government Organization Act (1979)</i>	Environment Canada	Assigns the national leadership for water management to the Minister of the Environment
<i>International Boundary Waters Treaty Act</i>	Department of Foreign Affairs and International Trade (DFAIT)	Prohibits the bulk removal of boundary waters from Canadian Basins for any purpose, including export.
<i>Fisheries Act</i>	Department of Fisheries and Oceans (DFO)	Protects fish habitat by prohibiting habitat disturbance and ensures the construction of a fishway around any obstruction in a waterway.
<i>Navigable Waters Protection Act</i>	DFO	Prohibits dumping of wastes that may obstruct navigation and prohibits construction in navigable waters.
<i>Department of Indian Affairs and Northern Development Act</i>	(Indian and Northern Affairs Canada (INAC))	INAC is responsible for the development, implementation and interpretation of all legislation and policy relating to its responsibilities for water management in the Northwest Territories and Nunavut, approving type A licenses, enforcing licensed operations, and the collection of water data.
<i>Nunavut Waters and Surface Rights Tribunal Act (2002)</i>	INAC	This Act clarifies the mandates of the Nunavut Water Board and the Surface Rights Tribunal, in accordance with the Nunavut Land Claims Agreement and, as a result, creates legal certainty over the scope of their powers and responsibilities.
<i>Northwest Territories Waters Act (1989)</i>	INAC	Details how water may be used in the Northwest Territories. Establishes the NWT Water Board. The board is responsible for granting water use licences in the NWT, however, the Minister of INAC must give approval for the granting of a water use licence, with some exceptions.
<i>Arctic Waters Pollution Prevention Act (1985)</i>	Transport Canada and INAC	Introduced to prevent pollution of waters adjacent to the mainland and islands of the Canadian Arctic.
<i>Canada Shipping Act (1985)</i>	Transport Canada	Provides for the Governor in Council to make regulations with respect to prohibiting the discharge from ships of pollutants and prescribing substances and classes of substances that are pollutants.
<i>Dominion Water Power Act (1985)</i>	INAC	Sets out provisions for the construction, maintenance, operation of crown owned waterpower projects.
<i>Canadian Environment Protection Act (1999)</i>	National Office of Pollution Prevention	Provides for the protection of the quality of the environment and pollution prevention through the issuing of regulations, objectives, guidelines and codes of practice. S. 54(2) of the Act states that these objectives etc., shall relate to: d) the conservation of natural resources and sustainable development. Provisions of this Act focus of pollution prevention, release of toxics, air and water pollution.
Policies and Guidelines		
Federal Water Policy (1987)		<p>The policy was formulated after several years of intensive consultation, both within and outside the government. It addresses the management of water resources, balancing water uses with the requirements of the many interrelationships within the ecosystem. The policy takes into account the needs of all Canadians in its overall objective: to encourage the use of freshwater in an efficient and equitable manner consistent with the social, economic and environmental needs of present and future generations.</p> <p>To manage Canada's water resources, the federal government has defined two main goals:</p> <ul style="list-style-type: none"> ▪ To protect and enhance the quality of the water resource; and, ▪ To promote the wise and efficient management and use of water.
Agricultural Policy Framework		Drafted to better meet today's challenges, the Agricultural Policy Framework is composed of five components: business risk management, food safety and food

		<p>quality, science and innovation, environment and renewal.</p> <p>In the environmental part of the framework, signatories agree to reduce agricultural risks and provide benefits to the health and supply of water, with key priority areas being nutrients, pathogen, pesticides and water conservation. The Parties also agree to work towards a complete agri-environmental scan of all farms to identify priority farms and regions requiring corrective action, the completion and implementation of environmental farm plans.</p> <p>All provinces and territories have now signed on to the framework and have signed implementation agreements with the Government of Canada.</p>
Code of Environmental Stewardship	Government of Canada	<p>The code commits the government to sustainable development in all aspects of its operations and activities. Commitments include but are not limited to: a commitment to seek cost-effective ways of reducing the input of raw materials, toxic substances, energy, water and other resources; etc.</p>

Water Conservation and Related Program Initiatives

In this section many initiatives involve federal department/agency partnerships. These initiatives have been listed under the agency heading the initiative, or considered to be the lead. It should be noted however that in some cases "the lead" agency was not always apparent. In these cases the initiative is listed under any one of the partner organizations.

Intergovernmental Working Groups

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
<p>Interdepartmental Advisory Group on Water Conservation at Federal Facilities (WCFF)</p> <p>Formed in 1990 to help deliver the water conservation requirements of the Green Plan (no longer exists) and Code of Environmental Stewardship.</p>	Federal government	<p>The long-term goal of the WCFF initiative is the promotion of water use efficiency within the federal government by members of the group both individually and collectively. A major activity of the WCFF Advisory Group was the development of the Water Conservation Plan for Federal Government Facilities and the accompanying Manual for Conducting Water Audits and Developing Water Efficiency Programs at Federal Facilities, launched in 1993. Since then, WCFF members have promoted awareness of water efficiency through regional briefings, implementation of water efficient measures, training sessions, exhibits, publication of case studies and installation of washroom decals that advise people to save water and to report leaks. The WCFF was instrumental in amending the plumbing fixtures section of the National Master Specifications to reflect water efficiency and including water in the Federal Buildings Initiative Program. The WCFF has provided advice to the Auditor General's office on performance measures for water efficiency and to Public Works and Government Services Canada on the water conservation chapter for the Environmentally Responsible Construction and Renovation Handbook. The WCFF is currently helping the SDGO (see below) EMS Task Group develop and deliver the water efficiency part of their work plan.</p>	
<p>Sustainable Development in Government Operations Initiative (SDGO)</p> <p>(Natural Resources Canada, Environment Canada, Public Works and Government Services Canada)</p>	Federal government	<p>Purpose is to coordinate the federal effort to green government operations and encourage the report of concrete results among the departments and agencies that prepare Sustainable Development Strategies (SDSs). Water conservation and wastewater management is one of the 7 priority areas for action. Departments are encouraged to develop SDSs with concrete goals and actions to integrate SD into their policies, programs and operations. Those that prepare strategies must report on progress in meeting their commitments annually.</p>	<p>Since 1997, a number of federal departments have prepared Sustainable Development Strategies with targets to improve the government's environmental performance. Some of these initiatives are mentioned in the table below.</p>

Environment Canada (EC)

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Sustainable Water Use Branch	All	<p>Maintains Freshwater Website, an on-line information resource on Canadian water issues, including water conservation and efficiency. Website offers tips on how to conserve water and a large number of links to water related publications. Classroom materials for a variety of different grades are also provided. Other publications include: a number of water conservation related fact sheets, a consumer's guide to water conservation, a series of Wise Use of Water brochures. A number of water-related studies into municipal pricing, economic instruments, water use in Canada are also provided. Environment Canada also has a water use database which includes information on all major water users obtained from national surveys on: municipal water use, municipal water pricing, industrial water use. The department is also responsible for the development of the Water Efficiency Experiences Database (WEED) in partnership with the Canadian Water and Wastewater Association;</p> <p>Currently the branch is working with many different partners in the area of water conservation and efficiency. For example the branch is working with the CSA and CMHC to develop a guideline on the use of recycled household water for toilets; working with US EPA in the development of a water star label for water-related consumer products; mapping watersheds with NRCAN, including the development of an interactive website; partnering with Infrastructure Canada to influence criteria for federal financing of the municipal infrastructure program e.g. requiring monitoring and reporting of water use, watershed planning etc.; partnering with INAC in the development of a water audit manual for First Nation reserves. The Department is also working on a water efficiency plan for Canada in 2005 in response to a commitment made at WSSD.</p>	
<p>National Office of Pollution Prevention</p> <p>Responsible for the development and implementation of regulations, guidelines, codes of practice that target the management of toxics and other substances.</p>	ICI	<p>Developed the Canadian Pollution Prevention Information Clearinghouse featuring over 1000 P2 resources including fact sheets, case studies etc. The Office has also developed a series of Pollution Prevention Fact Sheets to help Canadians implement P2 practices at work, home etc. Water conservation is discussed in these documents. A Pollution Prevention Planning Handbook has also been published. Although the main purpose of the handbook is to help businesses that manage toxic substances prepare pollution plans that may be required under CEPA, the book also discusses opportunities for increased water use efficiency and conservation. Several Environmental Codes of Practice for specific industries and chemicals have also been developed. Codes of Practice for the steel industry target wastewater reuse and recycling.</p>	
Environmental Economics Branch		<p>Engaging with provinces and department partners to restart Nature survey, to bridge current gaps in nature related economic data, including for water activities. Current objective to estimate a national value for water. Pilot projects across country to be implemented. Other relevant work includes a study to determine best water pricing practices for municipalities.</p>	

Sources:

- Environment Canada. Freshwater Website. Available: http://www.ec.gc.ca/water/e_main.html
- Environment Canada. National Office of Pollution Prevention. Available: <http://www.ec.gc.ca/NOPP/EN/index.cfm>

Agriculture and Agri-Food Canada (AAFC)

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
National Water Supply Expansion Program Agriculture and Agri-Food Canada in partnership with the provinces	Agriculture	A four year \$60 million initiative under the Agricultural Policy Framework. The objective of the Program is to provide assistance to the agricultural community across Canada to help reduce the risk of future water shortages, and to meet the everyday growing needs of a vibrant Canadian agricultural sector, through the planning and development of secure, healthy and reliable water resources. Three tiers of projects are eligible under the program including: on-farm water infrastructure (like meters), multi-user water supply projects and strategic initiatives like groundwater exploration and monitoring etc. Financial assistance is available. The NWSEP will be implemented in the agricultural areas of Canada – British Columbia, the Prairies, Ontario, Quebec, and the Atlantic provinces.	So far the following provinces are currently implementing, or planning to implement the program: BC, AB, SK, MB, NS, PE
National Agri-Environmental Health Analysis and Reporting Program	Agriculture	A program to continue building agri-environmental information to help guide future government policies and programs and to track environmental performance of Canadian agriculture. The project builds on previous work that led to the publication in Feb. 2000 of the first comprehensive assessment of Canadian agriculture's environmental performance. It involves the development of agri-environmental indicators. Indicators for water use efficiency are currently under development.	The AAFC plans to publish an update of its Feb. 2000 report in 2005.
Drought Watch	Agriculture	On-line resource providing weekly maps of climate variability including precipitation/temperature/water supplies etc., farm water conservation tips during times of water shortage.	
AAFC Research Branch	Agriculture	AAFC also conducts research in the area of water management, water use efficiency and sustainable production systems.	

Sources:

- Agriculture and Agri-Food Canada. National Water Supply Expansion Program. Available: http://www.agr.gc.ca/env/index_e.php?section=h2o&page=h2o
- Agriculture and Agri-Food Canada. National Agri-Environmental Health Analysis and Reporting Program. Available: http://www.agr.gc.ca/env/naharp-pnarsa/index_e.php
- Agriculture and Agri-Food Canada. Drought Watch. Available: http://www.agr.gc.ca/pfra/drought/index_e.htm
- Agriculture and Agri-Food Canada. National Science Programs. Available: http://res2.agr.gc.ca/index_e.htm

Canadian Mortgage and Housing Corporation (CMHC)

CMHC is the Government of Canada's national housing agency. Responsibilities include developing new ways to finance home purchases, encouraging innovation in housing design and technology, and helping low income groups live in affordable housing.

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Canada Mortgage and Housing Corporation (CMHC)	Municipal, Residential, ICI	CMHC is a leader in promoting the concept of Healthy Housing, housing that promotes the health of its occupants while protecting the environment and maintaining affordability. Water conservation and efficient use is an important component of this initiative. Water related projects include: the development of a Household Guide to Water Efficiency on behalf of Canadian municipalities for distribution to residential users; research into water efficient toilet performance and many other water conserving technologies/practices; the development of water conservation fact sheets; and case studies.	

Sources:

- CMHC. Water Conservation. Available: <http://www.cmhc-schl.gc.ca/en/imquaf/himu/wacon/>

Industry Canada (IC)

IC works towards a fair, efficient and competitive marketplace, an innovative economy, competitive industry and sustainable communities.

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Industrial Research Assistance Program -Technology Partnerships Canada National Research Council of Canada and Industry Canada	Commercial, Industrial	Research in the area of industrial water and energy efficiency technologies and processes is supported primarily by the Federal government through advisory services and financial assistance. Through the IRAP-TPC Small and Medium Enterprises (SMEs) are eligible for up to \$3 000 000 in repayable project financing. The main objective of the program is to increase the technological competitiveness of Canadian firms. The program emphasizes advancing unproven technology to the point of performance testing and the various validation stages prior to commercialization. The development of technologies resulting in the enhanced conservation of water is eligible for financing under the Environmental Technology area of the program (NRC).	
Eco-efficiency	Commercial, industrial	IC initiatives relating to water conservation and efficiency include an eco-efficiency information website featuring industrial case studies and tools to help businesses develop their own eco-efficiency strategies; eco-efficiency workshops for business (in partnership with a number of other government/private partners); links to on-line and other resources addressing eco-efficiency and cleaner production.	
Canadian Environmental Solutions		A directory of Canadian companies providing technologies, products and services to address the environmental challenges faced by every sector of the economy. Companies that address water related issues are listed in their own directory	

Sources:

- National Research Council of Canada. (No date). IRAP/Technology Partnerships Canada. [Online]. Available: http://irap-pari.nrc-cnrc.gc.ca/english/iraptpc_e.html
- Industry Canada. Eco-efficiency. Available: <http://strategis.ic.gc.ca/epic/internet/inee-ee.nsf/en/Home>
- Industry Canada. Canadian Environmental Solutions – Water. Available: http://strategis.ic.gc.ca/cgi-bin/sc_coinf/ccc/index_gen/company.pl?lang=e&profileId=1541&tagid=226001

Infrastructure Canada

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
National Guide to Sustainable Municipal Infrastructure (InfraGuide) Infrastructure Canada in partnership with the National Research Council and the Federation of Canadian Municipalities	Public	A national network of people and of published best practice documents for use by decision makers and technical personnel in the public and private sectors. Based on Canadian experience and research the guide sets out the best practices to support sustainable municipal infrastructure decisions and actions in 6 key areas, one of them being potable water. Documents in this strategic area include one on Establishing a Metering Plan to Account for Water Use and Loss, Water Use and Loss in the Water Distribution System etc.	
Municipal Rural Infrastructure Program	Municipal	\$1 billion of federal financing was announced in 2003 to support smaller scale municipal infrastructure projects that improve the quality of life, sustainable development and economic opportunities of smaller communities. As of Feb. 14 2004 the Govt of Canada commenced negotiations with provinces, leading to a formal application process municipalities must follow to apply for the funds. Evaluating project criteria for water and wastewater infrastructure projects address water efficiency and conservation, and include: use of best practices, closed-loop resource management, is based on a strategy for local water and	So far New Brunswick, Ontario and Manitoba have the program in place.

		wastewater management providing for long-term sustainability, involves demand management including water metering and public education, a sustainable approach to financing	
Infrastructure Canada Program	Municipal	Launched in 2000 with a budget of \$2.05 billion to renew and build infrastructure in rural and urban municipalities across Canada. Top priority is green municipal infrastructure. Priority projects target water and wastewater systems and water management. Projects underway include water infrastructure improvement projects, metering projects, etc.	Projects are well underway across Canada.

Sources:

- Infrastructure Canada. Municipal Rural Infrastructure Program. Available: http://www.infrastructure.gc.ca/mrif-fimr/index_e.shtml?menu35
- MRIF. 2004. Project Business Case Guideline. [Online]. Available: <http://www.gnb.ca/0009/0373/0006/0001-e.asp>

Correctional Services Canada (CSC)

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Environmental Guidelines – Water Measurement and Conservation	Public	In accordance with the Department's Sustainable Development Strategy, environmental guidelines for the use of water in all dept. facilities have been developed. The objective is to implement a system for the measurement and monitoring of potable water consumed in institutions. The system will make it possible to: gather, record and save reliable and auditable data on water; formally manage this environmental aspect of CSC's Sustainable Development Strategy; and monitor on an ongoing basis the results and hence environmental performance.	

Sources:

- Correctional Services of Canada. 2003. Environmental Guidelines Water Measurement and Conservation. [Online]. Available: http://www.csc-scc.gc.ca/text/plcy/cdshtm/318-gl9-cd_e.shtml

Foreign Affairs Canada (FAC)

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Environmental Management System (EMS)	Public	FAC is committed to greening its own operations and has developed an EMS to help do this, in accordance with its Sustainable Development Strategy. Water conservation and efficiency is a priority target area. FAC identifies a number of individual and corporate actions intended to reduce water usage in their operations.	

Sources:

- Foreign Affairs Canada. Greening Operations – Water Usage. Available: <http://www.dfait-maeci.gc.ca/sustain/EnvironMan/system/emp/miscklst/area03-en.asp>

National Research Council of Canada (NRC)

The NRC has been active for more than 80 years and is the Government of Canada's premier organization for research and development. In addition to the water efficiency initiatives listed in the table below, the Council has partnered with a number of other departments in the implementation of water conservation and efficiency related projects. These projects are mentioned throughout this document and include a partnership with Infrastructure Canada and the Federation of Canadian Municipalities in the development of a National Guide to Sustainable Municipal Infrastructure (InfraGuide); and a partnership with Industry Canada in the administration of the Industrial Research Assistance Program -Technology Partnerships Canada.

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Institute for Research in Construction		The institute is a leader in research, technology and innovation for the Canadian construction industry. Through research and partnerships the institute works to improve the efficiency and durability of public infrastructure, among other things. Projects to improve water mains and sewer pipes have included: leak detection methods for plastic water distribution pipes, Leakfinder: a new system for pipeline leak detection, evaluation the effectiveness of cathodic protection of water mains etc.	Partnerships with industry and other interested parties ensure research targets industry needs.

Sources:

- NRC of Canada. Institute for Research in Construction. Urban Infrastructure. Available: <http://irc.nrc-cnrc.gc.ca/uir/index.html>

Natural Resources Canada

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Office of Energy Efficiency	Residential, ICI	Offers many energy-saving tips for using and maintaining appliances, vehicles and new housing. Water use efficiency and conservation is an important component of energy efficiency and specific tips to enhance water use efficiency in the home and business are identified.	
Federal Buildings Initiative Office of Energy Efficiency in partnership with Real Property Services, PWGSC	Public	Helps federal departments and agencies reduce energy and water consumption and greenhouse gas emissions. Private sector companies plan and implement cost-effective facility upgrades and retrofits. Other levels of government, institutions and private sector firms also draw on the FBI's experience for help in designing their own energy efficiency programs. The program is voluntary.	7000 federal buildings have already been upgraded, saving millions of dollars and reducing the risks related to climate change.

Sources:

- Natural Resources Canada. Office of Energy Efficiency. Available: <http://oe.nrcan.gc.ca/english/index.cfm?Text=N&PrintView=N>
- Natural Resources Canada. Office of Energy Efficiency. Federal Buildings Initiative. Available: http://oe.nrcan.gc.ca/FBI/home_page.cfm?PrintView=N&Text=Y

Public Works and Government Services Canada (PWGSC)

The Real Property Services Branch of Public Works and Government Services Canada acquires, manages, operates, maintains, repairs, builds and disposes of federal government department and agency property.

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Real Property Services Branch (RPS)		<p>The Branch has developed An Architects Guide for Sustainable Design of Office Buildings. The guide is directed primarily towards architects engaged in the renovation of federal facilities. It presents a set of design issues and strategies in support of RPS commitment to upgrading existing federal facilities to meet energy and resource use principles. Building water use is covered in the guide.</p> <p>An EMS has been prepared to ensure RPS meets its commitments in its Sustainable Development Strategy (SDS). Within this context several other projects have been carried out including: the development of a Water Audit Methodology Protocol and a Water Management Strategy for Property and Facilities Management. The Protocol defines how water is to be managed within the inventory and includes guidance on conducting preliminary evaluations, detailed water audits, work plans, water saving initiatives, and</p>	

		annual monitoring.	
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Sources:

- PWGSC, Real Property Services Branch. 1999. An Architects Guide for Sustainable Design of Office Buildings. [Online]. Available: <http://www.pwgsc.gc.ca/rps/content/publications-e.html>

Sectoral Initiatives

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Audubon Cooperative Sanctuary Program for Golf Courses	Golf courses	Provides comprehensive environmental education and conservation assistance to golf course superintendents and industry professionals. Water conservation is a major component of the program. By completing projects in a number of different program areas, golf course members become internationally recognized as a Certified Audubon Cooperative Sanctuary.	45 golf courses in Canada are currently certified.
ECOMmodation Rating Program Hotel Association of Canada (administered by CH2M Hill)	Tourism	A graduated rating system designed to recognize hotels, motels and resorts that are committed to improving their fiscal and environmental performance. Based on results of an audit, hoteliers are awarded a 1-5 green key rating and receive guidance on how to improve environmental performance.	Approx 44 Canadian hoteliers have received green-key rating.
Canadian Water and Wastewater Association (CWWA)	Municipal	Represents the common interests of Canada's municipal water and wastewater systems. CWWA policy states, "CWWA supports and encourages the development and implementation of water use, efficiency and conservation policies and programs by all water services." The CWWA assisted in the development of the Water Efficiency Experience DB in partnership with EC and CMHC and has just recently published the third edition of its publication "Maximum Performance, Testing of Popular Toilet Models". The CWWA also supports the web-based Water Efficiency Network, which allows any Canadian having an interest, role or responsibility in water management or conservation activities to exchange information on regulatory, policy and performance issues. The committee has recently announced the establishment of a water efficiency research fund.	

Sources:

- Hotel Association of Canada. Available: <http://www.hotelassociation.ca/programs/index.html>
- Canadian Water and Wastewater Association. Available: http://www.cwwa.ca/home_e.asp

PROVINCIAL AND TERRITORIAL INITIATIVES

ALBERTA (AB)

Water Supply and Demand Overview

Ninety-eight percent of all water that is allocated in Alberta is from surface water sources. The largest user of water is the agricultural crop irrigation sector, which accounts for almost 46 per cent of all surface water is used for agricultural irrigation. Another two per cent is used for livestock operations, growing specialty crops (greenhouses), and for running farms. Thirteen irrigation districts supply water to irrigate over 500,000 hectares, and to supply 50 communities with water for domestic uses. All of the irrigation occurs in southern Alberta in the South Saskatchewan River Basin. Three rivers including the South Saskatchewan, Bow River, and Oldman River provide the majority of water for this sector.

In 2001, total combined surface and ground water allocations were as follows:

- 44.8% irrigation
- 26.2% commercial cooling
- 11.1% municipal

- 6.5% commercial
- 3.1% water management
- 8.3% other agriculture, oil and gas, recreation and other sectors.

Water related issues in Alberta include water scarcity in the south, increasing water treatment costs and the potential for oil sands development leading to massive water needs. The winter, spring and summer of 2001 saw abnormally warm and dry weather conditions across Southern Alberta. In fact, that year the water supply only met 60% of the rights of its water license holders. Despite significant and successful efforts by government, industry, municipalities and farmers to share water and enhance efficiency, all reservoirs were nearly empty by the end of the year.

Sources:

- Alberta Environment Water Conservation website. Available: <http://www3.gov.ab.ca/env/water/Conservation/index.cfm>
- Advisory Committee on Water Use Practice and Policy: Preliminary Report. 2004. [Online]. Available: <http://www.waterforlife.gov.ab.ca/>

Water and Related Legislation and Policies

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>The Water Act W-3 RSA 2000</i>	Alberta Environment	<p>This piece of legislation authorizes water takings in the province, replacing the old 1931 Water Resources Act. In S. 2, the Water Act declares as its purpose, "the conservation and management of water, including the wise allocation and use of water...". According to the Act, farmers diverting less than 6250 cubic metres of water for the purposes of raising animals or applying pesticides to crops, statutory household use, fire-fighting, wells equipped with hand pumps, operating an alternate watering system and using surface water for livestock that are generally grazed, are exempted from obtaining a license.</p> <p>Important water conservation and sustainability components in the Act include:</p> <p>a) s. 15(1) of the Act states that the Director may establish a Water Conservation Objective pertaining to the amount and quality of water the Director deems necessary for the protection of the natural environment, management of fish and wildlife, protection of other instream uses</p> <p>b) s. 9. the development of a provincial water management planning framework to ensure the sustainability of Alberta's water supply. This framework will allow for the development of water management plans addressing local and regional issues.</p> <p>c) s. 8. The development of a provincial strategy for protecting and conserving Alberta's aquatic environments will also be a crucial part of this framework</p> <p>The Framework for Water Management Planning and The Strategy for the Protection of the Aquatic Environment came into effect on January 1, 2002. Applicants for an irrigation approval or licence under the Water Act must submit an Agricultural Feasibility Report along with their application so that the Department can assess the suitability of the land for irrigation. The water requirement, water quality and soil suitability is assessed.</p>
<i>Water (Ministerial) Regulation AR 205/98</i>	Alberta Environment	Identifies those activities exempt from licensing and approval processes. For example, the placing, constructing, installing, maintaining, replacing or removing of a watercourse crossing, or a telecommunication line crossing, does not require an approval. However, these activities must be carried out in accordance with designated Codes of Practice.
<i>Water (Offences and Penalties) AR 193/98</i>	Alberta Environment	Outlines all offences and penalties under the <i>Water Act</i> and its regulations.
<i>Water (South Saskatchewan Basin Water Allocation Regulation) AR 307/91</i>	Alberta Environment	This regulation regulates the use of water for irrigation in southern AB, where it is particularly dry and basin water supplies are almost fully allocated. The maximum volume of water that an irrigation district may divert and use under license is determined by the Controller of Water Resources through this regulation. As identified in s. 2, this volume is determined in accordance with the

		following criteria: a) water required at the farms; b) canal losses within the district; c) evaporation for district reservoirs; d) water flows returning to rivers. S. 7 also states that, "any licence issued in accordance with this Regulation may contain conditions limiting the amount of water that may be diverted and used when necessary to maintain minimum instream flows." Minimum flow rates are then listed for the Waterton River, Belly River and St. Mary River.
<i>Irrigation Districts Act I-11 RSA 2000</i>	Agriculture, Food and Rural Development	This Act provides for the formation, dissolution and governance of irrigation districts. These districts are recognized as independent corporations responsible for managing the water within them. Districts are licensed with a block of water and they decide how that water is distributed within the district.
<i>Municipal Government Act M-26 RSA 2000</i>	Municipal Affairs	Grants municipalities broad powers to pass and enforce bylaws
Policies and Guidelines		
Groundwater Allocation Policy for Oilfield Injection Purposes	Alberta Environment	This policy requires oil and gas operations to investigate alternative resource recovery methods and alternative sources of water before an application to use potable groundwater is made. The policy also outlines quantity limitations and time limit restrictions on water diversions.
Underground Water Injection Guidelines		To address public concern for the use of water in the oil industry, a multi-stakeholder Committee on Water Use Policy and Practice was formed to examine whether changes are needed to improve management of water related to underground injection. Preliminary guidelines for this management were drafted in March 2004, with the suggestion that more time be allotted to the committee for public and stakeholder consultation. The committee is now reviewing that feedback and preparing its final recommendations to the Minister of the Environment. Specific recommendations include, but are not limited to: <ul style="list-style-type: none"> ▪ The use of water management plans under the Water Act to provide guidance on the use of water in each basin. These plans could include conservation objectives. ▪ Applicants for water for underground injection should be required to identify and assess alternatives to non-saline water sources ▪ Provincial water conservation plan should be established (in line with Water for Life) identifying potential reductions in use of non-saline water for all sectors ▪ Research into alternative technologies to reduce the use of non-saline water sources for underground injection practices should be increased
Guidelines for Groundwater Diversion For Coalbed Methane/Natural Gas in Coal (CBM/NGC) Development (2004)	Alberta Environment	Summarizes the rules and processes already in place to guide CBM/NGC development where non-saline water is involved. Alberta Environment will consider adjustments or enhancements to these or any regulations relevant to CBM/NGC development as recommendations come forward from the current reviewing committee. A water working group was formed as part of the CBM/NGC review process in March 2004. Based on their recommendations the Multi-Stakeholder Advisory Committee overseeing the review is expected to develop final recommendations for submission to the AB government in November 2004.

Sources:

- Background: Water for Life – Water and Oil. [Online]. Available: <http://www.waterforlife.gov.ab.ca/html/background5.html>
- Advisory Committee on Water Use Practice and Policy. 2004. Preliminary Report. [Online]. Available: <http://www.waterforlife.gov.ab.ca/index.html>
- Alberta Environment. Coalbed Methane/Natural Gas in Coal Water Working Group. Available: <http://www.waterforlife.gov.ab.ca/html/coalbed.html>

Water Conservation and Related Program Initiatives

Provincial

Water conservation and water use efficiency has always been an important issue in Southern Alberta, where dry weather conditions and limited water resources supply the province's richest agricultural lands. However, continuing growth in this sector, along with increasing growth in the industrial sector and in the population in

general, is causing increased concern for the reliability of this supply. In response to these concerns, the province of Alberta has recently launched its Water for Life Strategy. Water conservation is one of three strategic directions the government identifies in the strategy.

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
<p>Water for Life: Alberta's Strategy for Sustainability</p> <p>A cross-ministry steering committee guides strategy development and implementation.</p> <p>(Key ministries include: Environment; Sustainable Resource Development; Agriculture, Food and Rural Development; Health and Wellness; Innovation and Science; Community Development; Economic Development; and Transportation)</p> <p>The Strategy is the Government's response to recent issues of fluctuating and unreliable water supply due to increased population growth, droughts and agricultural and industrial development.</p>	All	<p>The Strategy embraces a new water management approach and outlines specific strategies and actions to address issues of unreliable water supply. It is based on the following commitments to Albertans</p> <ul style="list-style-type: none"> Albertans will be assured their drinking water is safe. Albertans will be assured that the province's aquatic ecosystems are maintained and protected. Albertans will be assured that water is managed effectively to support sustainable economic development. <p>Water conservation is one of three key strategic directions the government identifies in the strategy, along with knowledge and research, and partnerships.</p> <p>Water conservation outcomes to guide and measure the success of the strategy in meeting these goals are identified in the short, medium and long term (2010/11 to 2013/14). Important outcomes include the development of watershed plans, the adoption of best management practices amongst the various sectors, and an overall improvement in the efficiency and productivity of water use in Alberta by 30 % from 2005 levels by 2015. Specific actions related to water conservation and identified in the strategy include, but are not limited to the following:</p> <p>Short term</p> <ul style="list-style-type: none"> Establish a system to monitor and report actual water use by all sectors on an on-going basis Determine and report on the true value of water in relation to the provincial economy Complete an evaluation and make recommendations on the merit of economic instruments to meet water conservation and productivity objectives Establish a public awareness and education program on water conservation in Alberta <p>Medium term</p> <ul style="list-style-type: none"> Prepare water conservation and productivity plans for all water using sectors Implement economic instruments as necessary to meet water conservation and productivity objectives <p>Long term</p> <ul style="list-style-type: none"> Establish an on-going monitoring program to ensure all sectors are achieving water conservation and productivity objectives <p>Specific sub-actions relating to each of the above listed actions are also identified in the strategy.</p>	
Alberta Environment Water Conservation Website (Alberta Environment)	All	Outlines a number of water conservation activities that can be applied in the residential, ICI and agricultural sectors, in addition to various other resources.	
Alberta Agriculture, Food and Rural	Agriculture	The Irrigation Branch offers a broad range of	

		<p>underground pipes</p> <ul style="list-style-type: none"> ICI water use study to better design water conservation and efficiency programs Water conservation and efficiency information specific to a number of different businesses, on website Water efficiency school program for grades 4-9 Community school programs Team Water Wise to address outdoor water inefficiencies in all sectors through education Mandatory watering restrictions during times of water shortage Waterways newsletter Water efficient fixtures by-law 	a day in 2003.
Town of Strathmore Non-potable irrigation system	Municipal	<p>A non-potable system for lawn irrigation has been in place for many years. The system delivers non-potable water to residential customers from irrigation ditches passing near to the town. Developers of new homes are required to install pipes to new lots. The homeowner pays a flat rate for the use of this water.</p> <p>Epcor initiatives include those identified below for Edmonton.</p>	Savings are significant during the summer months.
City of Edmonton	All	<p>Current initiatives include:</p> <ul style="list-style-type: none"> Universal water metering 2-part rates structures including a fixed monthly service charge and a variable charge based on consumption (inclining block rate for res, declining for comm.) Subsidized sale of rain barrels Water reuse at gold bar wastewater treatment plant Epcor voluntary odd-even watering program Epcor online home water audit Epcor public awareness via classroom programs (grades 1-6), internet, radio Epcor residential and commercial water efficiency guides and advice on website Epcor water efficiency coordinator Epcor water restriction measures during times of water shortage Epcor network maintenance program including meter maintenance, uni-directional flushing, leak detection, routine maintenance of main valves and curb service valves, cast iron pipe and line replacement program, corrosion control anode inspection and replacement program 	<p>Maintenance program has resulted in an overall decrease in UAW to less than 5% of total production. The cast iron water main replacement program in particular has reduced the number of annual main breaks from 1,600 per year in the mid 1980s to 500 per year, and has achieved a repair rate of 94% of main breaks within 24 hours.</p>

Sources:

- City of Calgary Waterworks. Available: <http://www.calgary.ca>
- Epcor. Available: <http://www.epcor.ca/default.htm>
- Roach, R., Huynh, V. and S. Dobson. 2004. Drop by Drop: Urban Water Conservation Practices in Western Canada. [Online]. Available: <http://www.cwf.ca>
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Sectoral

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Alberta Environment Farm Plan (Funded by Alberta Agriculture, the Federal government and others)	Agriculture	The Alberta Environmental Farm Plan (AEFP) is a non-profit company that helps farmers and ranchers identify environmental opportunities and challenges on their own land. AEFP was created in April 2002 because Alberta producers identified the need for delivery of an environmental farm plan program that was not 100% owned and operated by the government. AEFP is comprised of a team of industry, government and other stakeholders working together to develop and implement the program. The company has a nine-member board of directors and four staff. A worksheet on irrigation management assists farmers in assessing and improving the efficiency of water for irrigation on the farm.	
Alberta Irrigation Projects Association (AIPA)	Agriculture	AIPA represents Alberta's irrigation districts in government forum. Main activities include education and outreach, policy development and research activities. Research to improve the efficiency of water use is on-going, and includes studies to improve automated controls, new water control devices and enhanced monitoring equipment.	This research has contributed to a reduction in irrigation water use per hectare by one-third, from 15 years ago. Almost 2/3 of all land irrigated in S. Alberta is watered under low-pressure pivots.

Sources:

- Alberta Environmental Farm Plan. [Online]. Available: <http://www.albertaefp.ca/index.shtml>
- Alberta Irrigation Projects Association. Available:
- Hill, D. 2004. Every Drop Counts. In Corporate Knights – Waterlution Special Water Issue. [Online]. Available: <http://www.corporateknights.ca/water/03.pdf>

BRITISH COLUMBIA (BC)

Water Supply and Demand Overview

In 2003, a significant drought affecting southern British Columbia reduced water flow in many streams and rivers to historic lows. A survey of water purveyors in September 2003 indicated that 2.2 million people were affected by the drought, 84 water systems were under stress and 43 systems were expected to be under stress in spring 2004.

Currently, over 17% of surface water sources have reached or are nearing their capacity to reliably supply water in a normal year. Observation wells indicate that groundwater levels are declining in some areas of the province.

Most of the surface water allocated in the province is for the non-consumptive uses of water for power production and storage for power production. Agricultural, commercial, industrial and drinking water uses, together use only 3% of water licensed in British Columbia. Water use by sector is as follows:

- 22% for agricultural purposes
- 47% for industrial/commercial purposes
- 31% for drinking water purposes

Statistics for the Georgia Basin (where 74% of BC's population is located and where 75% of the municipal water in 1999 was consumed) indicate the following:

- 65% of municipal water is used for residential purposes
- 20% for commercial purposes
- 8% for industrial purposes
- 7% for other purposes

In addition, the average British Columbian uses 440 litres of water/day (Canadian average is 326 L/day).

Sources:

- Environment Canada. Water Use and Wastewater in the Georgia Basin. Available. http://www.ecoinfo.ec.gc.ca/env_ind/region/wateruse/gbwateruse_e.cfm. Last updated: Feb. 20 2004
- BC Ministry of Water, Land and Air Protection. 2000. Environmental Indicator 2000: Water Use in British Columbia. [Online]. Available: http://wlapwww.gov.bc.ca/soerpt/files_to_link/2000tecdocs/09-water-use-techdoc.pdf

Water and Related Legislation and Policies

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Water Act</i> (1996), Parts 2 and 3 (under <i>Water Act</i> consolidation, effective Nov 1, 2004)	Ministry of Land, Water and Air Protection (MLWAP)	Part 2 (Licensing, Diversion and Use of Water and Related Matters) and Part 3 (Water Users' Communities) regulate the diversion, use and storage of surface water through a comprehensive licensing system. All surface water uses must be licensed or approved. The system is based on a "first in line, first in right" principle (i.e., holders of older licenses have precedence if water becomes scarce). For any new water licence application with a proposed diversion rate of over 25,000 gallons per day (1.32 litres per second), a Development Plan must be completed. Water recycling and conservation measures should be documented, along with a description of how water flow will be monitored. Land and Water BC Inc. (LWBC), a government corporation, is responsible for some water inventory work, assessing water availability for allocation purposes, allocation decisions and regulation and enforcement of licenses.
<i>Water Act</i> , Part 4	Ministry of Sustainable Resource Management (MSRM)	Part 4 of the <i>Water Act</i> (Water Management Plans) provides for solution-oriented, legally binding water management plans. Plans are tailored to addressing local issues and could thus deal with water use efficiency. The Ministry of Sustainable Resource Management (MSRM) & the Ministry of Water, Land & Air Protection (MWLAP) are responsible for administering Part 4.
<i>Water Act</i> , Part 5	MWLAP	Part 5 of the <i>Water Act</i> provides for protection of wells and groundwater. Part 5 came into force November 1, 2004 and is largely enabling. Initial provisions of the <i>Groundwater Protection Regulation</i> (see below), which are currently being implemented, focus on standards for well construction and qualification requirements for well drillers & pump installers. MWLAP is responsible for administering Part 5.
<i>Groundwater Protection Regulation</i> under <i>Water Act</i> (enacted July 2004; in force November 2004)	MWLAP	S.3 of the <i>Groundwater Protection Regulation</i> states that its purpose is: <ul style="list-style-type: none"> To set out minimum standards for construction, identification, reporting on, testing, maintenance, alteration & closure of wells; To safeguard & maintain the integrity of groundwater; To promote the efficient use of groundwater; and, To require that activities related to well water and groundwater are undertaken in an environmentally safe manner, which precludes a contaminant entering the groundwater and protects human health and safety.
<i>Water Protection Act</i> (1995)	MWLAP	The <i>WPA</i> prohibits bulk removal of water from BC, and prohibits diversion of water between major watersheds in BC. It also reconfirms that the Province owns the surface water and groundwater in British Columbia (except in so far as private rights have been established) and has the right to ensure its protection and sustainable use.
<i>Environmental Assessment Act</i> (2002)		The BC Environmental Assessment Act requires that certain types of project proposals undergo an environmental assessment and obtain an environmental assessment certificate in order to proceed. For example, new or modified facilities designed to extract groundwater at a rate of 75 litres or more per second may be reviewable under EMA. Water diversion projects permitted under the <i>Water Act</i> to divert water at a maximum rate of >10 million m ³ /year may be reviewable under EMA.
<i>Drinking Water Protection Act</i> (2001)	Ministry of Health Services (MHS)	In June 2002, an Action Plan for safe drinking water was announced to modernize drinking-water protection in British Columbia. An amended <i>Drinking Water Protection Act</i> and regulations came into force in May 2003, replacing the Safe Drinking Water Regulation under the <i>Health Act</i> . Under the new drinking water legislation, the province has increased the basic expectations around assessing water systems, certifying operators and suppliers, and monitoring and reporting on water quality. The legislation gives drinking-water officers increased powers to protect water sources from contamination by any drinking-water health hazard. In addition, drinking-water officers will oversee a source-to-tap assessment

		of every drinking-water system in the province to address all potential risks to human health. The drinking water officer may order the water supplier to prepare an assessment response plan if an assessment has identified threats to the drinking water. An assessment response plan may include provisions for best management and conservation practices, and infrastructure improvement.
<i>Fish Protection Act (1997)</i> (S. 8-11 are not in force)	MSRM (except for S.12) MWLAP (S.12)	The <i>Fish Protection Act</i> has four major objectives: <ul style="list-style-type: none"> ▪ Ensuring sufficient water for fish; ▪ Protecting and restoring fish habitat; ▪ Improving riparian (streamside) protection and enhancement; and ▪ Giving local government greater powers for environmental planning. When the <i>FPA</i> was passed in July 1997, only one major section (prohibiting the construction of new dams on 14 rivers) was brought into force. In March 2000, Sections 6 and 7 (Sensitive Streams and Recovery Plans) were brought into force along with the Sensitive Streams Designation (see below) and Licensing Regulations. The remaining sections of the Act will come into effect over the next few years as supporting regulations, policies and procedures are developed. These include: <ul style="list-style-type: none"> ▪ S.8 provides for the issuance of streamflow protection licenses; ▪ S.9 allows orders for temporary reduction in water use in cases of drought; ▪ S.10 identifies fish and fish habitat considerations in water management plans (e.g., a plan could identify water use efficiency measures to provide additional water for fish and fish habitat); ▪ S.11 authorizes reduction of water rights in accordance with water management plan; ▪ S.12 covers provincial directives on streamside protection (see below).
<i>Sensitive Streams Designation Regulation (Mar 2000)</i> under <i>Fish Protection Act</i> and <i>Water Act</i>	Land & Water British Columbia Inc. (LWBC)	S.6 of the <i>Fish Protection Act</i> allows the designation of a sensitive stream to protect a fish population at risk because of inadequate water flow or degradation of fish habitat. To address this the <i>Sensitive Streams Designation Regulation</i> was developed. Sections relevant to water conservation include the following: S.5 of the <i>Sensitive Streams Designation Regulation</i> provides authority to require water licence applicants to provide information such as seasonal distribution of water demand, and any specific water conservation measures the applicant will use to minimize use of water. S.7 of the <i>Sensitive Streams Designation Regulation</i> provides authority to require information on proposed project mitigation strategies (including but not limited to water use metering and water conservation measures).
<i>Streamside Protection Regulation</i> under <i>Fish Protection Act</i> S. 12		The <i>Streamside Protection Regulation</i> (enacted under S.12 of the <i>Fish Protection Act</i> but not in force) protects streamside areas so they can provide natural features, functions & conditions, including those that maintain sustained water flows during low flow periods.
<i>Riparian Areas Regulation</i> under <i>Fish Protection Act</i> (deferred to Mar 31'05)		The <i>Riparian Areas Regulation</i> (enacted under S.12 of the <i>Fish Protection Act</i> in July 2004 and intended to replace the <i>Streamside Protection Regulation</i>) calls on local governments to protect riparian areas during residential, commercial and industrial development by ensuring that proposed activities are subject to an assessment.
<i>Water Conservation Plumbing Regulation</i>	Ministry of Community, Aboriginal and Women's Services (MCAWS)	The provincial Water Conservation Plumbing Regulation has been amended to require the installation of low consumption (6 litre) toilets in the Capital Regional District (CRD), which is piloting the regulation in BC. Effective January 1, 2005, low consumption toilets must be installed in new construction and renovations throughout the CRD. Other local governments that would like to apply the requirement for low consumption toilets in their jurisdictions may express their interest to the Ministry of Community, Aboriginal and Women's Services' (MCAWS).
<i>Municipal Sewage Regulation (1999)</i> under <i>Environmental Management Act</i>	MWLAP	The <i>Municipal Sewage Regulation</i> , which became effective in July 1999, encourages the use of reclaimed water. The <i>Regulation</i> identifies the permitted non-potable uses of reclaimed water as well as treatment and infrastructure requirements, effluent quality and monitoring requirements. A code of practice for the use of reclaimed water was produced in 2001 as a companion document to the <i>Regulation</i> .

Water Conservation and Related Program Initiatives

Provincial

Water conservation as a provincial issue has been on the table in British Columbia for over a decade. In 1993 a consultation series (Stewardship of the Water of BC) including a separate discussion paper on water conservation was developed. Fifteen actions for the conservation and efficient use of BC waters were proposed. Following up on this initiative, a Water Conservation Strategy for British Columbia was introduced in 1998. The strategy aimed to promote water conservation measures that could be adopted by water purveyors, local governments and users across the province. It identified 10 strategic directions and 20 actions for implementation ranging from public education to regulatory measures such as watering restrictions etc. As part of the Strategy, a Water Use Efficiency Catalogue was developed that compiled water conservation strategies implemented or ongoing throughout BC and identified the lead agencies and partners. In 1999, a Freshwater Strategy for British Columbia was proposed in 1999. The Strategy provided an overview of accomplishments, future directions, key challenges and priority actions for water management in BC. Water conservation was a key component of the strategy. Current initiatives relating to water conservation in the province are outlined below.

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
<p><i>Water Sustainability Action Plan for British Columbia (2004)</i></p> <p>(Water Sustainability Committee of the BC Water and Waste Association in partnership with the Ministry of Water, Land and Air Protection)</p>	All	<p>Builds upon the Water Conservation Strategy for British Columbia that was introduced by the same Ministry in 1998.</p> <p>The goal of the new Plan is to encourage province-wide implementation of fully integrated water sustainability policies, plans and programs. The Action Plan comprises 6 elements that link water management with land use, development and resource protection. Its implementation will depend upon financial support from both the government and the private sector. Action Plan elements are as follows: water sustainability website, water save tool kit for BC, water sustainability round table, green infrastructure partnership to develop a "best practice" Model Subdivision Bylaw and Green Infrastructure Standards, water balance model for BC and a watershed/landscape-based approach to community planning.</p>	<p>A provincial focus group session has already taken place to ensure that the water save tool kit will meet the needs of all stakeholders and to brainstorm around tool kit content, presentation, design etc.</p> <p>The water sustainability website is currently under development with a public launch anticipated in early 2005.</p> <p>The Water Balance Model for BC has also already been developed through an inter-governmental partnership. An Outreach and Continuing Education Program to create momentum and stakeholder support for the use of the model as standard practice in land development decisions is currently underway. Funding is required for further technical enhancements.</p>
<p>Drought Management Action Plan (2003)</p> <p>(Ministry of Sustainable Resource Management)</p>	All	<p>Contains immediate, short, medium and long-term drought management measures. Initiated in response to 2003 drought conditions.</p>	<p>Measures completed to date include: assisting communities in developing emergency response plans, encourage demand management by water purveyors, develop provincial drought management plan etc</p>
<p>Dealing with Drought Planning Assistance Program</p> <p>(Land and Water BC Inc.)</p>	Municipal, water purveyors	<p>Applications for funding assistance from local water suppliers interested in assessing, mitigating and responding to drought conditions through the development and implementation of drought management and water conservation plans and bylaws, are currently being accepted by the provincial govt. \$2 M in funding is available for this. A handbook for water suppliers, containing templates for processes and plans related to drought management, including water conservation and drought management plans, example bylaws and guidelines for establishing local drought management teams, is also available. Eligible applicants are local governments and improvement districts that are water suppliers.</p>	<p>Workshops providing an overview of how to develop these sorts of plans were offered to local water suppliers who had received grants in July/August 2004. Application deadline is December 31 2004.</p>
<p><i>Pollution Prevention Planning</i></p> <p>(Ministry of Water, Land and Air Protection)</p>	Industry	<p>Instigated by the BC government, in 2001 the Pollution Prevention Planning Implementation Advisory Committee, made up of a variety of different stakeholders, published its final recommendations concerning the development</p>	

Initiated by the Ministry of WLAP upon completion of a pollution prevention demonstration project with several other large industries in 1996.		of pollution prevention planning for large industry in BC. The report examines and addresses a broad range of issues including emissions and discharges, toxic substances, energy use, water use, material efficiencies, odour and noise. Several different approaches to P2 implementation are presented, from a government driven to business driven approach. However, in all approaches, the planning process is strictly voluntary amongst industry.	
(Ministry of Agriculture and Food)	Agriculture	In recent years the Ministry has developed several manuals and guides concerning water use efficiency and conservation in irrigation practices, including: BC Trickle Irrigation Design Manual Irrigation Scheduling Guide	

Sources:

- http://www.qp.gov.bc.ca/statreg/reg/W/WasteMgmt/129_99.htm
- 1998. A Water Conservation Strategy for British Columbia. [Online]. Available: http://www.env.gov.bc.ca/wat/wtr_cons_strategy/toc.html
- Water Sustainability Committee of the BCWWA. 2004. Water Sustainability Action Plan for British Columbia: Framework for Building Partnerships.
- http://www.waterbucket.ca/waterbucket/dynamicImages/386_WaterSustainabilityActionPlanforBC.pdf
- Pollution Prevention Implementation Advisory Committee. 2001. Recommendations for Implementing Pollution Prevention Planning for Large Industry in British Columbia. [Online]. Available: http://wlapwww.gov.bc.ca/epd/epdpa/industrial_waste/pollution_prvntn/P2IACReportFinal1.pdf
- Water Balance Model for British Columbia.
<http://www.waterbalance.ca/waterbalance/home/wbnBCIndex.asp>

Municipal and Regional

The City of Kamloops WaterSmart Program has been hailed as a provincial leader in the non-metering approach to water efficiency. In the table below, this program is contrasted with current water conservation initiatives in the Greater Vancouver Regional District (GVRD). With a population greater than 2 million, the GVRD has many times the 92, 459 inhabitants of Kamloops. The Greater Vancouver Regional District is a partnership of 21 municipalities and one electoral area that make up the metropolitan area of Greater Vancouver. The GVRD is responsible for the delivery of essential services like drinking water, waste water treatment etc. in a manner that makes it more efficient and economical than the delivery of these services by the individual municipalities.

Municipality or Region	Target Sector	Description	Results and Effectiveness
City of Kamloops WaterSmart Program Launched in 1992 to delay expansion of the city pumping facility	Residential	<p>Kamloops set the objectives of reducing peak period water consumption by 10 percent between 1992 and 1996, and 15 percent from 1997 on.</p> <p>Components of the program include:</p> <ul style="list-style-type: none"> ▪ A WaterSmart bike team available to visit elementary classrooms and to enforce watering bylaws ▪ An Aquanomics course providing students with both environmental and economic reasons to conserve water. Available to grades 4-7. ▪ Compulsory water use restrictions between May – August ▪ Demonstration Xeriscape garden and free workshops <p>In 2001 the City also instigated research into the effectiveness of universal water metering for Kamloops. The Water Use Efficiency Committee determined that universal water metering is the single most cost-effective method of</p>	<p>The program has proven to be effective, reducing average water consumption during peak summer months by 21%. \$100,000 per year in electricity costs was saved from reduced pumping of water. \$500,000 was saved annually in deferred interest charges. Each summer the program paid for itself within the first month, and generated an annual return on investment of over 500 percent.</p> <p>In 2003, the Watersmart message was delivered to more than 2500 students by the two educational programs.</p> <p>On October 15 2001 universal metering was defeated in a referendum. Residents will be footing a bill for an estimated \$9 million in added construction costs for larger water treatment facilities and operating costs.</p>

		achieving more efficient water use in Kamloops.	
Greater Vancouver Regional District	Residential, commercial, institutional, industry	<p>Water conservation initiatives in the GVRD include the following:</p> <ul style="list-style-type: none"> Conservation information targeting residents on website Water restrictions between June – October A SmartSteps program to help businesses improve the efficiency of energy, water and material use. A website provides information and technical advisors are available to guide business through the program A BuildSmart program providing information and resources to the design and construction community on green building. Water efficiency is an important element of the program. 	Since the implementation of sprinkling regulations in 1993, water consumption in the region has decreased on average by 15 per cent, with peak usage declining by 25 per cent.

Sources:

- City of Kamloops. WaterSmart Program. Available: <http://www.city.kamloops.bc.ca/environment/index.html>
- Greater Vancouver Regional District. Water Conservation. Available: <http://www.gvrd.bc.ca/water/conservation.htm>
- Greater Vancouver Regional District. SmartSteps Program. Available: <http://www.gvrd.bc.ca/smartsteps>
- Greater Vancouver Regional District. BuildSmart Program. Available: <http://www.gvrd.bc.ca/buildsmart/index.htm>

MANITOBA (MB)

Water Supply and Demand Overview

Manitoba is blessed with an abundant amount of both surface and ground waters; however, water supply constraints do exist in some parts of the province. Groundwater is the main source of water supply for much of rural Manitoba.

The statistics below represent proportional ground and surface water allocations (excluding hydropower) in the province. Water usage is measured via a number of sources and work is currently underway to consolidate the system of measurement.

- City of Winnipeg - 28% of total provincial withdrawals
- Irrigation - 24%
- Municipal supplies - 22%
- Industrial - 18%
- Other - 6%
- Other agricultural - 2%

According the Environment Canada Municipal Water Use Database, mean per capita water use in Manitoba is estimated at 249 L/day.

Water and Related Legislation and Policies

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>The Water Rights Act</i>	Manitoba Water Stewardship	States that all users of water, except domestic users of less than 25 000 l/day, require a license to use water. Priorities to water use are also outlined in the Act. The Water Licensing Branch within the Department of Manitoba Water Stewardship is in charge of granting licenses. The Department of Water

		Stewardship is the primary water planning and management authority in the province.
<i>The Water Rights Regulation 126/87 under the Water Rights Act</i>	Manitoba Water Stewardship	Sets out the fees payable according to license type. S. 8 of the regulation requires all license holders to keep records of water use on a form approved by the Minister. All licenses require water users to report water use on an annual basis. The majority of all current users have a monitoring and reporting condition attached to their license. In addition, point-of-use monitoring is widespread in Manitoba.
<i>The Water Resources Conservation and Protection Act (2000)</i>	Manitoba Water Stewardship	Forbids the removal of water from a water basin or sub-water basin in Manitoba, except in special circumstances (i.e. in containers less than 25L, for use in a product etc.).
<i>The Water Protection Act (proposed)</i>	Manitoba Water Stewardship	<p>Focus of this act is the entrenchment of water quality standards, objectives and guidelines into legislation. It proposes the establishment of water quality management zones and watershed planning authorities to develop watershed management plans. Municipal councils would be required to consider water management plans and water management zones in making planning and development decisions. As stated in s. 16 of the Act concerning the content of a watershed management plan, a plan must contain objectives, policies and recommendations concerning some or all of the following (only direct conservation ones listed here):</p> <ul style="list-style-type: none"> ▪ The protection, conservation or restoration of water, aquatic ecosystems and drinking water sources, ▪ Water demand management, water use practices and priorities, the conservation of water supplies, and the reduction of water use and consumption during droughts and other periods of water shortage, <p>The promotion of water conservation is an important component of the Act. As stated in s. 10 of the Act, regulations establishing water conservation programs and/or generally respecting the reduction of water usage in Manitoba are allowed.</p> <p>The proposed act also identifies the establishment of a Water Stewardship Fund that would be used to finance research, projects and activities in support of the act, as well as the development of watershed management plans and water conservation programs. The legislature is expected to vote on the Act before the end of 2004.</p>
<i>The Conservation Districts Act (1998)</i>	Manitoba Water Stewardship	<i>The Conservation Districts Act</i> in Manitoba authorizes the creation of Conservation Districts to provide for the conservation, control and prudent use of resources. Conservation Districts are groups of neighbouring rural municipalities whose boundaries are usually defined based on the watershed or drainage basin of the major river in the area. In partnership with the Province of Manitoba, these districts work to develop programs to effectively manage the natural resources of the area. Programs can be designed specifically to meet the needs of the district. Potential program areas might include water management and or conservation. Currently there are 16 districts in Manitoba making up over 60% of agro-Manitoba.
<i>The Sustainable Development Act (1998)</i>	Manitoba Conservation	The Sustainable Development Innovation Fund, originally created in 1989, was officially continued under the <i>Sustainable Development Act of 1998</i> . The fund provides grants in support of innovative projects, activities, research and developments that further the sustainability of Manitoba's environment, economy, human health, and social well-being and supports sustainable economic growth. One of the nine priority areas is that of water. The focus for this priority area is on initiatives that protect water quality, promote wise and efficient use of water, and conserve water. Revenue for the fund is derived from an environmental protection tax applied to glass liquor bottles and disposable diapers.
<i>The Environment Act</i>	Manitoba Conservation	Provides licensing authority, a framework for assessment, as well as comprehensive tools to protect, maintain, and restore the quality of all environmental components, including water. Users of any type whom divert less than the threshold amounts described in <i>Manitoba Regulation 164/88 of the Environment Act</i> do not require an Environment Act License.
<i>The Water Power Act</i>	Manitoba Water Stewardship	Establishes provincial ownership of all provincial water powers.
<i>The Water Resources Administration Act</i>	Manitoba Water Stewardship	Sets out responsibility for the provincial waterway system, designated flood areas, and all water control works.

Policies and Guidelines		
Applying Manitoba's Water Policies (1990)		<p>Conservation Policy Objective: To conserve and manage the lakes, rivers and wetlands of Manitoba so as to protect the ability of the environment to sustain life and provide environmental, economic, and aesthetic benefits to existing and future generations.</p> <p>Policy 4.1 of the Manitoba Water Policies associated with the issue of Water Supply states, "Demand management programs shall be implemented to conserve water and reduce the requirements for new water supply infrastructure"</p> <p>The policy also states that the following actions will be pursued by the provincial government:</p> <ul style="list-style-type: none"> ▪ The development of municipal water use rate structure options ▪ The promotion of municipal rate structures that support water conservation ▪ The development and maintenance of water source and use monitoring networks ▪ Encourage extensive metering of water supply systems ▪ Explore and promote water conservation technology etc.
<i>The Sustainable Development Act (1998)</i>	Manitoba Conservation	<p>Under this Act, several principles and guidelines relating to the use of Manitoba's natural resources are specified. These include:</p> <p>Principle: Conservation and Enhancement</p> <p>Manitobans should</p> <p>(a) Maintain the ecological processes, biological diversity and life-support systems of the environment;</p> <p>(b) Harvest renewable resources on a sustainable yield basis;</p> <p>(c) Make wise and efficient use of renewable and non-renewable resources; and</p> <p>(d) Enhance the long-term productive capability, quality and capacity of natural ecosystems.</p> <p>Continued</p> <p>Guidelines for Sustainable Development</p> <p>Efficient Use of Resources - which means</p> <p>(a) Encouraging and facilitating development and application of systems for proper resource pricing, demand management and resource allocation together with incentives to encourage efficient use of resources; and</p> <p>(b) Employing full-cost accounting to provide better information for decision makers.</p> <p>Continued</p>

Sources:

- Manitoba government. 2004. Province proposes legislative action to protect Manitoba's water supply. News release. [Online]. Available: <http://www.gov.mb.ca/chc/press/top/2004/03/2004-03-04-03.html>
- Bill 22, Water Protection Act. [Online]. Available: <http://web2.gov.mb.ca/bills/sess/b022e.php>
- Manitoba Department of Water Stewardship. Conservation Districts. [Online]. Available: <http://www.gov.mb.ca/waterstewardship/mwsb/cd/index.html>
- Manitoba Conservation, Pollution Prevention Branch. Sustainable Development Innovation Fund. Available: <http://www.gov.mb.ca/conservation/pollutionprevention/sdif/index.html>
- Sustainable Development Act. [Online]. Available: <http://web2.gov.mb.ca/laws/statutes/ccsm/s270e.php>
- Applying Manitoba's Water Policies. [Online]. Available: http://www.gov.mb.ca/conservation/watres/leg_&_policies.html

Water Conservation and Related Program Initiatives

Provincial

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
The Manitoba Water Strategy (2003)	All	Concerning water conservation, initiatives of today and tomorrow are outlined in the strategy. Future conservation activities shall include the continued development of appropriate education, financial instruments and taxation incentives to encourage	

		conservation objectives, the development of a watershed planning framework and guidelines that have conservation as a priority, plus more.	
Water Efficiency Program (Manitoba Conservation, Pollution Prevention Branch)	All	The objective of this program is to promote water efficiency amongst Manitobans. The program website provides suggestions for how to reduce water usage and consumption.	
The Sustainable Development Innovations Fund (Manitoba Conservation)	Municipal, water purveyors, commercial, institutional	The Sustainable Development Innovations Fund of Manitoba Conservation partnered with the Association of Manitoba Municipalities to develop and publish booklets that give specific water use efficiency suggestions to municipalities, water plant operators, small hotels and motels and schools. These guides can be found online at the following address: http://www.amm.mb.ca/res_tools.html .	
Covering New Ground (Manitoba Agriculture, Food and Rural Initiatives)	Agriculture	Covering New Ground is a recent government program aiming to provide producer groups and commodity organizations with financial and technical support to projects seeking solutions to environmental challenges. Most CNG demonstration projects explore on-farm practices in three main areas: forage and livestock; crop management, and integrated pest management. Regional delivery teams set program priorities for the various regions. Water quantity is a priority in some of the regions identified.	Initiated in 1998, over 1000 projects had been supported as of September 2003.
Wise Use of Water (Manitoba Conservation and Manitoba Water Stewardship) (Currently being developed)	All	Manitoba Conservation and Manitoba Water Stewardship are currently developing a "Wise Use of Water" public discussion piece suggesting work in the areas of water data; identifying, assessing and prioritizing approaches; integration of efficiency into codes, standards, funding etc.; tightening water distribution systems; water charges and fees; education; and partnerships. Once issued, public consultations on these issues will be held. A follow-up scientific research based document to this process is also planned. The purpose of the document is to identify water use by sector and withdrawal, to analyze the cost/benefit of various options promoting water use efficiency, and to identify appropriate policy changes for Manitoba. This document will be updated every 3 years.	
Integrated Watershed Planning (Manitoba Water Stewardship) (Currently being developed)	All	Manitoba Water Stewardship is encouraging the formation of local Water Planning Authorities to prepare Watershed Management Plans for their respective watershed. These plans will include consideration of: water quality standards, objectives and guidelines; water quality management zones regulations; studies relating to water, land use, demographics and the environment; public input; water management principles; provincial land use policies, development plans, and zoning-bylaws; and any other relevant information.	Integrated Watershed Planning will commence in April of 2005.
Water Stewardship Fund (Manitoba Water Stewardship) (Currently being developed)	All	The fund will offer grants and support to innovative water related efforts in the province. Specific to water conservation, one of the primary aims of the fund is to provide grants to assist in the implementation of watershed management plans or water conservation programs.	The fund is being developed and will be implemented in April of 2005.

Sources:

- 2003. The Manitoba Water Strategy. [Online]. Available: <http://www.gov.mb.ca/waterstewardship/waterstrategy/pdf/index.html#Conservation>
- 2003. Covering New Ground. [Online]. Available: <http://www.gov.mb.ca/agriculture/research/covering/about.html>
- Personal communication. Lisbeth Liebgott. Pollution Prevention Branch, Manitoba Conservation. CCME Task Group meeting, October 18, 2004.
- Personal communication. Ray Bodnaruk. Manitoba Conservation. 2002.

Municipal and Regional

The two conservation programs of the City of Winnipeg (population around 700 000) and the Town of Gimli, Manitoba (population 1600 at the time the program took place in 1996) are outlined in the table below.

Municipality or Region	Target Sector	Description	Results and Effectiveness
<p>City of Winnipeg 'Waterfront Program'</p> <p>Implemented to defer the need to expand the water supply system</p>	Residential, Institutional Industrial	<p>'Waterfront' is a web-based information source on water conservation initiatives taking place in Winnipeg. Initiatives implemented since the early 1990s include:</p> <ul style="list-style-type: none"> Public awareness campaign Slow the Flow Water Education Program for middle year students, available to interested teachers Residential retrofit program involving the sale of home water conservation kits Industrial water use survey Development of a database to assist in ongoing evaluation of the conservation program 	<p>Citywide improvements in water efficiency have deferred the expansion of the water supply system indefinitely.</p> <p>As of 2001, 100 classrooms were implementing the education program</p>
<p>Town of Gimli 'Water Conservation Program'</p> <p>Rationale: Town lagoon was at maximum capacity</p>		<p>Gimli's water conservation program was initiated and completed in 1996. Elements of the initiated included:</p> <ul style="list-style-type: none"> Water meter and toilet retrofit installation in all residences at no cost to homeowner Application of a volumetric water rate Water conservation workshops for residents Audits of water town water users including water efficiency recommendations Analysis of sewers for sources of infiltration using closed circuit television with identification of priority areas for repair 	<p>As of 1997, water consumption has decreased by approximately 25%.</p>

Sources:

- City of Winnipeg. 2001. Winnipeg's Water Conservation Program. Available: <http://www.winnipeg.ca/waterandwaste/water/waterfront/progress.htm>
- CWWA. Water Efficiency Experience Database – Water Conservation Program for Gimli, Manitoba. Available: http://www.cwwa.ca/WEED/Record_e.asp?ID=237

Sectoral

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Association of Manitoba Municipalities (AMM)	Municipal	The main function of the AMM is to lobby on behalf of all 199 municipalities in Manitoba on issues that affect them. As identified previously, in the area of water conservation, the AMM has developed and published water efficiency booklets for small and medium sized communities, motels/small hotels, schools, water plant operators and hospitals. Funding was provided through the Sustainable Development Innovations Fund. Water policy and conservation is an interest of the AMM.	
Manitoba Golf Superintendents Association (MGSA)	Golf	The MGSA functions to provide information, instruction and education to the benefit of its members. With the aid of Manitoba Conservation and a grant from the federal government MGSA has developed a self-assessment checklist to help interested clubs implement a Safety and Environmental Management System (SEMS). A section of the checklist is dedicated to proper water	To date 47 golf courses have participated. Only 15 have had follow-ups. Participating clubs have seen improvements in many areas including product substitution, reduced pesticide and water use, improved chemical storage etc.

		management and conservation.	

Sources:

- Association of Manitoba Municipalities. Available: <http://www.amm.mb.ca/default.htm>
- Manitoba Golf Superintendents Association. Available: http://www.mgsa.mb.ca/cim/42C182_271T7892.dhtm

NEW BRUNSWICK (NB)

Water Supply and Demand Overview

Water availability and shortage of supply have not historically been a major concern in New Brunswick. Most of the Province receives in excess of 1,100 mm of precipitation in a typical year with 20-33% of that coming in the form of snow. While the spring and early summer period tends to be dry, there is generally ample rain during the growing season.

Water use by sector in 2001 was distributed as follows: industrial uses 35%, public water supply 24%, aquaculture 28%, rural domestic 9%, and other uses (agriculture, golf courses, ski hills and bottled water) 5%. Surface water sources supply about two-thirds of the province's municipal population. Full metering is common among the province's larger towns and cities.

According to the Environment Canadian Municipal Water Use Database, per capita water consumption in New Brunswick is estimated at 414 l/c/day.

Water and Related Legislation and Policies

The Province does not have overarching legislation governing authorization and regulation of water withdrawals or prioritization of extractive uses. Protection of surface water and ground water levels and flows is, however, addressed through a number of *Clean Water Act* regulations that place restrictions on water abstractions and other activities that might interfere with the quality of public water supplies.

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Clean Water Act (1989)</i>	Department of Environment and Local Government (DELG)	The Act details the order-making powers of the Minister, which provide a means of controlling or stopping the discharge of contaminants, or of requiring the clean up of contaminated sites.
<i>Watercourse and Wetland Alteration Regulation 90-80 (1990)</i> under the <i>Clean Water Act</i>	DELG	Requires individuals planning a project that alters or diverts a surface watercourse or wetland to obtain a permit from the Minister. The Minister may impose conditions restricting the magnitude and timing of extraction.
<i>Wellfield Protected Area Designation Order 2000-47 (2000)</i> under the <i>Clean Water Act</i>	DELG	Protects municipal wellfields by providing standards for chemical storage and land use activities around designated wellfields. Activities that adversely affect the quantity or quality of water in a public ground water supply system are not permitted.
<i>Watershed Protected Area Designation Order 2001-83 (2001)</i> under the <i>Clean Water Act</i>	DELG	Protects municipal watersheds by providing standards for chemical storage and activities in and around designated watersheds. Places restrictions on the amount of water that may be extracted from a designated watershed. S. 6.o.VI states, "the maximum water withdrawal rate from any Protected Area A shall permit a maintenance flow of not less than 25 per cent of the mean monthly flow to be maintained in the watercourse at all times"
<i>Water Classification Regulation 2002-13 (2002)</i> under the <i>Clean Water Act</i>	DELG	Used to classify inland surface waters. The regulation sets goals for water quality on a watershed basis. It establishes water quality classes, and the associated water quality standards, and outlines the administrative processes and requirements related to the classification of water. The regulation has been developed to help watershed and other community-based groups to plan and set goals for surface water quality and watershed management.
<i>Environmental Impact Assessment Regulation 87-83 (1987)</i> under the <i>Clean Environment Act</i>	DELG	Requires individuals proposing certain projects to register with the Minister. Withdrawals of more than 50 m ³ /day must be registered. The Minister may place restrictions on the amount of water extracted from surface and ground water sources by persons operating a registered waterworks.

<i>Water Quality Regulation 82-126 (1982) under the Clean Environment Act</i>	DELG	Establishes an approval process for the construction, modification and operation of a source of contaminant, sewage works or waterworks. Only "waterworks" that extract more than 50 m ³ /day are regulated. The Department has occasionally used the regulation to control water extraction by industry however the general intent is to protect the quality of public water supplies.
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Water Conservation and Related Program Initiatives

Provincial

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Water for Life Strategy (Department of the Environment and Local Government) (Under development)	All	Currently developing a water strategy in consultation with other NB government departments.	Will likely lead to the implementation of a number of water conservation and economic instrument initiatives at the provincial level
(Department of the Environment and Local Government)	Residential	Water conservation tips for indoor and outdoor water use on website.	

Sources :

- DELG. New Brunswick Water Quantity Information, Water Conservation. Available: <http://www.gnb.ca/0009/0371/0007/0005-e.asp>

Municipal and Regional

Specific municipal water conservation programs in New Brunswick are limited, most likely due to an abundance of water resources and slow population growth in recent years. Municipal water conservation initiatives are dominated by efforts to meter water use and the application of volumetric charges. Universal water metering is now applied in the cities of Moncton and Fredericton. An example is highlighted below.

Municipality or Region	Target Sector	Description	Results and Effectiveness
City of Fredericton	All	By-law No. W-2 A, passed in February 2004, requires mandatory metering. Current water rates include a service charge of \$22 quarterly and a volumetric charge of \$0.49/m ³	The Utility is currently investigating various types of remote and automatic reading technology for safe and convenient service.

Sources:

- Fredericton By-Law No. W-2 A By-Law Relating to the Water and Sewer Systems. [Online]. Available: <http://www.city.fredericton.nb.ca/assets/documents/bylaws/W2B.pdf>

Sectoral

Initiative, Lead Agencies & Partners	Target Sector	Description	Results and Effectiveness
Produit au NB Grown and the Environmental Farm Plan (Agriculture Producers Assoc'n of New Brunswick) (APANB)	Agriculture	APANB represents NB farmers and lobbies on behalf of farmers for sustainable farming. The program is an educational strategy to inform the public of the significance of supporting NB farmers and educates farmers on the importance of following BMPs. A "Produit au NB Grown" label is used to identify NB products. To receive this label NB farmers must complete an EFP. The EFP is based on the same concept as in other provinces. The service is provided free of charge to the farming community by the APANB.	The Produit au NB Grown program was introduced in February 2004. To date, approximately 822 NB farms have participated in the EFP, with 500 receiving a certificate.

Sources:

- Agriculture Producers Association of New Brunswick. Available: <http://www.nbfarm.com/main.htm>

NEWFOUNDLAND AND LABRADOR (NL)

Water Supply and Demand Overview

Approximately 83% of the province's population receives its water supply from public sources and 17% from private sources. Eighty-eight percent of public waters are extracted from surface waters, which cover between 10-20% of the entire land area of the province, and the remaining is extracted from ground water sources. Dry summer months in recent years have been primarily addressed by local municipalities through the implementation of water conservation restrictions and programs, rather than through initiatives at the provincial level. Water supply and shortage have not historically been much of a problem in the province.

Water allocation by sector in Newfoundland and Labrador is estimated as follows:

- Municipal 125.65 million m³/year
- Fish Processing 8.24 million m³/year
- Aquaculture hatcheries 5.0 million m³/year
- Pulp and paper 118.0 million m³/year
- Thermal power generation (no estimate available)
- Bottling 0.0075 million m³/year

Newfoundland and Labrador requires more accurate estimate from those of 1995 and 1996 in relation to its water use sectors and enabling provisions in its *Water Resources Act*. As evident from the above statistics, water and thermal power generation is by far the largest non-consumptive user of water in the province.

According to the Environment Canada Municipal Water Use Database (1996), water consumption in the province is the highest in Canada, measured at 561 l/person/day. More recent provincial estimates put domestic water use at 450 L/capita/day.

Sources:

- Government of Newfoundland and Labrador. 2001. Source to Tap – Water Supplies in Newfoundland and Labrador. [Online]. Available: <http://www.gov.nl.ca/env/SourceToTap/SourceToTap/Report.asp>
- Personal Communication. A.K. Abdel-Razek.

Water and Related Legislation and Policies

The most significant initiative in the province addressing water conservation is the recently enacted *Water Resources Act* of 2002. Unlike legislation in other provinces, the Act does not specify a de minimus amount below which an approval and licence is not required. All non-domestic withdrawals from any water source, (surface, ground, marine and icebergs) require a Water Use Licence (WUL).

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Water Resources Act SNL (2002) cW-4.01</i>	Department of Environment and Conservation (DEC)	<p>An important principle of the Act is the wise use of water resources.</p> <p>Regulates the use of water through an approval and licensing system. Approvals are required for specific activities that affect water bodies and water and sewer systems (water quality protection) whereas a license allocates water for specified uses (water quantity protection). Domestic users do not require a license to use water according to the riparian rights doctrine. However, all other non-domestic users, no matter how little water they require, must have a license to take or divert water.</p> <p>Under the new legislation, persons with existing water rights (licenses, approvals etc.) must register those rights but do not need to apply for a new license (<i>section 10</i>). <i>Section 13</i> of the Act allows for the establishment of a public registry of water rights to keep track of water allocations in the province. This will help ensure better water use planning and management and avoidance of water use conflicts that may otherwise arise.</p> <p>The bulk removal of water is prohibited (<i>Subsection 12</i>). <i>Subsection 15</i> of</p>

		<p>the Act outlines the priority uses of water.</p> <p>The minister may also require a licensee to install and operate stream flow stations, to keep records on flow and pay the costs associated with this. The Minister may also attach terms and conditions to a permit authorizing municipal water supply operations.</p> <p>Section 29 of the Act also indicates that the Lieutenant Governor in Council may establish, in accordance with the regulations, economic measures such as incentives, royalties, subsidies, administrative and other fees and water use charges, for the purposes of ensuring the conservation and proper utilization of water resources, and for the financing of programs and other measures.</p> <p>S. 39 of the Act allows the minister, by regulation, to establish a source protection area surrounding a public water supply. In such an area, a person is not allowed to use or divert water to such an extent that it interferes with public water supply. The minister may also designate such an area to protect a wellfield.</p>
<i>Water Power Rental Regulations, Reg. 64/03 Under the Water Resources Act</i>	DEC	Sets annual rent for a water use license authorizing the generation of power from water. The annual rent for a water use licence shall be \$0.80 per megawatt hour of power generated.
<i>Municipalities Act (1999)</i>	Municipal and Provincial Affairs	Gives municipalities the power to construct, acquire, establish, own and operate public water supply systems, subject to the <i>Water Resources Act</i> (S. 156). It also gives Municipalities the authority to alter or divert watercourses for the purpose of improving the watercourse or supply (S. 161).
<i>An Act Relating to the Municipal Affairs of the City of St. John's (Chapter C-17 of the Revised Statutes of Newfoundland 1990)</i>		<i>Sections 112 and 114</i> of this Act aim to ensure the prevention of waste, undue consumption and the contamination of water supplied by the city to residents. In a case of misuse, the city may stop supplying water to that premises.
Policies and Guidelines		
Policy for Allocation of Water Use	DEC	Policy establishes a mechanism for issuing a water use license/approval to an applicant subject to the terms and conditions necessary to ensure efficient utilization of the water and fair distribution between competing uses. S. 4.2.6 of the policy requires the licensee to keep an account of water use and water quality and to regularly submit this information on prescribed forms to the Department.
Policy for Land and Water Related Developments in Protected Public Water Supply Areas	DEC	Outlines policy guidelines for land and water related developments in protected water supply areas. Allows municipalities to request the establishment of a Watershed Monitoring Committee and the development of a watershed management plan in designated areas under increasing pressure for multiple development activities.

Sources:

- Department of Environment and Conservation. 2002. Guide to the Water Resources Act. [Online]. Available: <http://www.gov.nf.ca/env/ActsReg/wraguide.pdf>

Water Conservation and Related Program Initiatives

Provincial

Outside of the *Water Resources Act*, Newfoundland and Labrador conservation initiatives are generally limited to the promotion of seasonal water-use restrictions in municipal systems.

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
(Department of Environment and Conservation)	All registered water users	Registered water users are required to report water usage figures every 6 months to one year using a Ministry form. Water withdrawal figures must be recorded for each month. Before the applicant is granted the license, the applicant is required to sign a Notification of Acceptance of Water Use Licence.	

Sources:

- Personal Communication, A.K. Abdel-Razek. October 18 2004. CCME Task Group Meeting, Toronto.
- Department of Environment and Conservation. Terms and Conditions of Water Use Licence Under NL Water Resources Act.

Municipal and Regional

Municipal water conservation initiatives in Newfoundland and Labrador are dominated by policies and restrictions aiming to reduce water consumption during dry periods. This is the case for both the City of Mount Pearl with a population 26,555 and for the City of St. John's with a population around 175,000.

Municipality or Region	Target Sector	Description	Results and Effectiveness
Town of Pasadena	Residential	In 1996 a water conservation study was undertaken in the town of Pasadena, Newfoundland. 50 households volunteered to have water meters installed. Half of these households were asked to continue with their normal water use practices, while the other half received educational materials and water conservation devices.	Even before the conservation devices, including faucet aerators, low flow showerheads, toilet flappers and Frugal flush adapters, were installed water consumption decreased by an average of 20% in these households. After installation of the devices, overall water consumption was reduced by approximately 43%.
City of Mount Pearl Water Conservation Program	Residential, ICI, Municipal	Three main initiatives are part of this program: - Year-round conservation policy containing certain restrictions on watering of lawns, cleaning sidewalks, washing vehicles etc. - Investigation of water distribution system to identify and repair leaks - Installation of water meters on water entry points into Mount Pearl to monitor overall city water usage.	The city is currently working towards having remote monitoring placed on this equipment to give the city more timely access to water usage data on a daily basis.
City of St. John's Water Conservation Order	Residential, ICI	The Order was introduced in the summer of 2002 and is still in effect. It applies to all outdoors uses of water, governing the watering of lawns, washing of vehicles and sidewalks etc by time of day and type of equipment. The City has installed 1027 meters for non-residential uses from its municipal water supply system between 1998 to present.	

Sources:

- Atlantic Planners Institute. 2000. Newfoundland and Labrador Waters. [Online]. Available: http://www.atlanticplanners.org/newsletr/april2000/water_nf1.htm
- City of Mount Pearl. Environmental Initiatives. Available: <http://www.mtpearl.nf.ca/enviro.asp>
- City of St. John's. Water Conservation Order. Available: <http://www.stjohns.ca/cityservices/water/waterconservation.jsp>

Sectoral

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Environmental Farm Plan (Delivered by Newfoundland and Labrador Federation of Agriculture and funded by Agriculture and Agri-foods Canada, Environment Canada, and others)	Agriculture	Program is based on the same concepts as in other provinces.	

NORTHWEST TERRITORIES (NT)

Water Supply and Demand Overview

In the Northwest Territories, only 8 of 33 communities have piped water distribution systems. These include Fort Smith, Hay River, Yellowknife, Edzo and Rae, which have predominantly inground pipes and Norman Wells, Inuvik, and Fort McPherson, which have predominantly above-ground pipes or utilidors (insulated boxes). Water for commercial and industrial purposes in these municipalities is typically supplied through piped systems while water used for residential purposes is often trucked. In combination with communities in Nunavut, only 16% of communities are serviced by centralized distribution systems. Seventy-four percent have trucked water supply and waste disposal systems, and the remaining 10% have private supply systems.

Although the operating costs for trucked-in water service are very high, the lower capital costs make it more economic than piped service for most northern communities. Consumption is much lower for areas with trucked service, about 80-90 litres per capita per day in the Northwest Territories. According to the Environment Canada Municipal Water Use Database (1996), overall per capita water use in NWT is estimated at 268 l/capita/day.

Sources:

- Environment Canada. 2004. Water – How we Use it. [Online]. Available: http://www.ec.gc.ca/water/en/info/pubs/primer/e_prim03.htm Last updated: July 13 2004.

Water and Related Legislation and Policies

The NWT does not have a policy to conserve water.

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Constitution Act (1867)</i>		The federal government, through the Department of Indian and Northern Affairs, has the overall responsibility for the management of water resources in the North.
<i>Northwest Territories Waters Act (1989)</i>	Indian and Northern Affairs Canada (INAC)	S. 6 allows the Minister of INAC to delegate water management responsibilities to the Minister of the NWT. S. 8 of the Act details how water may be used. All users in a water management area require a license unless they are a domestic user, an instream user or require the water for emergency use. S. 10 establishes the NWT Water Board to provide for the conservation, development and utilization of waters in a manner that will provide the optimum benefit for all Canadians in general and, in particular, for the residents of any part of the Northwest Territories for which the Board is authorized to issue licences. The board is responsible for granting water use licences in the NWT, however, the Minister of INAC must give approval for the granting of a water use licence, with some exceptions. The Board may include any conditions in the license it deems appropriate, including conditions relating to the use of the water, monitoring of use, the submission of specific plans etc. The Act is enforced by INAC.
<i>Northwest Territories Water Regulations (SOR/93-303) Under the NWT Waters Act</i>	Indian and Northern Affairs Canada	Sets out in different schedules for various sectors (i.e. industry, agriculture, municipal etc.), the criteria for which a license to use water is not required. The regulation also describes in more detail the information to be included in license applications for these sectors, water use fees. S. 15 states, Every licensee shall maintain accurate and detailed books and records, and shall submit a report to the Board each year, on or before the anniversary of the date of issuance of the licence, setting out the quantity of water used under the licence.
<i>Mackenzie Valley Resource Management Act</i>	Indian and Northern Affairs Canada	With its passing, the responsibility for the management and regulation of natural resources in specific areas was handed down from INAC to local boards, including the Gwich'in Land and Water Board, the Sahtu Land and Water Board, the Mackenzie Valley Land and Water Board. Permitting and licensing of water use as detailed in the NWT Waters Act is the responsibility of these boards. Minister approval is required before the board can grant a type A license. License applications deemed by the board to result in significant environmental impact are referred to the Mackenzie Valley Environmental Impact Review Board, also established under this Act.
<i>Yukon-Northwest Territories Transboundary Water Management Agreement (2002)</i>	Government of Canada, NWT and Yukon	Provides a means for the NWT and the Yukon to address transboundary water- management issues and provide protection to the aquatic environment. The agreement also allows for the establishment of water quantity and quality objectives for waters entering the NWT from the Yukon.
<i>Department of Indian Affairs and Northern Development</i>	INAC	Gives INAC overall responsibility for water management in the NWT. INAC is responsible for the development, implementation and interpretation

<i>Act</i>		of all legislation and policy relating to its responsibilities for water management in the Northwest Territories and Nunavut, approving type A licenses, enforcing licensed operations, and the collection of water data.
<i>Hamlets Act (2004)</i> <i>and the</i> <i>Cities, Town and Villages Act (2004)</i>		Delegates power to make bylaws and for the provision of services, public utilities and operations to municipalities. The council may make bylaws respecting public utilities, the management and use of lands in the hamlet/municipality etc.
Policies and Guidelines		
A Policy Respecting the Prohibition of Bulk Water Removal from Major River Basins in the Northwest Territories	INAC	Prohibits the bulk removal of water from the NWT. Principles include: <ul style="list-style-type: none"> ▪ The wise and sustainable use of water is critical to protect the health of ecosystems in the NWT... ▪ The conservation and protection of water in the NWT...requires the cooperation of all parties that manage water and regulate its use.

Sources:

- INAC. 2003. A Policy Respecting the Prohibition of Bulk Water Removal from Major River Basins in the Northwest Territories. [Online]. Available: http://www.ainc-inac.gc.ca/ps/nap/wat/pdf/polprohnwt_e.pdf

Water Conservation and Related Program Initiatives

Provincial

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
(Northwest Territories Housing Corporation) Rationale: High demand for and cost of trucked water services.	Residential	NWTHC installed wastewater reuse systems in five single-family homes within Yellowknife's Dene First Nation community. Grey and black water is treated and recycled for non-potable uses. System capacity is 1000 L/day each. Total cost of each system, including purchase, shipping, modification and installation was \$13,295 per system.	Anticipated benefits include a significant reduction in demand for potable water, savings of nearly \$5000 per year per house in trucked water service costs, availability of more water for non-potable uses.
Managing Drinking Water Quality in the Northwest Territories: A Preventative Strategy and Framework Established to respond to specific NWT challenges and the Walkerton, North Battlefield incidents.	All	Based on a review of similar initiatives across Canada, the 2003 strategy emphasizes a multi-barrier 3 pronged approach: keeping NWT water clean, making drinking water safe, and proving it to be safe. Coordinated watershed decision-making is an important component of the keeping water clean strategy. Specific actions include the establishment of an inter-jurisdictional committee to develop a source protection plan for the province, the designation of watershed areas, the development of emergency response plans, the development of watershed management plans, and the education of the public concerning source protection and water conservation.	
Arctic Energy Alliance (Representatives from Public Works and Services; NWT Housing Corporation; Resources, Wildlife and Economic Development, Municipal and Community Affairs, NWT Association of Communities, NWT Public	Residential, commercial, industry	A not-for-profit organization, the Energy Alliance was formed through a partnership between several government bodies. Northwest Territories Power Corp and Northland Utilities Ltd are also members. The focus of the alliance is to enhance energy efficiency and the uptake of renewable energy sources in the territory. Water use efficiency is often addressed in energy efficiency projects. An energy efficiency advisory service is provided at	

Utilities Board make up the Board of Directors)		no cost to all organizations and residences in NWT, energy audit and assessment services are also available.	
Energy Conservation Program Resources, Wildlife and Economic Development	Public sector, non-profit organizations	Provides funding for projects that reduce the amount of electricity purchased, heating fuel or water used in facilities owned or leased by the Government of the Northwest Territories.	In 2003/2004 a community arena in Tulita received low-flow showerheads and toilets, in addition to several energy efficiency installations. Water savings are estimated at 33,000 L per year.

Sources:

- Northwest Territories Housing Corporation. Case Study #2, Yellowknife, Northwest Territories. Available: <http://www.north-rthn.org/FactSheets/Yellowknife.htm>
- 2003. Managing Drinking Water Quality in the Northwest Territories: A Preventative Strategy and Framework. [Online]. Available: <http://www.pws.gov.nt.ca/pdf/WaterAndSanitation/WaterFramework.pdf>
- Arctic Energy Alliance. Available: www.aea.nt.ca

Municipal and Regional

Municipality or Region	Target Sector	Description	Results and Effectiveness
City of Yellowknife Water Supply Infrastructure Upgrade	Public	Since the mid 1980s, the city has undertaken a water supply infrastructure upgrade program, a leak detection survey and installation of water meters at trailer courts. Water supply lines using the bleeder system continue to be upgraded to a double line service that prevents pipes from freezing and saves significant amounts of water.	Through a cost-sharing program offered by the city, nearly all leaks have been eliminated and water consumption by trailer park owners has been cut in half.

Sources:

- Government of Canada. Canada and Freshwater: Experience and Practices. [Online]. Available: <http://www.sdinfo.gc.ca/reports/en/monograph6/ecoaprch.cfm>. Last updated: Jan. 22, 2003

NOVA SCOTIA (NS)

Water Supply and Demand Overview

Water is abundant in Nova Scotia. However, prolonged dry spells in recent years have raised some concern as farmers relying on streams for their sole water source, with no backup water supply for irrigation, have suffered loss of crops in areas such as the Annapolis Valley.

Interestingly, only 54% of Nova Scotians receive treated drinking water from central ground or surface water supplies operated by municipal water utilities. Forty-six percent of the population relies on private wells for water supply.

According to the Halifax Regional Water Commission, Halifax residents consume approximately 400 litres/capita/day. According to the Environment Canada Municipal Water Use Database (1996), per capita water usage for Nova Scotia is 269 l/capita/day.

Sources:

- CMHC. Halifax, Nova Scotia: Home Tune-Up Program. Available: http://www.cmhc-schl.gc.ca/en/imquaf/himu/wacon/wacon_103.cfm
- Nova Scotia Department of Environment and Labour. 2002. A Drinking Water Strategy for Nova Scotia. [Online]. Available: <http://www.gov.ns.ca/enla/water/h2ostrat.pdf>

Water and Related Legislation and Policies

Name	Agency	Description, Roles and Responsibilities
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Legislation and Regulations		
<i>The Environment Act (1995)</i>	Department of Environment and Labour	Under <i>part X</i> of the act, water and watercourses, including groundwater, are vested in the Crown; the Minister has supervision over use and allocation of water resources. Annual administrative and withdrawal fees for approvals have been established, with some exceptions (e.g., agriculture).
<i>The Activities Designation Regulations and the Environmental Assessment Regulations Under the Environment Act</i>	Department of Environment and Labour	Requires an approval from the Ministry for the withdrawal of water from a watercourse greater than 23 000 L/day, and for storage of more than 25 000 cubic meters of water. In the surface water permitting process, the Ministry can require, as a condition of approval, the preparation of a long-term plan to monitor streamflow in order to assess and evaluate the impacts of the water withdrawal on water resources. Applicants may also be required to develop a contingency plan for mitigation of any unexpected adverse effects. The development of a long-term water withdrawal monitoring plan is mandatory in the groundwater permitting process. A water budget must also be prepared in the application process for a surface water permit, so that the Ministry can determine whether the proposed rate of water withdrawal can be sustained particularly during periods of seasonal low flow. A project which involves the transfer of water between drainage basins where the drainage area to be diverted is greater than one square kilometer must undergo an environmental impact assessment.
<i>Water Resources Protection Act (Bill 32) (2000)</i>	Department of Environment and Labour	The act forbids the removal of water from the Atlantic Drainage Basin, which is essentially the entire province. However, there are exceptions to this rule. For example, water may be removed if it is to be transported in bottles no larger than 25 L, it is included in packaged foods or products, etc.
<i>Public Utilities Act</i>	Service Nova Scotia and Municipal Relations	Allows the Utility and Review Board (UARB) to set rates that municipal water utilities are permitted to charge their customers. The UARB also regulates N.S. Power Inc. and other power utilities in the province under this legislation.
<i>Municipal Government Act (1998)</i>	Service Nova Scotia and Municipal Relations	Bestows much of the regulatory authority for land use to Municipalities.
Policies and Guidelines		
Statement of Provincial Interest Regarding Drinking Water under the <i>Municipal Government Act</i> (SPI)	Service Nova Scotia and Municipal Relations	This SPI (and others made under the act) must be adhered to when a municipal planning strategy and land use by-laws are being developed. Provides guidelines to municipalities on how to protect municipal water supply by restricting inappropriate development. Recommended considerations include: balancing the expansion of existing uses against the risks posed to water quality.

Sources:

- Nova Scotia Environment and Labour. 2004. Guides to Groundwater and Surface Water Withdrawal Approvals. [Online]. Available: <http://www.gov.ns.ca/enla/water/pdf/guideToSurfaceWaterWithdrawalApprovals.pdf>
- Statements of Provincial Interest. [Online]. Available: <http://www.gov.ns.ca/snsmr/muns/manuals/pdf/mga/mgasch-b.pdf>

Water Conservation and Related Program Initiatives

Provincial

In addition to the specific provincial initiatives detailed below, Agriculture Canada and Geological Survey of Canada are working with provincial departments to provide education on water conservation and alternate on-farm water supplies, to make infrastructure improvements and to study regional aquifers.

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Drinking Water Strategy (2002)	All	A conservation based action plan for the integrated management of water on a watershed basis, began after proclamation of	As a condition of the approval process, municipalities/water utilities must submit System

(Department of Environment and Labour through a new Inter-departmental drinking water management committee) In response to the Walkerton Inquiry Recommendations		the Environment Act in 1995 (section 105 of the act). The focus is the sustained maintenance of water quality in the province. Source protection and water pricing to reflect the true cost of water services are important components of the strategy. The department will continue to work with municipalities in developing drinking water protection plans that may include the establishment of watershed plans, a Protected Water Area designation, land use by-laws etc. Roll out of the province's water strategy beyond 2005 will place more emphasis on a broader range of water resources issues.	Assessment Reports (by 2004) and Source Water Protection Plans. These must be submitted by fall 2005. The ministry has already developed a set of booklets (online) to guide municipalities in this process. The main emphasis is on protection of water quality, yet utility managers should assess water quantity issues and develop appropriate strategies.
Pollution Prevention Program (Department of Environment and Labour working with a variety of partners)	Commercial, industrial, institutional, public	Provides information, research and technical assistance. The role of the branch is to identify pollution prevention opportunities, to research and develop pollution prevention plans and programs. Current projects include the Eco-efficiency Business Assistance Program (described below), and the Lunenburg Municipal Water Pollution Prevention Program, also described below. The province is also working with the golfing industry to develop pollution prevention plans that include irrigation efficiency.	
The Eco-Efficiency Business Assistance Program (Lead agency: The Eco-Efficiency Centre NGO) Partners: Department of Labour and Environment + others	Manufacturing	The Centre is a project of the Faculty of Management at Dalhousie University. The program funds up to 75% of the cost of a consultant to identify pollution prevention and efficiency options and strategies within a willing Nova Scotian Small and Medium Enterprises (SME) that meets program criteria. For example, the SME must manufacture or process goods, have fewer than 500 employees, be prepared to cost share in the project, have intent to engage in recommended solutions etc. The program is available until December 2004. Water conservation and efficiency of use is an important element of eco-efficiency in the workplace.	
(Funding for research has been provided by the Department of Environment and Labour, Health and others)		A number of projects related to wastewater reuse and water use efficiency, including the domestic use of rainwater cisterns, have been conducted by the Centre for Water Resource Studies at the University of Dalhousie.	

Sources:

- Nova Scotia Department of Environment and Labour. 2002. A Drinking Water Strategy for Nova Scotia. [Online]. Available: <http://www.gov.ns.ca/enla/water/h2ostrat.pdf>
- Nova Scotia Department of Environment and Labour. Pollution Prevention Program. Available: <http://www.gov.ns.ca/enla/envin/p2/default.asp>
- The Eco-Efficiency Centre. Available: <http://www.mgmt.dal.ca/sres/eco-burnside/businessassistanceprogram.html#Description>

Municipal and Regional

Municipality or Region	Target Sector	Description	Results and Effectiveness
Town of Lunenburg The Lunenburg Municipal Water Pollution	Businesses, residents, schools, municipal officials	The program encourages water pollution prevention, water conservation and protection of municipal infrastructure by reducing the discharge of hazardous materials and pollutants to the municipal sewerage system.	

Prevention Program In partnership with the Department of Environment and Labour		The three-year pilot program launched in 2001 will serve as a model for other communities in Nova Scotia. Current pollution prevention initiatives include: the development of a water conservation garden featuring xeriscaping, residential home tune ups involving the installation of water conservation kits, the development of a green business network to promote pollution prevention in NS SMEs.	
Halifax Home Tune-up Program Halifax Regional Water Commission in partnership with Clean Nova Scotia	Residential	Program focuses on helping homeowners to improve energy and water use efficiency. The program offers residents a comprehensive environmental assessment of their home. Participants are provided with a report, information and recommendations for saving resources and money. A water conservation kit is also provided.	As of 2002, statistics indicate an overall reduction in water consumption of approximately 6 per cent. This is attributed to both educational efforts and the installation of water-conserving devices. With approximately 1,050 homes currently assessed, this amounts to approximately 16,000 cubic metres of water conserved. This also results in an equal reduction of wastewater discharge. Further reductions may be realized through behavioural changes resulting from the program.

Sources:

- The Lunenburg Municipal Water Pollution Prevention Program. Available: www.gov.ns.ca/enla/envin/p2/projects.asp
- CMHC. Halifax, Nova Scotia: Home Tune-Up Program. Available: http://www.cmhc-schl.gc.ca/en/imquaf/himu/wacon/wacon_103.cfm

Sectoral

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Atlantic Golf Superintendents Association (AGSA)	Golf	AGSA has promoted a number of pollution prevention projects on NS golf courses, with funding assistance from the Canada/Nova Scotia Cooperation Agreement on Sustainable Economic Development. The primary focus has been on integrated pest management but has also included recommendations for naturalization of vegetative areas and use of drought-tolerant plants.	
Sustainable Tourism Project (Tourism Industry Association of Nova Scotia)	Tourism industry	The Sustainable Tourism Project was established in 1993 to bring together government and industry stakeholders in the development of a sustainable tourism strategy. A Sustainable Tourism Self-Audit Workbook and a Sustainable Tourism resource centre have been developed. The workbook titled, "A Question of Balance", is a comprehensive, step-by-step resource that offers operators practical guidance on how to conduct an audit of their business and how to implement eco-efficient strategies that may result in cost savings and improved environmental performance. Water conservation is a major component of the workbook.	
Environmental Farm Plan (EFP) (Nova Scotia Federation of Agriculture with funding from Agriculture and Agri-food Canada and the NS Department of Agriculture and Fisheries)	Agriculture	The Nova Scotia EFP program differs from other provinces, in that program coordinator and an agricultural engineer develop an action plan for the farmer. In other provinces each farmer develops the EFP based on following workbooks. Water supply and management is still an important component of the program.	

Sources:

- Environment Canada. 2001. Pollution Prevention Canadian Success Stories. Atlantic Golf Superintendents Association. Available: <http://www.ec.gc.ca/pp/en/storyoutput.cfm?storyid=20>

- Tourism Industry Association of Nova Scotia. Sustainable Tourism Project. Available: <http://www.tians.org/sustain.html>
- Nova Scotia Federation of Agriculture. Available: <http://www.nsfa-fane.ca/default.htm>

NUNAVUT (NU)

Water Supply and Demand Overview

Although water resources may appear to be abundant in Nunavut, groundwater is generally not accessible and surface watercourses receive relatively little recharge due to minimal precipitation.

While portions of the communities of Iqaluit, Rankin Inlet, and Nanisivic have piped above-ground water distribution, most customers are served by trucked supplies. Only 16% of communities in Nunavut and NWT combined are serviced by centralized water distribution systems. Of the remainder, 74% have trucked water supply and waste disposal systems and 10% exist on private systems.

Although the operating costs for trucked-in water service are very high, the lower capital costs make it more economic than piped service for most northern communities. Consumption is much lower for areas with trucked service averaging about 200 litres per capita per day.

Sources:

- Environment Canada. 2004. Water – How we Use it. [Online]. Available at http://www.ec.gc.ca/water/en/info/pubs/primer/e_prim03.htm Last updated: July 13 2004.

Water and Related Legislation and Policies

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Constitution Act (1867)</i>		The federal government, through the Department of Indian and Northern Affairs, has the overall responsibility for the management of water resources in the North.
Nunavut Land Claims Agreement (1993)	Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada	<p>Outlines Inuit water rights, which are constitutionally protected and supersede any rights granted under water legislation.</p> <p>Article 13 of the Act establishes the Nunavut Water Board to manage and regulate water resources in the Nunavut settlement area, including regulation of water withdrawal. Its jurisdiction includes all of Nunavut's inland freshwater sources. Under the Agreement, the Board is also required to cooperate with the Nunavut Planning Commission to develop land use plans that affect water, and with the Nunavut Impact Review Board to assess environmental and socio-economic impacts of water-related project proposals. Permits are not required for domestic or personal water use, fire fighting, boating, swimming etc. All other water users require a license.</p>
<i>Nunavut Land Claims Agreement Act (1993)</i>	Indian and Northern Affairs Canada (INAC)	This Act ratifies the Land Claims Agreement, making it legal and giving it effect.
<i>Nunavut Waters and Surface Rights Tribunal Act (2002)</i>	INAC	<p>This Act clarifies the mandates of the Water Board and the Surface Rights Tribunal, in accordance with the Nunavut Land Claims Agreement and, as a result, creates legal certainty over the scope of their powers and responsibilities. Although the efficient use of water is not mentioned directly in the act, it is indirectly addressed by the requirement that the Board is prohibited from issuing, renewing or amending a licence if there may be a substantial effect on the quality, quantity or rate of flow of waters through Inuit-owned land (unless the applicant has entered into an agreement with the Inuit to compensate for any loss or damage or the Board has determined the appropriate compensation). The Nunavut Water Board (NWB) may therefore require water conservation efforts as a condition of licensing. A water monitoring program is typically prescribed by the NWB to the proponent, whom must follow the program and report on it in order to retain its license.</p> <p>On Inuit owned lands, regional Inuit organizations representing the regional Inuit population, are responsible for granting land use permits, which is a prerequisite for the receipt of a water license. On federally owned lands the Canadian government is responsible for this.</p>
<i>Department</i>	INAC	Gives INAC overall responsibility for water management in Nunavut.

<i>of Indian Affairs and Northern Development Act</i>		INAC is responsible for the development, implementation and interpretation of all legislation and policy relating to its responsibilities for water management in the Northwest Territories and Nunavut, approving type A licenses, enforcing licensed operations, and the collection of water data.
<i>Canada Corporation Act</i>		Incorporates the Nunavut Tunngavik Corporation (Tunngavik Inc.), a corporation without share capital responsible for ensuring and monitoring the implementation of the Land Claims Agreement. As a result, the organization plays an important role in ensuring that Inuit water rights as outlined in the agreement are protected.
Policies and Guidelines		
A Policy Respecting the Prohibition of Bulk Water Removal from Major River Basins in Nunavut	INAC	Prohibits the bulk removal of water from Nunavut. Principles include: <ul style="list-style-type: none"> the wise and sustainable use of water is critical to protect the health of ecosystems in Nunavut... the conservation and protection of water in Nunavut...requires the cooperation of all parties that manage water and regulate its use.
Nunavut Tunngavik Water Policy (2003)	Nunavut Tunngavik Inc. (NTI)	Outlines a comprehensive vision for water use and management on Inuit Owned Lands (IOLs). Policy statements of particular interest include the following: Designated Inuit Organizations (DIOs) shall ensure that water use proponents undertake measures to protect water quality, quantity and flow; and that appropriate monitoring is carried out. Nunavut Tunngavik Inc. (NTI) and DIOs shall ensure that fair water prices are set as a means to maximize benefit to Inuit, manage water demand, and minimize adverse effects from all activities on IOLs. Decisions concerning the management of water uses will be based on the Inuit way of doing things as well as scientific information. Implementation of the policy is primarily the responsibility of the Regional Inuit Organizations (RIO or RIA).
Framework for Managing Water on Inuit Owned Lands (2003)		As the RIA has the right to compensation for any adverse effect upon water flow, quantity or quality on IOLs, the framework outlines procedures for the RIA to follow in determining the affect of proposed development on waters, negotiating compensation agreements, monitoring water resources and setting fees for water use. Traditional Ecological Knowledge of water flow and quantity is an important input in determining the affect of a project. Using the procedures outlined in this document to estimate the affect of a proposed project on water resources in IOLs, the RIA is able to influence the NWB in the permitting process. The potential for having to pay out compensation and pay fees for water use set by the RIA, may provide an incentive to the proponent to use water efficiently.

Sources:

- Nunavut Water Board. [Online]. Available at <http://www.nwb.nunavut.ca/default.htm>
- INAC. 2003. A Policy Respecting the Prohibition of Bulk Water Removal from Major River Basins in Nunavut. [Online]. Available: http://www.aicn-inac.gc.ca/ps/nap/wat/pdf/polprohnuna_e.pdf
- NTI. 2003. Nunavut Tunngavik Water Policy.
- 2003. Water Management Framework for Inuit Owned Lands (IOLs).

Water Conservation and Related Program Initiatives

Territorial

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Freshwater Management Framework for Nunavut (proposed) Rationale: Concern for water quality		A proposed framework to establish a harmonized watershed-approach to managing the quality and quantity of Nunavut's water resources. Water conservation, sustainable development and integrated management are proposed as guiding principles.	
Healthy House Water Management Systems	Residential	Wastewater reuse systems are being installed in five existing multi-family homes (17 units) in the Inuit community of Cape Dorset. They will treat grey and	Several systems have been installed in Iqaluit and planned for Cape Dorset.

Initiated by Northwest Territories Housing Corporation Funded by Nunavut Gov't Rationale: High demand for and cost of truck haulage of potable water and wastewater.		black water from each building and cycle it back for toilet flushing and laundry purposes. Each system has a capacity of 1000 L/day. Total capital costs for each building are expected to be about \$45,200. Annual operation and maintenance costs are projected at \$1,125 per building.	Projected benefits include significant reductions in the demand for potable water, availability of more water for non-potable household uses, savings of nearly \$12 000 per year per building in the cost of trucked water and reduced cost for truck haulage of wastewater.
Regional Inuit Association (RIA) Land Use Permitting and Inspections RIA and Nunavut Impact Review Board	All	RIA annually inspects developments on IOLs to ensure that proponents are respecting the water related terms and conditions of licenses.	
Water Monitoring Business Plan for NWT and Nunavut INAC		INAC supports the collection, analysis and dissemination of information about water resources. The water monitoring business plan focuses on increased monitoring in high priority areas (communities, industry sites etc.), a focus on real-time data, upgraded monitoring equipment, and planning partnerships.	Released in 2003 and implementation is on-going.

Sources:

- Creative Communities Research Inc. Case Study #4: Cape Dorset, Nunavut. [Online]. Available at www.north.rthn.org/FactSheets/CapeDorset.htm
- INAC. 2003. Water Monitoring Business Plan Northwest Territories and Nunavut. [Online]. Available at http://www.ainc-inac.gc.ca/ps/nap/wat/pdf/watmoni_e.pdf

Municipal and Regional

Municipality or Region	Target Sector	Description	Results and Effectiveness
City of Iqaluit 'Apex Healthy House Project 2001' Funded in partnership with the Federation of Canadian Municipalities	Residential	The 2001 demonstration project was initiated in response to the water treatment plant nearing capacity, the high cost of hauling water by truck, and the wear and tear on city streets. The project involves installation of a treatment plant in the community that will directly supply 11 Apex households with recycled water.	It is estimated that these systems would cut water usage by 50%. The number of water delivery trips would be reduced by 75% saving the city about \$34 000 a year.

Sources:

- The Apex Healthy House Project. [Online]. Available at <http://healthyhousesystem.com/apex/textHandouts.sxw.pdf>

ONTARIO (ON)

Water Supply and Demand Overview

In the Great Lakes Basin (GLB), where the majority of water-taking occurs in the province (94%), consumptive uses of water across all sectors (and the entire GLB) have been estimated at 5% of total water takings. Agricultural irrigation, public water supply and industrial uses of water result in the greatest consumptive losses

in the basin, at 29%, 28% and 26% respectively. Average consumptive loss rates in the agricultural sector are greater than 70%, and in some cases reaching loss rates of up to 90%. Average consumptive loss rates in the public water supply sector and the industrial sector are estimated at 10%. Based on projected growth and development patterns in Ontario until 2020, the following water use and consumption trends by sector are expected:

- Power generation: Increase in withdrawals shadowing growth and development
- Commercial/Industry: Gradual reduction in withdrawals in response to increasingly restrictive pollution control legislation, advances in technology, and a shift in the sector from heavy manufacturing to service-oriented industries
- Municipal/domestic/rural: Gradual reduction in withdrawals in response to increased water conservation efforts
- Agriculture: Significant increase in water demand for irrigation due to expected increases in food production, and higher unit area demand for water as a result of climate change. Water use for agriculture in Ontario continues to climb significantly.

Assuming a continuing extension of these trends, a 19% increase in consumptive water use is estimated for the Basin. However, under an aggressive conservation effort, this increase in consumptive water use could be limited to a 1% increase (International Joint Commission report).

At the local level, an increasing number of cities and municipalities are projecting or experiencing water shortages. This is due in large part to below normal summer precipitation and low water levels in Ontario since 1998, and continuing population and economic growth (Ontario Ministry of Natural Resources, 2003). This is of particular concern in southern Ontario where water demand has been projected to surpass locally available supply in many regions and municipalities.

Sources:

- International Joint Commission. 2001. Protection of the Waters of the Great Lakes: Final Report to the Government of Canada and the United States. [Online]. Available: <http://www.great-lakes.net/lakes/>

Water and Related Legislation and Policies

The management of surface and ground water quantity in Ontario is quite complex. Primary regulatory responsibilities are held by the Ministry of Environment and the Ministry of Natural Resources with Conservation Authorities and municipalities also playing key roles.

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Ontario Water Resources Act (OWRA)</i>	Ministry of Environment (MOE)	<p>The piece of legislation authorizing water takings in the province. S. 34 of the OWRA requires anyone taking more than a total of 50,000 litres of water in a day, with some exceptions, to obtain a Permit to Take Water.</p> <p>Permit conditions may be imposed including requirements for metering and reporting water use and for submission of water conservation plans.</p> <p>Applications for water takings are considered by the MOE through the Permit to Take Water program.</p>
<i>Water Taking and Transfer Regulation, O. Reg. 387/04 under the OWRA</i>	MOE	<p>The purpose is to "provide for the conservation, protection and wise use and management of Ontario's waters, because Ontario's water resources are essential to the long-term environmental, social and economic well-being of Ontario".</p> <p>The regulation identifies "high use watersheds" where applications for new and/or expanded takings for certain types of water uses will not be permitted.</p> <p>The regulation imposes mandatory requirements for daily metering (or other approved measurement) and annual reporting of water use by <u>all</u> permit holders. The requirements are being phased in by sectors over a 3 year period. All permit holders will be monitoring their water takings by 2007.</p>

<i>Sustainable Water and Sewage Systems Act (2002 (SWSSA))</i>	MOE	Ontario is the only province to have adopted full cost pricing principles into its regulatory framework for water supplies. Under this Act, the province has made the full recovery of municipal water and sewer services mandatory for municipalities. The SWSSA cannot be proclaimed until regulations are developed that will provide the content details to municipalities for reports and plans required by the Act. The Ministry of Environment is working with other ministries on a strategy to develop regulations to support this important initiative.
<i>(Proposed) Drinking Water Source Protection Act</i> (Proposed In response to recommendations outlined by Justice O'Connor in the Walkerton Inquiry Report)	MOE	The development of mandatory watershed source protection plans throughout the province is a key component of this proposed Act. Every source protection plan would have to include a water budget to assess the amount of water available in the watershed and the amount of water being removed. Protection plans would also have to identify all significant withdrawals of water, all sources of pollution, areas of groundwater vulnerability and wellhead areas. Vulnerability mapping would show where source protection measures are most urgently needed. The Ontario government released a White Paper in February 2004 to consult on the planning aspects of source protection legislation including the preparation, roles and responsibilities, approvals and appeals of source protection plans. Draft legislation based on comments received on the White Paper was posted for public comment in June 2004. Following the comment period on the planning aspects of source protection legislation (August 2004), the ministry considered the advice of the government committees working on the implementation aspects of the legislation, and any comments received on the proposed legislation, and is combining the planning components and implementation components into one comprehensive source protection bill.
<i>Ontario Building Code</i>	Ministry of Municipal Affairs and Housing (MMAH)	A regulation was filed in 1992 amending the Building Code to address water efficiency. Water-use efficiency requirements for water fixtures used in all new construction and renovation are regulated as follows: <ul style="list-style-type: none"> • Faucets: 8.4 litres/min or less (as of 1993) • Showerheads: 9.8 litres/min or less (as of 1993) • Toilets: 6 litres/flush or less (as of 1996)
<i>Conservation Authorities Act</i>	Ministry of Natural Resources (MNR)	Operating at the watershed and local level, conservation authorities (CA) lead or play an important role in a variety of regulatory, operational and planning activities pertaining to natural resources management. Primary water quantity-related responsibilities include flood management, drought-response management, monitoring and modeling, and water supply management. CA's are also involved in resource monitoring and inventorying, watershed planning, landowner outreach and assistance, and conservation education. Often in partnership with the province, developers and municipalities, many have completed watershed plans identifying the impacts of anticipated land use changes and population growth on ground and surface water resources and action plans to mitigate these impacts. Member municipalities within the watershed participate in the administration and operation of the CA through representation on the Board of Directors. CAs may construct and operate dams and reservoirs, prohibit or regulate watercourse alteration, and construct, operate and maintain flood and erosion control structures.
<i>Emergency Plans Act</i>	MNR	Designates MNR as the lead agency in coordinating emergency response to floods and drought. MNR has the lead responsibility for the verification of precipitation and streamflow condition levels in the Ontario Low Water Response program.
<i>Planning Act</i>	MMAH	Empowers and governs municipalities in land use planning and provides for the development of statements of provincial interest to be regarded in the planning process.
Policies and Guidelines		
Ministry of Environment Water Management Policies, Guidelines, and Provincial Water Quality Objectives	MOE	The over-arching policy for water quantity management in the province is "To ensure the fair sharing, conservation and sustainable use of the surface and ground waters of the province". MOE also outlines the following specific guideline relating to the conservation of water:

		<p>"All reasonable and practical measures should be taken to conserve the quantity of surface and ground water to sustain ecosystem integrity and to maximize its availability for existing or potential uses".</p> <p>The guideline further indicates that in order to conserve groundwater and protect streamflow, all new flowing wells must contain a flow control device in accordance with Ontario regulation 903. It also indicates that specific statements respecting water conservation should be incorporated into appropriate planning documents and that all parties proposing or reviewing proposed projects in such areas should ensure that appropriate water conservation measures are undertaken.</p>
The Provincial Policy Statement (PPS) under the <i>Planning Act</i>	MMAH	<p>The PPS defines provincial interests and provides policy direction to municipalities in the long range and inter-municipal planning of infrastructure including water and sewage services.</p> <p>Policy 1.6.4 for Sewage and Water states that water conservation and water use efficiency shall be promoted.</p> <p>Policy 2.2.1 for Water states that planning authorities shall protect, improve or restore the quality and quantity of water by promoting efficient and sustainable use of water resources, including practices for water conservation and sustaining water quality.</p>

Sources:

- Ministry of the Environment. (2004). Watershed-based source protection planning. [Online]. Available: <http://www.ene.gov.on.ca/envision/water/spp.htm>
- Ministry of Environment (and Energy). (1994). Water Management Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment (and Energy). [Online]. Available: <http://www.ene.gov.on.ca/envision/gp/3303e.pdf>

Water Conservation and Related Program Initiatives

Provincial

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
MOE	ICI	Resource conservation guides for a number of industries have been published.	
Ontario Low Water Response (MNR and Conservation Authorities) Program implemented in response to below average precipitation and low water levels in ON.	All	Program aims to ensure provincial preparedness, to assist in coordination and to support local response in the event of a drought. The plan outlines the means for measuring and quantifying drought and the three condition levels leading up to it. Water use restrictions increase with level. CAs or MNR verify a Level 1 condition and are responsible for setting up a local response team. The team then works to achieve a 10% reduction of water use in the watershed. In a level II situation, restrictions on non-essential water uses may be applied and a 20% reduction of water use in the watershed. At level III, water use may be restricted for a range of water users and decisions regarding priority uses must be made.	
Ontario Ministry of Agriculture and Food (OMAF)	Agriculture	Program relates to better irrigation techniques, water use efficiency and water management. A number of Best Practice guides and fact sheets have been developed.	
(Research funded by OMAF, implemented in partnership with University of Guelph)	Agriculture	Research & Development in areas of water resource management and conservation.	

Sources:

- Ontario Invests in Alternative Irrigation Sources. July 31 2002. [Online]. Available: http://www.uoguelph.ca/~c-ciarn/news/news_2002_jul.html

- Ministry of Environment and Energy. 1997. Guide to Resource Conservation and Cost Savings Opportunities in the Plastics Reprocessing Sector. [Online]. Available: http://www.cpia.ca/epic/docs/resource_conservation_and_cost_savings.PDF
- Ontario Ministry of Natural Resources. (2003). The Ontario Low Water Response Plan. [Online]. Available: http://www.mnr.gov.on.ca/MNR/water/publications/OLWR_2003.pdf

Municipal and Regional

In this section the water conservation programs implemented by the cities of Toronto and Barrie and the Grand River Conservation Authority are investigated. As the most populace city in Ontario, Toronto is facing increasing demand for water and wastewater services and has recently gone through a comprehensive process to identify best practice water conservation measures for the city.

Municipality or Region	Target Sector	Description	Results and Effectiveness
<p>Toronto Water Efficiency Plan 2002</p> <p>Rationale: Growing demand for water and for expanded water and wastewater treatment capacity and services.</p>	Residential, ICI, Utility	<p>Program Goal is to reduce peak day demand by 275 ML/d by 2011 and reduce wastewater flow by 86 ML/d by 2011.</p> <p>Measures include:</p> <ul style="list-style-type: none"> ▪ System Leak Detection (municipal) ▪ Computer Controlled Irrigation Program (municipal) ▪ Water Restrictions Program in times of need (all) ▪ Toilet Rebate Program (single family residential, public, multi-unit residential, ICI) ▪ Washing machine rebate program (single family residential, multi-unit residential, ICI) ▪ Indoor water audit program (ICI) ▪ Outdoor water audit program (single family residential, multi-unit residential, ICI) 	<p>Estimated to cost city 1/3 the cost of infrastructure expansion while achieving the same goal. Expected to avoid \$29 million in operating costs related to chemical and energy use in water and wastewater treatment. When plan is fully implemented and water savings are sustained, savings could amount to more than \$4.5 million per year after 2011.</p>
<p>City of Barrie Water Conservation Program 1995</p> <p>In partnership with the Ontario Clean Water Agency and MOE.</p> <p>Rationale: Growing demand for water and for expanded water and wastewater treatment services.</p>	Residential, ICI	<p>Program Goal is a reduction in water use of 50 L/day per person for 15,000 households</p> <ul style="list-style-type: none"> ▪ Production and free distribution of a Water Efficiency Handbook ▪ Even/Odd Lawn Water By-law ▪ Toilet and showerhead rebate program (residential) ▪ Washing machine rebate program (residential) ▪ Metering of all water customers ▪ Increasing block rate structure for residential users 	<p>Between 1995 and 1997, a total of 10 500 households received 15 000 Ultra Low Flush toilets. A water savings of approximately 62 litres per person per day was achieved in those households participating in the program. Total program savings translated to 55 L/person/day for the system. Water savings of 1 628 cubic litres per day were generated, allowing the city to defer expensive capital expansion project. These efforts saved an estimated \$17.1 million in net deferred capital expenditures. Over 3000 washing machine rebates were awarded 1998-2002.</p>
Water Budget and Balance Analysis (MOE, MNR and CAs)	Watershed, all sectors	MOE, in cooperation with MNR, is currently funding several CAs, in the development of water budget pilots. These budgets are intended to form the technical basis for provincial and municipal decision making related to water use, and may serve as examples that could be implemented in other areas throughout the province.	If the proposed source protection legislation survives, the development of water budgets will be mandatory in Ontario watersheds, and Conservation Authorities will play an even greater role in the sustainable management and conservation of local water resources.

Sources:

- Works and Emergency Services. 2002. Toronto's Water Efficiency Plan. [Online]. Available: <http://www.city.toronto.on.ca/watereff/plan.htm>
- USEPA. Cases in Water Conservation: How Efficiency Programs Help Water Utilities Save Water and Avoid Costs. [Online]. Available: <http://www.epa.gov/owm/water-efficiency/utilityconservation.pdf>
- Bellamy, Sam. (2002). Water in the bank? In: Grand Actions: The Grand Strategy Newsletter, volume 7 number 2. [Online]. Available: http://www.grandriver.ca/GrandStrategy/pdf/ga_mar02.pdf

Sectoral

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
<p>Ontario Water Works Association</p> <p>A voluntary membership organization of drinking water professionals dedicated to protecting public health through the delivery of safe, sufficiency and sustainable drinking water in Ontario.</p>	Public	OWWA supports best practices in the stewardship of water through continuous improvement of technology, science and management, and by influencing government policy. Water efficiency committee is active in the following areas: water efficiency awards, produce articles and run workshops on relevant topics, produce guidebooks on principles and practices related to planning and implementing a municipal water efficiency program.	
<p>Ontario Environmental Farm Plan</p> <p>Lead by Ontario Federation of Agriculture, Christian Farmers Federation of Ontario, Ontario Farm Animal Council, AGCare, and delivered by the Ontario Soil and Crop Improvement Association and OMAF</p>	Agriculture	Developed by the farm community and funded by the provincial and federal government, the program assists farmers to identify areas of environment concern on their farms, to set realistic goals and to implement enhancement projects. A grant of \$1500 is available to farmers willing to implement their action plans. Farmers voluntarily attend an introductory workshop and are given a workbook to conduct a self-assessment of their farm operation. Water efficiency is but one of the components addressed in the workbook. Using best practice reference materials the farmer may continue to develop an action plan. Once reviewed and approved by a committee of peers, the farmer is eligible for the incentive.	Since launch in 1993, approximately \$15 mill has been claimed by about 11, 500 producers. Each dollar of federal grant has on average triggered \$ 3 investment by the farmer towards the same project for a total investment of over \$60 million. Over 27 000 farmers have attended workshops. Budgeted funds are currently exhausted for the program, however, a new version of the program should be launched in the near future.

Sources:

- Ontario Water Works Association. Available: <http://www.owwa.com>
- Ontario Soil and Crop Improvement Association. EFP Incentive Dollars Fully Committed. [Online]. Available: <http://www.ontariosoilcrop.org/EFP.htm>

PRINCE EDWARD ISLAND (PEI)

Water Supply and Demand Overview

Prince Edward Island is the only Canadian province that is 100 % dependent on groundwater for drinking and most other uses. Fifty-seven percent (57%) of island residents obtain their drinking water through private wells. Drought conditions and increasing economic development in recent years is beginning to put a strain on provincial groundwater resources. In a recent CBC news article, a Charlottetown official was quoted as saying "We certainly don't have much availability to keep developing subdivisions, attracting any industry to PEI., or Charlottetown, or any businesses that have a water consumption need."

According to the Environment Canada Municipal Water Use Database (1996), PEI registers the lowest per capita water usage in the nation at 186 l/capita/day.

Sources:

- PEI CBC News. Water Supply Under Stress. News release October 20 2004. Available: http://pei.cbc.ca/regional/servlet/View?filename=pe_water20041020

Water and Related Legislation and Policies

Water conservation as a specific issue is not currently addressed in provincial legislation. However, there are several provincial programs targeting a reduction in water consumption. These are listed in the following section.

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Environment Protection Act</i>	Department of Environment, Energy and Forestry	Section 10 of the Act authorizes water withdrawal from surface water bodies. Prior to extracting water from any stream or river, a person must first obtain a Watercourse Alteration Permit (Water Withdrawal Permit).
<i>Water Well Regulation under the Environment Protection Act</i>	Department of Environment, Energy and Forestry	Regulates the extraction of water from subsurface aquifers. Anyone wishing to establish a high capacity well must first obtain a Groundwater Exploration Permit. Once well construction is complete and the Department has assessed the impacts on other users and stream flow as acceptable, a Groundwater Allocation Permit is issued.
Policies and Guidelines		
Agricultural Irrigation Policy		<p>Groundwater: Under no circumstances will the rate of groundwater extraction be permitted to exceed 50% of the annual recharge for any area influenced by a well.</p> <p>Surface water: Maintenance flow will be calculated for all surface water systems, and will be calculated on the basis of 70% of the flow rate that is exceeded 50% of the time in any month. Flow measurement gauges will be installed in watersheds where the permitted withdrawal rate approaches 50% of the amount of water that is predicted to be available in excess of maintenance flow. Monitoring to ensure that actual stream flow does not drop below maintenance level will occur. A Watercourse Alteration Permit will be required by any person withdrawing water at a rate in excess of 50 Imperial Gallons per Minute or when the total daily withdrawal exceeds 10 000 imperial gallons.</p> <p>In watersheds where there is a high demand for the available water for irrigation, a committee will be formed for the watershed consisting of each irrigating farmer and representatives from the Departments of Environmental Resources and Agriculture. While the aim of the group is to coordinate efficient options for water extraction, including management of pond levels, alternating extraction activities and other sharing mechanisms, it will not conduct management activities.</p>
Sustainable Resource Policy	Department of Agriculture, Fisheries and Aquaculture	Announced in Nov 2002. An umbrella policy that aims to bring all parts of natural resource management together under one policy. Sets a direction for the future of PEI's environment and for the work of all government departments. Current focus in the PEI agricultural sector, forestry, aquaculture and fisheries will be included in time. Several tools to achieve policy goals have been implemented in the Agricultural sector, including enhanced environmental farm planning, funding for on-farm soil and water conservation projects etc.

Sources:

- Agriculture, Fisheries and Aquaculture. Agricultural Irrigation Policy. Available: http://www.gov.pe.ca/photos/original/irrigatpolicy_e.pdf
- Agriculture, Fisheries and Aquaculture. PEI Sustainable Resource Policy. Available: <http://www.gov.pe.ca/af/agweb/index.php3?number=72033&lang=E>

Water Conservation and Related Program Initiatives

Provincial

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Drinking Water Strategy (Formerly Department of		Step 10 in this 10-point plan indicates that the Department will work with municipalities and land owners in development of a strategy for municipal wellfield protection	

Fisheries, Aquaculture and Environment)		by spring 2004.	
Low-interest loan program for water-conserving systems (Department of Agriculture, Fisheries and Aquaculture)	Agriculture	Provides low interest loans to producers that purchase and implement alternative water efficient irrigation technologies. Eligible expenses include: <ul style="list-style-type: none"> ▪ Man-made reservoirs to collect surface runoff ▪ Side ponds which use diverted stream water at low flow rates ▪ Low capacity wells to replenish manmade reservoirs ▪ Drip irrigation systems <p>Dates of eligibility are from April 1, 2003 to March 31, 2006, and the payback for each applicant will be on a five-year repayment schedule. Applicants must have completed an Environmental Farm Plan and will be required to provide 20 percent equity towards the project costs. The Department will monitor the impact of the new systems on crop yield and water conservation.</p>	
Canada-Prince Edward Island National Water Program (Federal-provincial partnership)	Agriculture	Announced in April of 2004. The \$2.3 million program is intended to enhance information on water conservation, groundwater and surface water resources, and efficient use of irrigation water; promote the use of water infrastructure such as low-flow technologies and metering; and conduct water studies. The program will provide technical and financial assistance to individuals and/or incorporated groups of farmers, agricultural and conservation groups, rural communities and municipalities, agri-business and rural enterprises, education institutions, and provincial governments, agencies and crown corporations to help plan and develop agricultural water projects listed as eligible under the three categories of: on-farm water projects, multi-user water supplies, and strategic initiatives. The program is scheduled to end in 2006.	
Evaluation of ULF Gravity Toilets in Two Schools 2001 (Formerly Department of Fisheries, Aquaculture and Environment)	Residential, ICI	Engineering Technologies Canada was retained to carry out a study to calculate how much (if any) water can be saved in schools by using 6 L instead of conventional 13.2 L gravity toilets and to determine if there is a higher rate of plugging or double flushing in 6 L toilets.	The study concluded that the 6L toilets tested did not result in increased flushing due to plugging. The average net water savings achieved over a toilet that flushed 13 L was 46-60 %.
Reuse of Renovated Municipal Wastewater for Golf Course Irrigation 1999 (Initiated by the Department of Technology and Environment, prepared by the Centre for Water Resources Studies at the U. of Dalhousie)		The objective of this study was to provide information that would help guide decisions concerning the reuse of renovated municipal wastewater for golf course irrigation, with particular reference seasonal applications such as those that might exist on PEI. Specifically, the report attempts to identify and provides references to information about matters that should be taken into consideration in the design, planning and management of golf course irrigation systems that use renovated water. Nine Canadian golf courses using renovated water for irrigation purposes were identified and studied.	

Sources:

- Department of Environment, Energy and Forestry. Drinking Water Strategy. Available: <http://www.gov.pe.ca/infopei/oneListing.php3?number=50234&PHPSESSID=3c68553fee1262df6c9f214026ffc8ed>
- Agriculture, Fisheries and Aquaculture. Programs and Services Quick Reference. [Online]. Available: <http://www.gov.pe.ca/af/agweb/index.php3?number=78586&lang=E#Environmental>. Last updated: October 2004
- Agriculture and Agri-Food Canada. 2004. News Release: Water Program Announced for Prince Edward Island. [Online]. Available: http://www.agr.gc.ca/cb/print_e.php?s1=n&s2=2004&page=n40423a
- Engineering Technologies Canada. 2001. Evaluation of Ultra Low Flow (6L) Gravity Toilets in Two Schools. [Online]. Available: http://www.gov.pe.ca/photos/original/fae_6L_toilet.pdf

- Centre for Water Resources Studies. 1999. Reuse of Renovated Municipal Wastewater For Golf Course Irrigation. [Online]. Available: <http://www.gov.pe.ca/infopei/onelisting.php3?number=1000162>

Municipal and Regional

Cavendish Resort Municipality in PEI attracts almost a million tourists each year as it boasts some of the most beautiful beaches in the province and is the home of “Anne of Green Gables”. The resident population in the municipality, however, is a mere 267. Water supply and security is becoming more of a problem in the region due to the growing tourist industry.

Municipality or Region	Target Sector	Description	Results and Effectiveness
Cavendish Resort Municipality. 'Water Conservation and Development Plan' Funding from Canada/PEI Labour Market Development Agreement (LMDA)	Tourism	In June 2003, Cavendish launched its Water Conservation and Development Plan. The municipality has over 40 projects it wants to tackle over the next few years. One of them is a Water Quality and Conservation project. Although the focus of this project is the testing of local residential and business water supply and the provision of water testing training, education material will also be provided on conserving water usage.	Two water conservation officers were hired in the summer of 2003 to look for abandoned wells and oil tanks, identify problems in the local water supply, and distribute educational information to residents and businesses.

Sources:

- CBC New. June 23 2003. Cavendish Takes Sustainability Step. Available: http://pei.cbc.ca/regional/servlet/View?filename=pe_cavendish20030623
- Canada/PEI Labour Market Development Agreement. Government Funding to Assist Cavendish Area With Water Testing and Conservation Project. News Release June 23 2003. Available: http://www.lmda.pe.ca/view_news.php?id=98

Sectoral

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Enviro Church Conservation Project (Diocese of Charlottetown with funding from Environment Canada and technical assistance from the Environmental Coalition of PEI)	Church	Introduced in 2002, the Diocese of Charlottetown will undertake environmental assessments of the buildings on its 56 parishes. The program will reduce energy use, water consumption and wastewater production by about 10% and reduce hazardous household and chemical lawn products use by about 20%. In addition, educational materials will be supplied to parishioners to increase their awareness of the initiatives undertaken by their local church and to encourage similar efficiencies in their own homes.	
Environmental Farm Plan (EFP) (Delivered by PEI Federation of Agriculture and funded by Agriculture and Agri-food Canada, technical and financial assistance provided by provincial government)	Agriculture	Based on the EFP concept in other provinces, the program has recently received additional funding for an Enhanced EFP program. The new program, which will be delivered by the Federation, will offer technical assistance to Prince Edward Island producers to develop more comprehensive environmental plans for their farms.	Currently, Prince Edward Island leads the country with approximately 75 per cent of producers having developed EFPs to improve the environmental performance of their operations.

Sources:

- Diocese of Charlottetown. Enviro Church Conservation Project. Available: <http://www.dioceseofcharlottetown.com/projects/envirochurch.html>

- Agriculture and Agri-food Canada. Enhanced Environmental Farm Planning Coming to Prince Edward Island. News Release Aug. 19 2004. Available:
http://www.agr.gc.ca/cb/index_e.php?s1=n&s2=2004&page=n40819a

QUEBEC (QC)

Water Supply and Demand Overview

Québec is water rich province, 10% of its land area covered by freshwater. It has among the largest per capita water resources available in the world. The level of residential consumption observed in Québec is also among the highest in the world, at approximately 400 litres per person per day (l/p/d). For comparison, the Canadian average is on the order of 350 l/p/d, the United Kingdom is at 200 l/p/d and France at 150 l/p/d. Total quantity of water drawn for residential use is approx. 1, 712 million m3 of water.

Interestingly, the agricultural sector (not including the fish farming industry) is not a large consumer of water in Québec. In fact, many agricultural producers have suffered from excess water and have had to set up drainage systems in their fields.

In the industrial sector, the ready availability of water has favoured the establishment of enterprises for which this resource is essential. For 1994, it is estimated that companies in the pulp and paper, petroleum, primary metallurgy, and organic and inorganic chemicals sectors consumed 996 million m3 of water. Sixty nine percent of this use is accounted for by the pulp and paper industry and 21% by the primary metallurgy sector.

Sources:

- Government of Québec. (2002). Québec Water Policy: Water. Our Life. Our Future. [Online]. Available:
<http://www.menv.gouv.qc.ca/eau/politique/index-en.htm>

Water and Related Legislation and Policies

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Civil Code of Québec</i>		Outlines the rules regarding the property of the 'hydric' domain. Describes also the rights and duties associated with waters that are tied to land property/title.
<i>Water Resources Preservation Act 2001</i>	Ministry of the Environment	Prohibits very large transfers of water out of Québec, with some exceptions.
<i>Environment Quality Act</i>	Ministry of the Environment	S. 22 of the Act specifies that a certificate of authorization from the Ministry is required before carrying out any works or projects in a watercourse.
<i>Groundwater Catchment Regulation 2002</i> Under the <i>Environment Quality Act</i>	Ministry of the Environment	Sets out rules in connection with groundwater catchment for human consumption, as well as for the exploitation of groundwater resources such as spring or mineral water. These rules prevent the owner of a land to exploit groundwater in a way that reduces the level of phreatic water for adjacent landowners.
<i>Watercourses Act</i>	Ministry of the Environment and Ministry of Natural Resources, Wildlife and Parks	Outlines the rules regarding the uses of watercourses. Section 5 indicates that land owners may improve any watercourse passing through or along their property with the construction of dams, dykes etc for the purpose of manufacturing, operating a mill etc.
<i>The Land Use Planning and Development Act</i>	Ministry of Municipal Affairs, Sports and Recreation	Describes the responsibilities of the Regional County Municipalities in the development of territorial Plans.
<i>Municipal Code of Québec and Cities and Towns Act</i>	Ministry of Municipal Affairs, Sports and Recreation	Outlines rules surrounding the management and use of municipal watercourses and the establishment and operation of water services. Water services in Québec primarily come under the municipalities, which own much of the infrastructure related to drinking water and wastewater. Municipalities plan, finance, maintain and control most activities related to these services.
Policies and Guidelines		
Québec Water		Development of the policy began in 1997. After years of public consultation, the final policy was published in 2002. Three main issues were identified in the

Policy 2002: 'Water. Our Life. Our Future'		consultations, including the need to recognize water as a collective heritage of all Québécois, to protect public health and aquatic ecosystems and to manage water in an integrated manner and from a perspective of sustainable development. Five strategic orientations are identified in the policy, including: Reform of water governance; Integrated management of the St. Lawrence River; Protection of water quality and aquatic ecosystems; Continuation of water clean-up and improved management of water services; Promotion of water-related recreo-tourism activities. See below for specific commitments made.
Lakeshores, Riverbanks, Littoral Zones and Floodplains Policy	Ministry of the Environment	Describes measures to promote the quality of lakes and streams by protecting lakeshores, riverbanks, littoral zones and floodplains. The municipalities and the Regional County Municipalities are responsible for the implementation of these measures

Water Conservation and Related Program Initiatives

Provincial

To date, provincial water conservation efforts and initiatives have come mainly in the form of financial support to local efforts and Non Government Organizations.

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Québec Water Policy	All	<p>Specific government commitments related to water conservation include:</p> <ul style="list-style-type: none"> - The development of water charges for the withdrawal and disposal of water resources - The development of a means for municipalities to calculate the cost of water services - The development of a Québec strategy for the conservation of drinking water which makes the allocation of any financial assistance contingent upon the adoption, by municipalities, of measures to conserve water and reduce leakage. This strategy must aim for a reduction, within 7 years, of at least 20% in average per capita water consumption for all of Québec, and for a reduction in water losses through leakage, within 10 years, to no more than 20% of the total volume of water produced. - The establishment of a water-conservation program in government buildings - The provision of financial and technical support to 33 watershed agencies, which will be responsible for the development of watershed masterplans. 	<p>The Minister of Environment announced that measures will be in place next spring with a tax of \$ 0.01 /m³</p> <p>The Ministry of Municipal Affairs, Sports and Recreation should produce a report in 2004</p> <p>The Ministry of Municipal Affairs, Sports and Recreation has delayed the production of the strategy to 2005</p> <p>The program has started and there are 36 buildings (of 349) that have water meters</p> <p>All of the 33 watershed agencies are now in place and have received their subsidy. A complete structure of governmental support is now in place.</p>
Water Conservation Campaign (PEEP) (Réseau Environnement, partner Ministère de l'Environnement du Québec)	Municipal	Réseau Environnement is a non-profit organization that encourages public awareness and information to promote water conservation in Québec. It is comprised of both a technical and an awareness section. The technical program aims to promote technical exchanges among municipalities on optimal methods to manage their water supplies and demands. The PEEP campaign has been organized every year since 1977, with the objective of working with municipal representatives and supplying them	Approximately 70 municipalities are participants in the campaign

		with the necessary campaign tools. Municipalities pay according to services rendered and the population of the municipality.	
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Sources :

- Réseau Environnement. Available: <http://www.reseau-environnement.com/RENV/ui/user/events/eventDetails.jsp?eventId=74>

Municipal and Regional

Municipality or Region	Target Sector	Description	Results and Effectiveness
Ville de Laval	Schools	An education campaign concerning the efficient use of water was initiated by the city in 1992. Classroom education is provided to grade 5 classes in the city. The water cycle, from source to its return, is explained, emphasizing the rationale for the efficient use of water. Classes are also invited for study visits to the water purification and wastewater treatment plants in the city. Other initiatives implemented in the city include: <ul style="list-style-type: none"> ▪ Summer lawn watering bylaw ▪ A regulation requiring all new connections to the water distribution network to have water meters 	65 schools participate in the program annually, and about 4000 students have been educated so far. About 2000 water meters are installed a year.
Montreal (Montreal Urban Community in partnership with 6 drinking water producing municipalities in its territory, the Ministry of the Environment, Environment Canada Biosphere and Réseau Environnement)	Commercial, Institutional, Industry	An awards program, recognizing Montreal enterprises for their efforts in the conservation of drinking water, was initiated by the city in 1997. Each year a "Biosphere" award is awarded to each of the 6 winners from the three eligible sector categories. Two prizes are awarded in each category, one to recognize efforts of intervention, and the other to recognize efforts of awareness. The award is presented on the first Monday of the month of May, during the cities "water conservation days". Applications submitted for nomination by enterprises must reflect the results of the year preceding the entry and the application must apply to an activity or program implemented or realized within the past 5 years.	As of 2000, nearly six million cubic metres of water had been saved by prizewinners.

Sources:

- Portail de la Ville de Laval. Available: http://www.ville.laval.qc.ca/pls/wlav/wlav.site.show?p_type=1&p_no=1
- Ville de Montreal. Montreal Waste Water Treatment Plant. Available: <http://services.ville.montreal.qc.ca/station/an/accustaa.htm>

SASKATCHEWAN (SK)

Water Supply and Demand Overview

In the last century, Saskatchewan has seen both periods of severe drought and severe flooding. Waterlogging is a common problem in parts of Saskatchewan, particularly in the southeast. Due to this variability in water supply, there has been a need to divert or store water to support human activity. For example, there are over 7000 small dams on creeks and streams that are primarily for stock watering purposes, over 60 000 wells and thousands of dugouts.

The majority of the water withdrawals are for irrigation. The breakdown of province-wide water usage is as follows:

Surface Water

- Irrigation 30.2%
- Multiple use (including storage of water for wetland creation) 22.8%
- Other 16.8%
- Municipal 15.8%
- Industrial 11.8%
- Domestic 2.7%

Ground Water

- Industrial 47%
- Municipal and Domestic 47%
- Recreation and other 5%
- Irrigation and Multiple 1%

Total current withdrawals have been calculated to be 140,790 cubic decametres annually.

Sources:

- Saskatchewan Environment. 1999. Overview of Saskatchewan's Water Resources. *In* Water Management Framework. [Online]. Available: <http://www.se.gov.sk.ca/ecosystem/water/framework/PAGE5.htm#Appendix%20III>

Water and Related Legislation and Policies

Saskatchewan does not have a formal water conservation plan at this time but is in the process of developing one.

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Saskatchewan Watershed Authority Act (2002)</i>	Saskatchewan Watershed Authority (SWA)	This Act establishes the Saskatchewan Watershed Authority. The Authority consolidates the water management components from several previous provincial water management institutions. It was created to meet source water protection requirements set out in the province's Long term Drinking Strategy. Its mandate, amongst other things, is to promote the economical and efficient use, distribution and conservation of the water, watersheds and related land resources of Saskatchewan. The Authority is responsible for the allocation of ground and surface water, the inventory and analysis of water sources and the administration and control of all water infrastructure including operations and planning and the maintenance of provincially owned water management infrastructure. It is also responsible for the management of watershed and aquifer planning, for the development of partnerships and projects that help provide healthy watersheds and the provision of assessment and monitoring practices that ensure the protection and restoration of the province's water sources. S. 45 of the Act states landowners do not require a water license for the use of adjacent surface waters, or ground waters, for domestic purposes. However, ALL other water users require a license.
<i>Saskatchewan Water Corporation Act (2002)</i>		Establishes SaskWater as a crown corporation responsible for providing water, wastewater, and related services to municipalities, industrial, government and domestic customers in the province. It provides system assessments, project management of water infrastructure projects and water and water treatment operations. The corporation was created in response to actions outlined in the Long Term Safe Drinking Water strategy. SaskWater currently owns and operates 12 regional water supply systems, 5 municipal water treatment systems, 2 wastewater treatment systems and 4 irrigation projects in Saskatchewan. It also serves 50 municipal customers, 34 industrial customers and 1,300 individual rural households
<i>The Conservation and Development Act (1979, last amended 2002)</i>	SWA	Enables rural landowners to establish a Conservation and Development Area to facilitate the development of works to conserve and develop agricultural land and water resources.
<i>The Groundwater Conservation Act and Groundwater</i>	SWA	An Act respecting the Drilling of Water Wells and the Conservation and Utilization of Ground Water. The regulation outlines permit requirements for ground water exploration, registration of machines for drilling, drilling

<i>Regulations (1978, last amended 2002)</i>		and evaluation, abandonment of test holes and wells, and regulations for the use of ground water.
<i>The Water Power Act (1978, last amended 2002)</i>	SWA	Provides for the regulation of water power development.
<i>The Watershed Associations Act (1978, last amended 2002)</i>	SWA	Enables two or more agencies to establish a Watershed Association to facilitate the planning and development of works to conserve and develop land and water resources on a watershed basis.
<i>The Water Regulations (2002) Under the Environmental Management and Protection Act</i>	Saskatchewan Environment	Outlines permitting requirements surrounding the construction and operation of water and wastewater works for potable water systems only.
<i>The Irrigation Act (1966, last amended 2004)</i>	Department of Saskatchewan Agriculture, Food and Rural Revitalization (SAFRR)	The Act requires all individuals wishing to develop new irrigation projects to obtain an Irrigation Certificate. The certificate confirms that the land is suitable for irrigation from the specified water source, thereby protecting the province's water and land resources. Since January 2 1997 individuals cannot receive irrigation services from irrigation districts or the SAFRR without an Irrigation Certificate. Projects constructed prior to this date have been grandfathered from having a Certificate. Projects are exempt from certification if they require less than 12,000 cubic meters of water annually. In the certification, many soil and water criteria must be met.
<i>Planning and Development Act (1983, last amended 2004)</i>		An Act respecting Planning and Development in Urban, Rural and Northern Municipalities. Gives authority to municipalities in land use planning, including the development of water supply and distribution plans.
Policies and Guidelines		
A Water Conservation Policy (proposed)		The Minister responsible for the Saskatchewan Water Corporation announced in September 2004 that "Our provincial government is now actively studying the whole issue of water conservation with the view to bringing forward a comprehensive water conservation policy and the people of the province will be consulted on this issue in the months to come." The Minister responsible for the Watershed Authority has also announced that the Watershed Authority will develop a water conservation plan and public consultations will begin before the end of the year.
Treated Municipal Wastewater Irrigation Guidelines (2004)	Saskatchewan Environment	A permit to construct, extend or alter any treated wastewater irrigation works must be obtained from Saskatchewan Environment. Required application information is outlined, in addition to a number of guidelines concerning the design of the works, wastewater treatment, soils and topography, siting, land control, irrigation water quality criteria, monitoring and reporting.

Sources:

- Saskatchewan Watershed Authority. Available: <http://www.swa.ca>
- SaskWater. Available: <http://www.saskwater.com>
- Water Trouble Ahead: Researcher. [Online]. Available: <http://www.waterconserve.info/articles/reader.asp?linkid=34983>
- Saskatchewan Environment. 2004. Treated Municipal Wastewater Irrigation Guidelines. [Online]. Available: http://www.se.gov.sk.ca/environment/protection/water/epb_235_treated_municipal_wastewater_effluent_irrigation.pdf

Water Conservation and Related Program Initiatives

Provincial

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Long Term Safe Drinking Water Strategy 2002 Motivated by the North Battleford Inquiry.	Municipal	Builds upon the Water Management Framework of 1999 that established goals, objectives and actions for water management, in the province. Source protection is an important component of the new strategy. The SWA commits to working	The SWA has developed a watershed and aquifer planning model. The SWA has focused its activities and programming in watersheds

		with municipalities and others to develop comprehensive watershed management plans. Other actions include: requiring municipalities to have bylaws and protection plans in place to protect water supplies	deemed most in need.
Canada-Saskatchewan Irrigation Diversification Centre (Saskatchewan Agriculture, Food and Rural Revitalization, Irrigation Crop Diversification Corporation, Saskatchewan Irrigation Projects Assoc.)	Agriculture	The Centre promotes crop diversification and sustainable irrigation practices to provincial producers and industry.	

Sources:

- Saskatchewan's Safe Drinking Water Strategy. [Online]. Available: <http://www.se.gov.sk.ca/environment/protection/water/drinking.asp>
- Saskatchewan Watershed Authority. Protecting Our Water: A Watershed and Aquifer Planning Model for Saskatchewan. [Online]. Available: <http://www.swa.ca/publications/documents/ProtectingOurWater.pdf>
- Canada-Saskatchewan Irrigation Diversification Centre. Available: <http://www.agr.gc.ca/pfra/csfdc/csfdc.htm>

Municipal and Regional

Municipality or Region	Target Sector	Description	Results and Effectiveness
City of Regina Water Conservation Program Established in 1988 to delay the need for a \$40 mill expansion of the wastewater treatment plant.	Residential	<ul style="list-style-type: none"> ▪ Summer water conservation public awareness campaign promoting a voluntary watering plan ▪ Year round display at Home and Garden Show ▪ Free Xeriscape workshops with workbook ▪ Xeriscape demonstration site ▪ Conservation tips in water bills 	The program has been successful. Since the late 1980's average day water usage has been reduced by 20%, and peak day water use is down by 25%. A fall 1998 survey showed nearly three-quarters of Regina residents practice water conservation

Sources:

- City of Regina. Water Conservation. Available: http://www.regina.ca/content/info_services/water_sewer/water_conserv.shtml

Sectoral

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Saskatchewan Conservation Learning Centre Inc. (CLC) (Funded by many government, industry institutions)	Agriculture	A producer driven, non-profit corporation with formal status as a registered charity, the centre demonstrate at a farm scale, soil and water conservation technology. It also serves as a field laboratory for evaluation and applicability of new research and technology. Scientists from federal, provincial, private and university research institutions conduct research at the centre. Each year the centre undertakes between 30-40 short term projects that highlight soil/water conservation. A well-developed school program for students of all grades is also offered.	Since its inception in 1994, 13,578 youth have participated in the CLC's school program.
Destination Conservation Saskatchewan (Administered by the Saskatchewan Environmental Society (SES), with funding from many different	Institutional (schools)	A student driven, educational and technical program to save energy, conserve water and reduce waste in Saskatchewan schools. A collaborative project between SES and several school boards. The following are part of the educational component: training of school staff/parents in implementing the program, manuals, home guides, curriculum links etc. A	Destination Conservation has saved 11 Saskatchewan School Divisions over \$650,000 in just six years of operation. Typically, school divisions have seen a 10% reduction in water use.

government and private sources)		couple of program options are offered in the technical component, providing differing financing options for technical retrofits in the school.	
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Sources:

- Saskatchewan Conservation Learning Centre. Available: <http://www.conservationlearningcentre.com/index.html>
- Saskatchewan Environmental Society. Destination Conservation Saskatchewan. Available: <http://www.environmentalsociety.ca/index.html>

YUKON (YK)

Water Supply and Demand Overview

In recent years the Yukon Territory has been experiencing drought conditions. As stated in the Yukon State of the Environment report for 1999, 51 years of weather information indicate that 1998 was the driest year ever recorded in the territory. According to Environment Canada, annual precipitation was 34 percent below normal in this year. Residents in Whitehorse rural subdivisions that rely on groundwater were finding their wells drying up or providing insufficient volume.

Water flows are normally abundant throughout the summer months, often peaking in late August or early September.

Water allocation by sector in 1998 was as follows (data are based on amount of water permitted for withdrawal according to license):

- Municipal (75.4%)
- Placer mining (12.6%)
- Conservation (6.9%)
- Other (2.1%)
- Hardrock mining (2.1%)
- Agriculture (0.9%)

In 2001, per capita water use (total water use divided by population) in the City of Whitehorse was 560 litres/day down from 840 L/cap/day in 1998. High per capita usage can be attributed in large part to distribution system leakage and the use of bleeder-devices for preventing pipes from freezing. The reduced usage rates in 2001 reflect replacement of some free-flow bleeders with thermostatically controlled devices.

Sources:

- Yukon Government, Department of Renewable Resources. 2000. State of the Environment Report 1999. [Online]. Available: <http://www.environmentyukon.gov.yk.ca/soe/soe1999info.shtml>

Water and Related Legislation and Policies

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
The Water Act 2003	Department of the Environment	<p>Responsibility for water management was transferred from the federal government to the Yukon government on April 1, 2003. The Act is administered by the Environmental Programs Branch, Water Resources Section. The branch also conducts environmental assessments for water license applications, and designs and coordinates water studies as needed.</p> <p>The Yukon Water Board is also established in this Act (s. 8). The board is an independent administrative tribunal. It is primarily responsible for the issuance of water use licenses for the use of water and/or the deposit of waste into water. It's objective, according to s. 10 of the Act is to, "provide for the conservation, development and utilization of waters in a manner that will provide the optimum benefit from them for all Canadian and of the residents of the Yukon in particular." The board is also responsible for the environmental assessment of some water use applications.</p>

		S. 6 of the Act requires that all persons using water in a water management area are licensed to do so. A license is not needed for domestic use, firefighting purposes, and instream uses. S. 13 indicates that the Board may include in a license any conditions it considers appropriate, including conditions relating to the manner of use of waters permitted to be used under the license, conditions relating to studies that must be undertaken, plans to be submitted and monitoring to be undertaken, etc.
<i>Waters Regulation 2003 Under The Water Act</i>	Department of the Environment	Outlines the circumstances for which a water license is not required in a water management area. For example, for industrial undertakings, water use of less than 100 m ³ / day does not require a license. According to the regulation, conservation plans are not required for municipal undertakings, or for any type of undertaking. A license for agricultural water takings is not required for takings less than 300 m ³ /day.
<i>Yukon-Northwest Territories Transboundary Water Management Agreement (2002)</i>	Government of Canada, NWT and Yukon	Provides a means for the NWT and the Yukon to address transboundary water management issues and provide protection to the aquatic environment. The agreement also allows for the establishment of water quantity and quality objectives for waters entering the NWT from the Yukon.
<i>Mackenzie River Basin Transboundary Waters Master Agreement (1997)</i>	Government of Canada, NWT, Yukon, BC, AB, SK	Creates the Mackenzie River Basin Board. The parties to the agreement commit to managing the use of the water in a sustainable manner, resolving issues cooperatively, etc. The Board provides a forum for communication, coordination, information exchange, notification and consultation among all six jurisdictions and the public. It is also the agreement from which the Yukon-Northwest Territories Transboundary Water Management Agreement arose.
<i>Yukon First Nation Final Agreements (Umbrella agreement finalized in 1990) – Chapter 14, Section 14.10.1 (Water management)</i>	Government of Canada, Yukon and First Nations	States that Canada and Yukon commit to make best efforts to negotiate water management agreements with other jurisdictions that share the same drainage basins with the Yukon. First Nations rights to water are outlined.
<i>Environment Canada – Yukon Hydrometric Agreement</i>		Yukon currently maintains a formal cost sharing agreement with Environment Canada for the design, construction and operation of the hydrometric and sediment sampling networks in the Territory. Data from this network is currently used for flood forecasting, project design assessment and operation, as well as for inventory purposes including flow monitoring, watershed characterization and climate change monitoring.
<i>Public Drinking Water Systems Regulation (2004)</i>	Department of Health and Social Services	Addresses every aspect of the drinking water system from "source to tap". The regulation provides specifications for the protection, operation and maintenance of a public drinking water system. As the title suggests the regulation covers suppliers of drinking water in situations where there are multiple users. All types of water supply systems are covered by the regulations, including drilled wells, which must be developed to the Canadian Groundwater Association standards. The regulations require the submission of drill logs.
<i>The Prohibition of Bulk Water from Major Drainage Basins in the Yukon Territory</i>	Department of the Environment	The removal of freshwater in bulk quantities from any major drainage basin within the Yukon is prohibited. Any licenses submitted to the Minister responsible for the Water's Act authorizing bulk water removal will not be approved. Bulk water removal is defined as any water transferred out of a river basin in any individual container greater than 40 litres in volume, or removal by any means that involves permanent out-of-basin transfer, whether it is by diversion, tanker or other mechanism.

Sources:

- Government of Yukon. 2001. Water Resources Branch. [Online]. Available: <http://www.environmentyukon.gov.yk.ca/water/index.shtml>
- Yukon Water Board. [Online]. Available: <http://www.yukonwaterboard.ca/index.htm> Last updated July 15, 2004

Water Conservation and Related Program Initiatives

Provincial

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
(Department of Mines, Energy and Resources, Agriculture Branch)	Agriculture	Provides advice to farmers in all aspects of farm management including conservation techniques and new farm technology.	
Energy Solutions Centre Inc.(ESC) (Funded by the Yukon Development Corporation and Natural Resources Canada)	Residential, ICI, Public	The Energy Solutions Centre is a service and program delivery agency for the Federal and Yukon governments' programs relating to energy efficiency and green power. The Centre offers a number of business and residential energy efficiency programs, including the provision of energy audits and financial incentives for enhanced energy efficiency. Water conservation may play a role in many of these projects. The Centre is also involved in the expansion of a groundwater-monitoring database covering all Yukon municipalities and first nation communities as a first step in assessing the aquifer characteristics underlying these communities. ESC's focus was on the ground source energy potential beneath Yukon communities for climate control. As a component of the project, ESC purchased 1000 well logs from Midnight Sun Drilling as well as rights to future logs.	ESC has offered the expanded database and assorted well logs to Yukon Water Resources for long term management and maintenance. With this database, Water Resources and Community Services will develop a web-based database and input the newly acquired drill logs, as well as drill logs from other sources, into the database.

Sources:

- Department of Mines, Energy and Resources – Agriculture Branch. [Online]. Available: http://www.emr.gov.yk.ca/Agriculture/Extension_%ADServices.htm Last updated Oct. 6 2004
- Energy Solutions Centre Inc. Available: <http://www.nrgsc.yk.ca/index.php>

Municipal and Regional

Municipality or Region	Target Sector	Description	Results and Effectiveness
City of Whitehorse	Municipal, All	Domestic use is generally not metered. Commercial and industrial customers are metered and pay by volume. To reduce water consumption the city implemented a by-law requiring that all new construction and retrofitting include low flow toilets. Thermostatically controlled bleeder devices were also introduced. A Watershed Management Plan for the city was also finalized in 2004; however, the focus of this plan is water quality.	The bleeder reduction program has significantly reduced total water use.
City of Dawson	Public	A low-flow bleeder system was installed in 2003.	Water consumption for the city was reduced by 27%.

Sources:

- Yukon Government, Department of Renewable Resources. 2000. State of the Environment Report 1999. [Online]. Available: <http://www.environmentyukon.gov.yk.ca/soe/soe1999info.shtml>

Sectoral

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Towel Saver Program (Tourism Industry Association of the Yukon) (TIA)	Hotels, motels	The TIA Towel Saver Program encourages guests in Yukon accommodations to reduce daily towel replacement in an effort to reduce water and energy consumption. TIA Yukon also promotes the national Green Leaf Eco-rating Program, which recognizes hotels, motels etc., for improvements in environmental performance. These initiatives are done in partnership with Natural Resources Canada, Department of Business, Tourism and Culture, Yukon Development Corporation, BC and Yukon Hotels' Association, and Hotel Association of Canada.	

Sources:

- Tourism Industry Association of the Yukon. Available: http://www.tiayukon.com/Page_programs.htm

APPENDIX A.2 UNITED STATES

National Water Supply and Demand Overview

At the global scale, the United States would appear to possess adequate renewable water resources in relation to its current needs. On the other hand, an uneven distribution of these resources relative to water-intensive growth and development has resulted in water shortages and user conflicts particularly in the western states.

Total freshwater withdrawals (excluding hydropower) amounted to 345 billion US gallons per day (477 billion m³ per year) in 2000. Surface water withdrawals accounted for 76% of all takings. Withdrawals by major sector were crop irrigation 39.7%, thermal power 39.4%, public water supply 12.6%, industrial 5.4%, livestock (including aquaculture) 1.6%, rural domestic 1.0%, and mining 0.6%. While the intensity of withdrawals is generally higher in the east, sustainability concerns are more serious in the west. Six states - California, Idaho, Colorado, Nebraska, Texas and Montana - together account for more than 60% of total U.S. crop-water usage.

Total Yr 2000 Freshwater Withdrawals for Selected States (excluding hydropower)
(Million US gallons/day)

State	Public Supply	Other Domestic	Irrigation - crop & landscape	Lives-tock	Aqua-culture	Industrial	Mining	Thermal Power	Totals
Arizona	1,080	29	5,400	-	-	19.8	85.7	100	6,720
California	6,120	286	30,500	409	537	188.0	23.7	352	38,400
Florida	2,440	199	4,290	33	8	291.0	217.0	658	8,140
New Mexico	296	31	2,860	-	-	10.5	-	56	3,260
Total USA	43,300	3,590	137,000	1,760	3,700	18,500	2,010	136,000	345,000

Overall U.S. water usage peaked in 1980, declined about 10% between 1980 and 1985, and has been relatively stable since. The decline is attributed to water-efficiency improvements in the thermal power, irrigation and industrial sectors. Thermal power and irrigation withdrawals have been largely stable since 1985 in spite of increases in production. Total public water supply usage has tripled since 1950 while population has increased by about 93%.

Sources:

- Adapted from U.S Department of the Interior & U.S Geological Survey 2000. See <http://water.usgs.gov/pubs>

Federal Water Conservation Initiatives

Under the United States constitution, considerable water management powers are vested in the federal government. While states do have important law-making powers relating to water resources, their processes and end results must adhere to minimum national standards in order for them to access program funding available from the many federal agencies involved in water management. Given the extensive 'carving-up' of watersheds and major aquifers by state boundaries, the vestige of ultimate power over water with the federal government is critical to its effective management. Special purpose bodies have been created to manage water resources in some large and heavily used river basins.

As in Canada, U.S water allocation principles and laws differ from east to west, i.e. riparian or common law rights in the east vs. prior appropriation rights in the west.

One or more federal agencies can be involved in water conservation planning and implementation depending on the water-use sector. Key agencies include the Environmental Protection Agency (US EPA), Dept of Agriculture (USDA), Dept of Energy (DOE), and Dept of the Interior (DOI).

US EPA provides water conservation program planning guidance relative to public water utilities in conjunction with its responsibilities for administering the *Safe Drinking Water Act (1996)*. The agency's Guidelines for Preparing Water Conservation Plans formally released in 1998 currently serve as a model for municipal water authorities in the U.S and in other countries. EPA's effluent quality standards and watercourse standards have also played a significant role in encouraging water-use intensive industries and municipalities to reduce their water usage.

EPA promotes water conservation and efficiency as a cost-saving element of infrastructure renewal and sustainability initiatives and as integral consideration in watershed management planning. It is also considering the establishment of a national water-efficiency labeling program for water-using appliances and other devices similar to that of the Energy Star Program.

USDA and DOI are involved in the promotion and facilitation of conservation initiatives in crop irrigation particularly in the Western States. DOI is also the home of the U.S. Geological Survey (USGS) with its responsibilities in monitoring, compiling, evaluating and disseminating information on water availability and water use throughout the country. The Dept of Energy may emerge as a more significant player in water conservation efforts with its active involvement in promoting the synergistic benefits of water and energy conservation.

ARIZONA (AZ)

Water Supply and Demand Overview

Much of Arizona lies in a desert climate. As such, most settlement and economic growth is focused in areas where dependable sources of water exist. Groundwater accounts for 40% of overall water use.

Water and Related Legislation and Policies

The Arizona Department of Water Resources (DWR) administers Arizona's water resources policies and laws. Its responsibilities include administration and oversight of surface and ground water rights, well drilling, groundwater recharge activities, water monitoring, and long range planning. Much of the focus is on five Active Management Areas (AMAs). These were established to provide long-term management and conservation in areas of strong demand and limited groundwater supplies.

Area Management Plans are developed with a 10-year horizon. The first plans came into effect in 1980 so are now in their 3rd generation, i.e. 2000-2010. The plan establishes conservation requirements for municipal, agricultural and industrial water users with those requirements becoming increasingly stringent under each successive plan. Extensive stakeholder consultations are involved.

Name	Agency	Description, Roles and Responsibilities
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Legislation and Regulations		
<i>Groundwater Management Act 1980 - Groundwater Management Code</i>	Department of Water Resources	<p>The Arizona Groundwater Management Code establishes the legal framework for conserving and managing water in Arizona's most populous areas.</p> <p>Primary Goals:</p> <ul style="list-style-type: none"> To control severe overdrafting of aquifers To provide a means to allocate limited groundwater resources to most effectively meet the changing needs of the state; and To augment Arizona's groundwater resources through supply development <p>Provisions:</p> <ul style="list-style-type: none"> establishes a program of groundwater rights and permits prohibits irrigation of new agricultural lands within 5 Active Management Areas (AMA) requires preparation of water management plans for each AMA designed to create a comprehensive system of conservation targets and other water management criteria requires developers to demonstrate a minimum 100-year assured water supply for new growth requires metering/measuring of water pumped from all large wells requires annual water withdrawal and use reporting; these reports may be audited to ensure water user compliance with the provisions of the Groundwater Code and management plans; penalties may be assessed for non-compliance
Groundwater Rights	Department of Water resources	<p>A groundwater right or permit is required unless the person is withdrawing from an "exempt" well or a well with a maximum pumping capacity of 35 US gallons/min.</p> <p>Grandfathered rights, service area rights, and withdrawal permits are required to withdraw water from non-exempt wells in all AMA's</p> <p>Unless irrigation occurred between 1975 and 1980 and the user received an irrigation grandfathered right for the historical agricultural acres, no new lands may be put into production within an Active Management Area.</p>
Policies and Guidelines		
Assured Water Supply program	Department of Water resources	<p>The Assured Water Supply Program covers subdivision development within an AMA.</p> <p>In order to obtain a Certificate of Assured Water Supply, five criteria must be met:</p> <ol style="list-style-type: none"> 1. The water supply must be physically, legally, and continuously available for the next 100 years. 2. The water must meet water quality standards or be of sufficient quality. 3. The proposed water use must be consistent with the management goal of the AMA. 4. The proposed water use must be consistent with the current management plan of the AMA. 5. The developer must demonstrate the financial capability to construct any necessary water storage, treatment, and delivery systems.
Adequate Water Supply program	Department of Water resources	<p>The Adequate Water Supply program, first created in 1973, operates outside of AMAs. Developers are required to obtain a determination from DWR concerning the quantity and quality of water available before any lot sales can occur. If the application for a Water Adequacy Report successfully demonstrates that water of sufficient quality will be physically, legally, and continuously available for the next 100 years, then the Department will determine the water supply to be adequate. If the water supply is determined to be inadequate, the developer may still sell lots, but the inadequate determination must be disclosed to potential buyers in the public report approved by ADRE and in all promotional materials. If the proposed subdivision will be served by a provider with a Designation of Adequate Water Supply, then the developer only has to provide a written commitment of service from the designated provider.</p>

Sources:

- Overview of Arizona Groundwater Management Code. [Online]. Available at <http://www.water.az.gov/adwr/Content/Publications/files/gwmgtovw.pdf>

Water Conservation and Related Program Initiatives

State

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Water Management Assistance Program	Department of Water Resources	The Arizona DWR Water Management Assistance Program provides financial and technical assistance to help water users meet their conservation requirements, to facilitate renewable water supply utilization, and to obtain information on hydrologic conditions and water availability in the Active Management Areas (AMAs).	

Sources:

- Water Conservation, Augmentation and Monitoring Programs. [Online]. Available at <http://www.water.az.gov/watermanagement/Content/Conservation/default.htm>

Municipal and Regional

Municipality or Region	Target Sector	Description	Results and Effectiveness
City of Tucson	Residential	November of 1999 Tucson Water published "The Homeowners Guide To Using Water Wisely"	
Miscellaneous	Residential	Use of grey water for landscape irrigation is permitted under the following restrictions: -for private residential use only -must be used at site where it is generated -cannot be used in conjunction with spray irrigation equipment -maximum use is 400 gallons per day	

Sources:

- Homeowners Guide to Using Water Wisely. [online]. Available at http://www.ci.tucson.az.us/water/conservation/conservation_general/Homeowner.pdf

CALIFORNIA (CA)

Water Supply and Demand Overview

In average water years like 2000, California receives about 200 million acre-feet of water from precipitation and imports from Colorado, Oregon and Mexico. Of this **total supply**, about 50-60 percent either is used by native vegetation, evaporates to the atmosphere, provides some of the water for agricultural crops and managed wetlands (effective precipitation); or flows to Oregon, Nevada, the Pacific Ocean, and salt sinks like saline groundwater aquifers and the Salton Sea. The remaining 40-50 percent, or **dedicated supply**, is distributed among urban and agricultural uses, water for protecting and restoring the environment, or storage in surface and groundwater reservoirs for later use.

In any year, some of the dedicated supply includes water that is used multiple times (reuse) and water stored from previous years. Ultimately, about a third of the dedicated supply flows out to the Pacific Ocean, in part to meet environmental requirements, or to other salt sinks. For wet and dry years, the total supply and the distribution of the dedicated supply to various uses differ significantly from the example above for an average year.

California's unique geography and climate have allowed it to become one of the most productive agricultural regions in the world. The Sierra Nevada Mountain range bordering the eastern edge of the State captures and stores winter precipitation that is used for summer irrigation in the Central Valley. California produces over 250 different crops and leads the nation in production of 75 commodities. California is the sole U.S. producer of almonds, artichokes, dates, figs, raisins, kiwifruit, olives, persimmons, pistachios, prunes and walnuts.

California agricultural producers use roughly 30 million acre-feet of water a year on 9.6 million acres. California's vast water infrastructure was developed to provide water for irrigation with agriculture using 80% of the State's developed water supply.

Ongoing population growth (projected to increase from 32.1 million in 1995 to 47.5 million by 2020) and greater awareness of environmental requirements have increased pressure on California agriculture to use water more efficiently and to make more water available for urban and environmental uses. Reducing agricultural water usage has proved difficult as California producers are already among the most efficient in the country and are reluctant to improve water efficiencies if it means sacrificing existing crop yields.

Water and Related Legislation and Policies

Lead responsibilities for water management are held by the Department of Water Resources. Within DWR, the Office of Water Use Efficiency (OWUE) oversees water use efficiency planning and coordination, provision of technical and financial assistance, information collection and dissemination and ongoing water resources evaluation. More specifically, OWUE:

- Provides expertise to local agencies and individuals regarding agricultural and urban water and energy conservation, reclamation and reuse of water, land and water use, and drainage management.
- Manages the California Irrigation Management Information System (CIMIS) by collecting weather data from over 120 stations and disseminating calculated reference evapotranspiration rates to assist landscape and crop managers irrigate efficiently.
- Assists in establishing mobile laboratories that conduct irrigation system evaluations.
- Carries out data analysis, demonstration projects, and research to achieve energy and water use efficiency.
- Provides loans and grants to make more efficient use of water and energy resources.

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Urban Water Management Act of 2003</i>	Department of Water Resources (DWR)	<p>The Act requires water utilities serving 3,000 or more customers, or providing over 3,000 acre-feet of water annually, must make every effort to reliably meet customer demands during normal, dry, and multiple dry years. It also requires preparation of an Urban Water Management Plan for the service area. Plans are subject to DWR review and approval.</p> <p>DWR assists urban water utilities in preparing the management plans and in implementing conservation programs.</p> <p>DWR staff review plans submitted in accordance with the Act. Results are provided to local and regional water suppliers through a review letter. Results are also compiled into a Legislative Report provided to California Legislature one year after plans are due to DWR.</p>
<i>Agricultural Efficient Water Management Act of 1990</i>		Established the Agricultural Water Management Council (formed in 1996) to help in development of water management plans and in the promotion and implementation efficient water management practices.

Water Conservation and Related Program Initiatives

State

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Commercial, Industrial, and Institutional (CII) Water Management Program	ICI	The role of the Commercial, Industrial, and Institutional Program is to disseminate information on improved water use efficiency technologies and help local agencies develop and implement CII water use efficiency programs. This includes assisting in compliance with California Urban Water Conservation Council BMP directives and obtaining financial assistance for implementing water and energy efficiency programs.	
CII Voucher Program (San Diego County Water	ICI	The CII Voucher Program is managed by the Authority for all participating member agencies. The	

Authority, Metropolitan Water District)		Authority, its member agencies and the Metropolitan Water District fund the program.	
H ₂ OUSE Website (California Urban Water Conservation Council)	Residential	Website offers a list of water saving tips for a homeowner	
The Program Development Unit (Department of Water Resources)	Agriculture	The Program Development unit encourages and promotes irrigation practices and technology that lead to efficiency in water and energy use. To achieve this goal, the unit: 1. Conducts training and educational workshops on new technologies for water and energy efficiency measures. 2. Partners with other agencies, growers, and water use efficiency experts to work with growers on developing innovative water and energy efficiency projects, guidelines and training. 3. Works with Irrigation/Water districts that pump groundwater or provide pressurized water to growers, to do pump testing to achieve optimum performance. Promotes the benefits of testing to water suppliers that haven't been testing. Coordinates activities with local energy utilities and the Agricultural Water Management Council to facilitate the implementation of local and regional pump testing. 4. Works with University of California and California State University to develop guidelines and technical specifications to evaluate the use of variable frequency drives.	
Association of California Water Agencies (ACWA) State Outreach Handbook	All	ACWA, founded in 1910, represents and provides services to members. From legislation, to regulatory activity, to broad policy issues, ACWA is on the front lines in state and national capitals as a constant and respected advocate for California's public water agencies.	
California Irrigation Management Information System (CIMIS)	DWR	DWR manages a network of over 120 automated weather stations across the State. The real-time data assists crop irrigators to schedule and manage their water usage more efficiently.	

Sources:

- Office of Water Use Efficiency homepage. [Online]. Available at <http://www.owue.water.ca.gov/index.cfm>
- San Diego County Water Authority. [Online]. Available at <http://www.sdcwa.org/manage/conservation-cii.phtml>
- California Urban Water Conservation Council. [Online]. Available at <http://www.h2ouse.org/>
- California Department of Water Resources: Current Programs in Water Use Efficiency. [Online]. Available at <http://www.owue.water.ca.gov/agdev/pgm/pgm.cfm>
- Association of California Water Agencies. [Online]. Available at <http://www.acwanet.com/>

FLORIDA (FL)

Water Supply and Demand Overview

Floridians were using an estimated 7.7 billion US gallons of freshwater per day (US bgd) in 2000 and total demand is projected to reach 9.1 US bgd by 2020. Agricultural uses account for some 52% of current withdrawals with public supply use making up about 31%.

The Floridian Aquifer supplies most of Florida's ground water needs. It is the potable supply for such cities as Tallahassee, Jacksonville, Gainesville, Orlando, Daytona Beach, and portions of Tampa and St. Petersburg. It also serves thousands of individual domestic, agricultural, industrial and commercial users.

One of the worst droughts in Florida's history occurred in 2001. This together with rapidly growing water demands led state and local water management agencies to begin a process aimed at identifying additional measures to increase water efficiency. The public process resulted in the preparation of the April 2002 document entitled 'Florida Water Conservation Initiative'. The report's 51 priority recommendations for improving water use efficiency were captured in a Joint Statement of Commitment outlining agency roles and responsibilities for implementation.

Sources:

- Florida Water Conservation Initiative. April 2002. Florida Dept of Environmental Protection

Water Management Roles and Responsibilities

The *Florida Water Resources Act of 1972* gives state regulatory control over water quantity and quality issues to the Department of Environmental Protection. The Department of Environmental Protection oversees the programs and activities of the state's five Water Management Districts (WMDs).

Water management districts are responsible for issuing a variety of water-related permits including the Consumptive Use Permit (CUP). The CUP allows water to be taken from a surface or ground water source for reasonable and beneficial uses. Permits are required for uses withdrawing water from a well that measures six inches or more in diameter, involving an annual average taking of 100,000 US gallons of water or more per day, or having the capacity to pump 1 US million gallons or more per day.

The Water Conservation Goal of the state is to "prevent and reduce wasteful, uneconomical, impractical, or unreasonable use of water resources". Conservation of water is required of all water users except where it is determined to be "not economically or environmentally feasible".

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Florida Water Resources Act 1972</i>	Department of Environmental Protection (DEP)	Gives lead regulatory responsibilities over water quantity and quality issues to the Department of Environmental Protection (DEP) and establishes five water management districts (WMDs) - Northwest Florida WMD, Suwannee River WMD, St. Johns River WMD, South Florida WMD and the Southwest Florida WMD. DEP is given regulatory supervision over the districts and is to delegate water resources programs to them where possible.
<i>Florida Watershed Restoration Act 1999</i>	DEP	The <i>Florida Watershed Restoration Act</i> further outlines the responsibilities of key water management agencies including the Department of Environmental Protection (DEP), Department of Agriculture and Consumer Services (DACS) and the five Districts with respect to a suite of integrated management functions.
<i>62-40.412 Water Conservation</i>	Department of Environmental Protection	Water Management Districts are expected to work with and assist local and regional governments "in designing and formulating plans and programs to conserve water to meet their long term needs, including incentives such as longer term more flexible permits, economic incentives, and greater certainty of supply during water shortages". They have the mandate for: - Prescribing efficiency measures for all urban, industrial, and agricultural users including: <ul style="list-style-type: none"> • Restrictions against inefficient irrigation practices • Imposition of year-round time-of-day restrictions (subject to variances or exemptions) on particular irrigation activities or irrigation sources • Minimization of unaccounted for water losses • Promotion of water conserving rate structures • Use of water-conserving plumbing fixtures, xeriscape, and rain sensors - Implementing public information and education programs - Coordinating activities with neighbouring districts
<i>Part VI, chapter 373.62: Water Conservation</i>	Florida Statutes	Requires any person purchasing or installing an automatic sprinkler system to install a rain sensor that will override the irrigation cycle when sufficient rain has fallen.
Policies and Guidelines		
Water Supply Facilities Work Plan	Department of Community Affairs	Municipal governments are required to project local needs for at least a 10-year period, identify and prioritize the water supply facilities and sources that will be needed to meet those needs, and include a Five-Year Schedule of Capital Improvements required. Each listed capital improvement must identify its

		accompanying revenue source(s).
Watershed Management Program 1999	Department of Environmental Protection	<p>The Watershed Management Program was created to guide implementation of the provisions of the Florida Watershed Restoration Act. It covers the areas of:</p> <ul style="list-style-type: none"> - Watershed management planning and coordination - Watershed monitoring and data management - Watershed assessment - Ground water assessment - Non-point source management - National Pollutant Discharge Elimination System (NPDES) stormwater permitting

Sources:

- Florida Department of Environmental Protection. [Online]. Available: <http://www.dep.state.fl.us>
- Department of Community Affairs. [Online]. Available at <http://www.dca.state.fl.us/fdcp/DCP/WaterSupplyPlanning/watersupplyplanning.htm>

Water Conservation and Related Program Initiatives

State

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Florida Water Conservation Initiative. 2002	All	<p>Developed in response to growing demands and water supply conflicts that were exacerbated by the 2001 drought. The goal was to determine "what can be done to make significant, permanent and cost-effective improvements in water use efficiency".</p> <p>The result of the public process was a report containing 51 recommendations covering:</p> <ul style="list-style-type: none"> - Agricultural irrigation - Landscape irrigation - Water pricing - ICI BMP certification programs - Indoor water efficiency measures - Wastewater reclamation and reuse 	
Joint Statement of Commitment for the Development and Implementation of a Statewide Comprehensive Water Conservation Program for Public Water Supply (JSOC)	WMDs	<p>The JSOC is an agreement among key water management agencies and partners to collaborate on measures for improving water-use efficiency.</p> <p>The JSOC partners are developing a work plan spelling out specific tasks, milestones, cost estimates and responsibilities. The work plan is to be completed by February 2005 and will include recommendations regarding:</p> <ul style="list-style-type: none"> - Standardized definitions and performance measures - Establishment of a clearinghouse for water conservation - Development of a standardized conservation planning process for utilities - Implementation of pilots through cooperative agreements with volunteer utilities. 	
Agricultural Water Conservation Program	Agriculture	<p>The Florida Dept of Agriculture and Consumer Services supports state and local conservation efforts targeted at agricultural producers. This includes:</p> <ul style="list-style-type: none"> -Providing cost-share assistance for irrigation system water-efficiency retrofits and demonstrations. -Promoting development, implementation and updating of voluntary interim measures and best management practices adopted by rule. -Providing assistance to the water management districts in the development and implementation of consistent methodologies for the allocation and 	

		management of waters used for crop irrigation.	
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Sources:

- Florida Senate. [Online]. Available at <http://www.flsenate.gov/Welcome/index.cfm>

NEW MEXICO (NM)

Water Supply and Demand Overview

Water and Related Legislation and Policies

The New Mexico Office of the State Engineer encourages water conservation in all water use sectors through the educational efforts of its Water Conservation Program. It assists water rights applicants in preparing water conservation plans and is in the process of establishing formal policies to guide conservation planning.

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
	State Engineer	New Mexico law requires the State Engineer to consider water conservation when reviewing an application for water rights. Water right permits that are issued include a water conservation condition stating that the permittee "shall utilize the highest and best technology available to ensure conservation of water to the maximum extent practical."
Water Planning Program	NM Interstate Stream Commission (ISC)	<p>New Mexico has in place legislation for a regional water-planning program carried out by the New Mexico Interstate Stream Commission (ISC). The regional water-planning program was adopted by the New Mexico Legislature in 1987 (72-1-43 and 72-14-44 N.M.S.A., Cum Supp. 1993). The planning strategy was created at a regional level "due to the many variables in climate, water supply, water demand, and legal and institutional constraints to water resources management in New Mexico". There are a total of sixteen water-planning regions.</p> <p>The ISC put together a <i>Regional Water Planning Handbook</i> in 1994, aiding with water plans at the regional level. Each region is responsible for "identifying water supply, projecting demand, and where water is determined to be inadequate to meet projected demand, which is almost always the case in New Mexico, regions must develop strategic alternatives to meet their water shortage challenges".</p> <p>Water plans must include recommended alternatives for regional water resources management, water conservation, protection of the regional public welfare, and time lines for implementing the water plan. Investigations are also used to identify unappropriated ground water resources that may be reserved on behalf of a region.</p>
State Water Plan	NM Interstate Stream Commission	Adopted by the New Mexico Interstate Stream Commission Dec. 17 2003
Policies and Guidelines		
Infrastructure funding eligibility		Preparation and submission of a water conservation plan is a prerequisite in applying for state funding assistance for local infrastructure projects.
Use of grey water		In 2003, the State Legislature approved use of grey water for residential landscape uses. Gray water is considered to include wastewater from baths, showers, bathroom sinks and clothes washers.

Sources:

- Office of the State Engineer [Online]. Available. <http://www.seo.state.nm.us/water-info/NMWaterPlanning/NMWP-index.html>
- Use of Grey water [Online]. Available. <http://www.seo.state.nm.us/publications/00-01-annual-report/isc.html>

Water Conservation and Related Program Initiatives

State

Initiative, Lead Agencies and Partners	Target Sector	Description	Results and Effectiveness
Water Conservation Program (Office of the State Engineer and New Mexico Interstate Stream Commission)	Water Management Districts	The New Mexico Office of the State Engineer encourages water conservation in all water use sectors through the educational efforts of its Water Conservation Program. The agency is also establishing water conservation policy guidelines for water rights applicants.	

Sources:

- New Mexico Water Conservation Program. [Online]. Available: <http://www.seo.state.nm.us/water-info/conservation/index.html>
- <http://www.seo.state.nm.us/water-info/NMWaterPlanning/NMWP-index.html>
- <http://www.seo.state.nm.us/publications/00-01-annual-report/isc.html>

Municipal and Regional

Municipality	Target Sector	Description	Results and Effectiveness
City of Albuquerque	Residential and ICI	<p>The goal is to reduce water usage by 40% by 2014.</p> <p>To achieve this, the City is using a mix of regulatory, outreach and incentive measures.</p> <p><i>Water Conservation and Water Waste Ordinance</i></p> <ul style="list-style-type: none"> - Defines water waste as any water, other than natural precipitation, that flows from one person's property to the public right-of-way or to an adjacent property - Penalties can range from \$20 for a first offence up to \$1000 per occurrence - Upon the 8th violation, a flow limiter is installed on the water service allowing only enough water for basic drinking water and sanitation needs. <p><i>Time-of-Day Watering Ordinance</i></p> <ul style="list-style-type: none"> - Watering is not permitted between 10am and 6pm from April 1 to Sept 30. <p>The City has one of the US's most comprehensive incentive programs. Each household can obtain a free water audit and free installation of low-flow showerheads, high-efficiency faucet aerators, auto-shutoff hose nozzles and a toilet dam.</p> <p>Several water-efficiency rebates are offered including:</p> <ul style="list-style-type: none"> - low-flow toilets (\$125/unit) - washing machines (\$100/machine) - dishwashers - rainwater barrels - sprinkler timers - xeriscaping (\$800) - hot water recirculation units <p>Commercial and residential customers are also eligible for rebates.</p>	<p>Water usage dropped from 250 US gallons per/cap/day when the program began in 1995 to 193 US gpcd in 2003. Residential demands, which account for nearly 70% of total usage, decreased by 32% over the same period.</p> <p>Uptake to date has included:</p> <ul style="list-style-type: none"> - 50,000 toilets - 2,000 xeriscape conversions covering more than 3,000,000 square-feet - 6,000 washing machines - 9,000 residential water audits and retrofits - 23,000 multi-family unit customer audits and retrofits

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Sources:

- City of Albuquerque at <http://www.cabq.gov/waterconservation>
- City of Albuquerque at <http://www.cabq.gov/waterconservation/comply>

APPENDIX A.3 OTHER COUNTRIES

AUSTRALIA (AU)

Water Supply and Demand Overview

Most of the precipitation that falls upon Australian soils soaks into the ground. In fact, only 12% of its rainfall runs off into the river system, and most of this runoff occurs in tropical monsoon areas where there are few communities and minimal development.

In 2002, a National Land and Water Resources Audit indicated that water resources from 26% of Australia's surface management areas and 31% of its groundwater management units were fully allocated or overallocated.

In 1996-7, Australia used 26,000 GL of water. Consumption by sector was as follows:

- 75% for irrigation,
- 20% for urban and industrial purposes and
- 5% for stock and domestic use.

Between 1983-4 to 1996-7, the irrigation water use increased by 76%, urban and industrial water use increased by 55%, and rural livestock and domestic use fell by 2%. Irrigated crop areas increased by 26%.

Australia has the 3rd highest per capita water usage after the USA and Canada among Organization for Economic Cooperation and Development countries. Households use about 59% of all urban water; of which 54% of the water used in the average Australian household is used for flushing toilets and watering gardens. The remaining water is used mainly in industry/commercial establishments (21.2%) and local government (6.7%).

In recent years, Australia has experienced widespread drought. Water restrictions have been implemented in most capital cities, bringing home to the urban population that water is a limited resource.

Sources:

- Australian Academy of Technological Sciences and Engineering. 2004. Water recycling in Australia. [Online]. Available: <http://www.atse.org.au/index.php?sectionid=597>

Water and Related Legislation and Policies

The Commonwealth

The Commonwealth or national government of Australia has only limited powers in the regulation and management of water. The high court has ruled that the Commonwealth is entitled to constitutional powers over the environment, the scope of which is generally decided by negotiation between Commonwealth and state governments. Commonwealth roles in urban water management are primarily in national leadership, standard setting, intellectual contribution and financial investment.

The Australian Commonwealth Department of Agriculture, Fisheries and Forestry (AFFA) is responsible for major aspects of natural resource management, agriculture and food, including lead responsibility for the Commonwealth Government's water policy reforms under the Council of Australian Governments.

Under the Environment Protection and Biodiversity Conservation Act of 1999, commonwealth responsibility for matters of national environmental significance rests with Environment Australia (EA). Environment Australia's responsibilities with respect to urban water management include developing and implementing a planning and management framework for marine and estuarine water quality protection and implementation of water protection programs. EA also shares responsibility for a number of water matters with AFFA.

State and Territory Regulatory Agencies

Most aspects of urban water regulation are the responsibility of state and territory governments. Within each jurisdiction, there are generally four regulatory tasks, i.e. environmental protection; natural resource management; public health, and price setting.

Each state and territory has different legislation in place and different regulating authorities, making it very complicated to list out specific water management roles and responsibilities for Australia as a whole.

State and Territory Water Utilities

The oversight of water, wastewater, and stormwater management services (not including the catchment management function) are considered distinct functions that may be carried out by separate agencies in the states and territories. Typically, state agencies are responsible for water and wastewater while local governments manage stormwater.

In the State of Victoria, water services to residential, commercial and industrial customers within the Melbourne metropolitan area are supplied by four state-owned businesses. Melbourne Water, a statutory corporation owned wholly by the state government, is the wholesale supplier of water to these businesses. These businesses also collect sewage for treatment by Melbourne water.

In South Australia, the South Australian Water Corporation (SA Water) owns, manages and operates the great majority of South Australia's water supply and sewerage systems. The State Government also wholly owns SA Water.

Most utilities are required by law to have drought contingency plans in place. In Victoria, drought contingency plans are being revised across the state, so they are uniform with four different restriction levels. Many also implement various measures and programs to encourage water efficiency and conservation in the home and business.

Role of local governments

Local governments are responsible for varying aspects of urban water supply, wastewater treatment, and stormwater drainage. Local governments also manage local land use planning, zoning and development approval processes within urban areas.

Catchment Management Authorities

Most jurisdictions have adopted the principles of integrated catchment management (ICM), and created catchment management groups, although the roles of these groups vary around Australia. The largest of the catchment management institutions is the Murray-Darling Basin Commission (MDBC). The MDBC manages the water resources of the entire basin, including multiple catchment areas, across numerous state and local government boundaries. Integrated catchment management on the whole, however, is still an emerging concept in Australia.

Water management in Australia remains very fragmented and roles and responsibilities are often blurred. Water supply and wastewater treatment systems are typically managed separately from stormwater drainage systems, by different entities. Multiple agencies share responsibility for natural resource management; human health; environmental protection; and price setting.

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Environment Protection and Biodiversity Conservation Act</i>		This Act authorizes Environment Australia with responsibility for matters of national environmental significance. Environment Australia's responsibilities with respect to urban water management include developing and implementing a planning and management framework for marine and estuarine water quality protection and implementation of water protection programs. EA also shares responsibility for a number of water matters with AFFA.
Water Efficiency Labeling and Standards Scheme (WELS)	Ministry for the Environment and Heritage	In October 2002 a project to investigate the options for the introduction of mandatory national water efficiency labeling, possibly in conjunction with minimum performance standards, was announced. In September 2003, the Australian Government decided to prepare legislation to introduce a mandatory WELS scheme, to apply initially to

(proposed)		showerheads, clothes washers, dishwashers and toilets, with further provision for voluntary labeling of taps, flow regulators and urinals. In March 2004, a Regulation Impact Statement on the proposed scheme was released for public comment, after which it was decided that labeling of taps and urinals should also be made mandatory. In July 2004, a Bill to Parliament was introduced to provide for the establishment and operation of the scheme.
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Sources:

- Water efficiency labeling and standards scheme. Available: <http://www.deh.gov.au/water/urban/scheme.html>

Water Conservation and Related Program Initiatives

National

Initiative, Lead Agencies and Partners	Sector(s) targeted	Description	Results and Effectiveness
1994 Council of Australian Governments Water Reform Framework In 1994 the Council of Australian Governments (COAG), comprising the Prime Minister, Premiers, Chief Ministers and the President of the Local Government Association, established the Water Reform Framework.	States and Territories	The Framework outlines a package of measures intended to improve the efficiency of water use as well as the environmental management of the nation's river systems. The framework includes provisions for water entitlements and trading (permanent trading of water entitlements and the separation of land and water rights), environmental requirements, institutional reform, public consultation and education, water pricing and research. Water pricing, in the form of two part tariffs and volumetric pricing to consumers, is one of the key aspects of the reform. In 1995 COAG endorsed the National Competition Policy for Australia, under which payments, acting as financial incentives, were made available on a competitive basis to states and territories implementing a range of important reforms, including the Water Framework. The time frames for implementation of the Framework were set at five to seven years with full implementation by the year 2001. Timeframes for implementation were subsequently extended to 2005 for certain aspects including allocations and trading.	According to the national competition council, urban water reform is now largely complete (as of 2004). The results of the reform have included improved efficiency in water supply. Costs have been reduced overall by about 20 per cent and urban consumption has been reduced Australia wide generally by around 20 percent. However, few urban water service providers have considered how to account for externalities in their water charges and the National Competition Council considers that this represents the next stage in urban water reform.
Water Savings Project	All	In April 2003 the Australian government made a call to the public for ideas on how to make substantial water savings in urban, rural and regional Australia. The government has partnered with savewater.com.au to showcase many of the 555 good ideas and technologies shared by Australians.	555 ideas and technologies were submitted.
Voluntary Water Efficiency Labeling Scheme Managed by Water Services Association of Australia (WSSA)	Residential, ICI	The scheme has been in place across Australia since 1988. The WSAA program covers shower heads, toilets, taps, clothes washers, dishwashers, urinal flushing devices and flow regulators.	
WaterWise Australia	All	National program aims to encourage wise use of water by the whole community through educational and promotional strategies across water utilities, water industry organizations and state and local governments.	
Australian Water Conservation and Reuse Research Program (AWCRRP) (Australian Water		The program is divided into 2 stages. Stage 1 reviews the research in a number of fields identified to be critical to wider adoption of water conservation and reuse in Australia (i.e. social acceptance, health and risk assessment, implementing new technology etc). This work	

<p>Association, Commonwealth Scientific and Industrial Research Organization (CSIRO), Cooperative Research Centre (CRC) Water Quality Treatment)</p> <p>The program was founded in 2003 in response to statements in the Senate Inquiry Report on Urban Water Management (2002) recognizing the need for widespread adoption of urban water conservation and reuse.</p>		<p>should be presented in workshops in each state capital in Autumn 2004. The second stage is to identify and initiate a national portfolio of innovative demonstration projects and develop the research program to support those.</p>	
<p>Water Recycling in Australia</p> <p>The Australian Academy of Technological Sciences and Engineering funded by the Australian Research Council</p> <p>Stimulated by the drought in 2001-2003</p>		<p>A research initiative to gather information and develop a report on water recycling in Australia. The resulting report outlines the current extent of water recycling in Australia, encompassing rainwater and stormwater, but with the main emphasis on the extent of treatment and recycling of domestic and industrial wastewater. It discusses a range of issues arising from both international and Australian experience. Suggestions and recommendations are made for the future management and use of recycled water.</p> <p>The paper also directly addresses stage one research goals of the AWCRRP. It forms the initial inventory of water conservation and reuse activities and issues in Australia in the AWCRRP program.</p>	

Sources:

- Australian Government: Department of Environment and Heritage. 2004. Council of Australian Governments Water Reform Framework. [Online]. Available: <http://www.deh.gov.au/water/policy/coag.html> Last updated: June 24 2004
- The Parliament of the Commonwealth of Australia. 2002. The Value of Water: Inquiry into Australia's Management of Urban Water. [Online]. Available: http://www.aph.gov.au/Senate/committee/ecita_ctte/water/report/contents.htm
- Australian Water Conservation and Reuse Research Program. Available: www.clw.csiro.au/priorities/urban/awcrrp
- Water efficiency labeling and standards scheme <http://www.deh.gov.au/water/urban/scheme.html>

NEW SOUTH WALES (NSW) (AU)

Water Supply and Demand Overview

Flows within NSW river systems are extremely variable between seasons and between years. Groundwater is a reliable source of water providing approximately 1 million ML, predominantly for irrigation, every year. Approximately three-quarters of allocated water in the State is assigned for irrigation purposes. Urban and industrial uses are the next largest users of water. In the urban sector, residential use dominates, representing about 57% of the water used in this sector in 1998/99. Commercial uses account for 12%, industrial 10%, institutional and public uses 5% and unaccounted for water amounts to 14%.

Sources:

- NSW Department of Land and Water Conservation. 2000. NSW Water Conservation Strategy 2000. [Online]. Available: http://www.dlwc.nsw.gov.au/care/water/conserv_strategy/wcs.pdf

Water and Related Legislation and Policies

Name	Agency	Description, Roles and Responsibilities
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Legislation and Regulations		
<i>NSW Water Act 1912</i>	Department of Land and Water Conservation	Provides for licensing of water diversions, charging for water and allocation of water. Part 9 of the Act requires Sydney Water Corporation and Hunter Water Corporation to operate under license. Occupiers of riparian land can take water without a license for domestic purposes, including watering stock and non-commercial irrigation. Replaced by <i>Water Management Act 2000</i>
<i>Water Management Act 2000</i>	Department of Infrastructure, Planning and Natural Resources (used to be DLWC)	The aim of the <i>Water Management Act 2000 (the Act)</i> is to provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations. One of the most relevant outcomes of the act concerning water conservation is the requirement of community water management plans. These plans have statutory standing and can address any aspect of water management from water sharing, environmental protection, drainage management etc. Water licenses are linked to this plan, which specifies how water is to be shared in the community. Individuals living within a management plan area are bound to the water-taking rules of the Act, whereas those outside of these areas remain under the Water Act 1912. Water management committees are formally constituted by the Minister and given specific TOR defining the water management area, the nature of the plan required, timeframe for the plan etc. The Act specifies the make up of the committee to ensure a balanced representation of all interest groups and government. Committees must consult with public in development of plans. The plan is effective for 10 years and all public authorities are bound by the plan. At the request of the minister, 36 draft management plans were developed by local water management committees and 31 have since become effective as of July 1 2004. The Act also provides for the establishment of a State Water Management Outcomes Plan (SWMOP) discussed in the policy section. The Water Act also lays out the terms and conditions for the licensing of Irrigation Corporations, private companies that supply water to irrigators. One of the conditions is the adoption of industry best practice through the implementation of Land and Water Management Plans (LWMPs). These plans are developed by community-elected working groups and outline an integrated strategy to overcome current natural resource issues in the community.
<i>Sydney Water Act (1994)</i>	Department of Urban Affairs and Planning	<p><i>Section 17</i> of the <i>Sydney Water Act</i> outlines the terms and conditions associated with the granting, renewal, enforcement etc. of Sydney Water Corporation's operating license. The operating license must be renewed every 5 years. <i>Section 8</i> of the operating license itself spells out the water conservation and demand management requirements of the corporation. As stated, these include:</p> <ul style="list-style-type: none"> ▪ A reduction in the amount of water the corporation draws from all sources to the following water conservation target levels <ul style="list-style-type: none"> ○ 364 litres per capita per day by 2004/5 (28% reduction from the 1990/1991 baseline of 506 L/cap/d) ○ 329 L/cap/d by 2014/2015 ▪ By September 1 each year Sydney Water Corporation must report to the license regulator on its progress in complying with the target ▪ By no later than 1 September each year, Sydney Water must provide a report (the Demand Management Strategy Implementation Report) to the License regulator on implementation of Sydney Water's Demand Management Strategy for the previous 12 months, to enable the regulator to consider and report on the matter as part of the Annual audit ▪ Important components of The Demand Management Strategy Implementation Report include: an estimate of past, current and projected water use by sector, a description of the frequency and magnitude of expected supply deficiencies, conservation measures currently adopted and being practiced, the cost of these, future plans for water reclamation and strategies to alter water use practices, an evaluation of these plans in terms of cost with contrast against the cost of alternative water supplies, an implementation schedule of future conservation actions found to be cost effective. ▪ Sydney Water must take action to re-use, intercept or otherwise prevent from discharge into the ocean, waterways and other waters, sewage or effluent by way of non-potable re-use. Sydney water is to meet the targets set by the Minister (58 megalitres per day) from time to time. ▪ Progress in meeting the target must be reported to the regulator no later than September 1 of each year. ▪ Sydney water, in support of the national water conservation and labeling scheme, is to encourage manufacturers of water appliances to continue to improve water use efficiency and to report on their progress in doing so no later than September 1 of each year.
<i>The Water Administration Act of</i>	Water Administration	Gives the exclusive right to use and control water in river and lakes, water naturally occurring on the surface, groundwater and water stored by works, to the Water

1986	Ministerial Corporation	Administration Ministerial Corporation (operating through the Department of Land and Water Conservation).
<i>The Local Government Act 1993</i>	Department of Local Government	Provides the statutory framework for the provision of water supply, sewerage and stormwater services in urban areas of country NSW.
<i>Water Sewerage and Drainage Regulation Under the Local Government Act</i>	Department of Local Government	Dual-flush toilets are mandatory under this regulation.
<i>Catchment Management Act 2003 (CMA)</i>	Department of Infrastructure, Planning and Natural Resources (DIPNR)	Provides for the creation of Catchment Authorities (statutory bodies) to encourage the protection, restoration and integrated management of natural resources on a catchment basis. Authorities are required to develop catchment action plans, in consideration of public consultations, and to implement these once approved by the Minister. Plans created under this act must be consistent with water management plans created under the <i>Water Management Act</i> and other acts.
<i>Environmental Planning and Assessment Act 1979</i>		Empowers state government and local councils to control activities occurring in a catchment. Activities can be controlled through local environmental plans (LEPs), regional environmental plans (REPs), and state environmental planning policies (SEPPs). REPs in particular are used on a catchment basis. Planning instruments established under this act also have precedence over plans created under the <i>CMA 2003</i> .
Policies and Guidelines		
State Water Management Outcomes Plan (SWMOP)		Sets out the over-arching policy context, targets and strategic outcomes for the development, conservation, management and control of the State's water sources. Targets for water use efficiency are detailed in the SWMOP and include a target specifying that Country town (local water utility) water consumption is to decline by greater than 5 percent per head of population on average Statewide, excluding Sydney Water Corporation and Hunter Water Corporation whose demand management targets are set in their operating licences.
Changing the Way We Think about Water		In March 2003, the Government responded to the imbalance in water supply/demand in its new urban water policy and reaffirmed its commitment to no new dams. The policy has clear implications for the ongoing implementation of Sydney Water's demand management program. The report states that Sydney Water must: <ul style="list-style-type: none"> Continue to invest in demand management and provide programs to low-income households free of charge Work with local councils and industry groups to make water smart buildings compulsory for new developments Provide opportunities to recycle treated wastewater where it is environmentally and economically viable Examine the feasibility of improving demand management by implementing a water-efficiency trading scheme
Farm Dams Policy (1999)		Allows landholders to capture 10% of the average regional rainfall runoff from their land. Replaces a rule allowing landholders to build a dam of up to 7 ML on their property without a license.

Sources:

- NSW Department of Land and Water Conservation. 2001. Water Management Act 2000: What it means for NSW. [Online]. Available: http://www.dlwc.nsw.gov.au/care/water/wml/pdfs/watermanagementact2000_booklet2.pdf
- Department of Land and Water Conservation. 2003. Caring for Our Natural Resources, Water. [Online]. Available: <http://www.dlwc.nsw.gov.au/care/water/>
- 2000. Sydney Water Operating License. [Online]. Available: <http://www.sydneywater.com.au/Publications/>
- Catchment Management Authorities Act 2003. [Online]. Available: <http://www.dlwc.nsw.gov.au/whatsnew/legislation.html>

Water Conservation and Related Program Initiatives

State

Initiative, Lead Agencies and Partners	Sector(s) targeted	Description	Results and Effectiveness
NSW State Water Reform Package		The package included processes to: 1. Improve sharing of water between water users and the environment. Actions	Most of the actions are complete or underway. Many of these are identified and

<p>Department of Land and Water Conservation, Environment Protection Authority, NSW National Parks and Wildlife Services, NSW Fisheries and NSW Agriculture</p> <p>Initiated in response to National COAG Water Reform Framework.</p>		<p>include the establishment of environmental flow rules, the establishment of water management committees and plans for stressed rivers, the development of guidelines to inform water management plans etc.</p> <p>2. Create investment confidence in the rural water sector through clearly defining access rights and expanding the water market. Actions include the separation of water access and use rights, improving water trading opportunities, the establishment of a new farm dams policy, the development of a water conservation strategy for NSW, cost recovery and water pricing requirements for the water industry etc.</p> <p>3. Reshape the relationship between Government and the community in managing water. Actions include the establishment of river management committees, the licensing of Sydney Water and Hunter Water etc.</p>	discussed as separate initiatives in this section.
<p>NSW Water Conservation Strategy 2000</p> <p>NSW Water Conservation Task Force, made up of non-governmental and governmental representatives</p> <p>Initiated as part of state water reform</p>	All	<p>After extensive public consultation, a Water Conservation Strategy was released for the state in 2000. The strategy contains 19 strategies and 55 actions to promote significant improvements in water conservation in NSW.</p> <p>Key government actions include: water allocation and volumetric charges as an incentive to water use efficiency, ensuring adoption of water conservation strategy principles by all government agencies, to encourage irrigators to adopt irrigation and drainage management planning outside of Land and Water Management Plan (LWMP) areas, develop water conservation targets for water suppliers etc.</p>	
<p>Water Reform Structural Adjustment Program (past) (WRSAP)</p> <p>NSW Department of Primary Industries</p>	Agriculture	<p>\$34 million was invested in this 5-year program in 1998. Aimed to assist irrigators to increase the productivity and sustainability of their industry for the long term. Provided practical help for the irrigator in several areas:</p> <ul style="list-style-type: none"> ▪ better decision making, in providing easier access to information, extension and training in best irrigation management practices and technologies through WaterWise on the Farm ▪ redevelopment through financial incentives to irrigators for improved water efficient operations (Water Use Efficiency Incentive Scheme). See below for further details on both of these initiatives. 	
<p>Irrigated Agriculture Water Use Efficiency Incentive Scheme (Past)</p> <p>Initiated as part of NSW government WRSAP</p>	Agriculture	<p>Initiated in 1998 by the NSW government, the scheme provided financial incentives to individual irrigators outside areas covered by Land and Water Management Plans to plan, adopt and monitor best irrigation management practices and water efficient technologies.</p>	<p>The Scheme, which was worth \$25 million and was operational until August 2003, funded water use efficiency improvements on over 500 irrigation farms in New South Wales.</p>
<p>WaterWise NSW</p> <p>WaterWise in the Catchment, Home and Garden are managed by the Department of Infrastructure, Planning and Natural</p>	All	<p>Aims to inform and educate the community on how to use water wisely. WaterWise does this through a range of information and practical materials promoting water conservation, reuse and recycling, which are distributed and promoted in programs implemented by local governments.</p> <p>In NSW, WaterWise is made up of the</p>	

Resources WaterWise on the Farm is managed by NSW Agriculture		following elements: <ul style="list-style-type: none"> • WaterWise in the Catchment • WaterWise in the Home • WaterWise in the Garden • WaterWise on the Farm 	
WaterWise on the Farm NSW Agriculture	Agriculture	Aims to identify, benchmark and document best irrigation management practices, technologies and systems, and through an associated WWF awareness campaign, assist irrigators to identify and adopt methods to improve their on-farm water use efficiency. The communication strategy of the program emphasizes irrigation industry involvement in identification of client needs, barriers to effective communication and methods to increase adoption of management techniques and efficient irrigation technologies. Promotional resources have been prepared for use by irrigator associations that promote the efficient use of agricultural water. The program is gathering momentum in other states and interstate communication is being fostered with a view to establishing a national program.	
Irrigation and Systems Management Project NSW Agriculture	Agriculture	Aims to increase awareness of crop water requirements, to improve irrigation skills, to improve irrigation systems and to promote best irrigation and drainage management techniques.	
NSW Agriculture	Agriculture	NSW Agriculture is also funding providing additional resources to: <ul style="list-style-type: none"> ▪ Document irrigation benchmarks and water use efficiency case studies ▪ Trial field technology for evaluating and monitoring farm water use for furrow irrigation ▪ Evaluate sub-surface irrigation technology for water conservation and efficiency and ▪ Develop water management decision support strategies for dryland cropping and livestock enterprises 	

Sources:

- NSW Department of Land and Water Conservation. 1998. Water Sharing: The Way Forward NSW Progress on the Water Reforms 1995-1998. [Online]. Available: <http://www.dlwc.nsw.gov.au/care/water/wr/pdfs/12.pdf>
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- Department of Infrastructure, Planning and Natural Resources. Be WaterWise. [Online]. Available: <http://www.waterwise.nsw.gov.au/about.html>

Sectoral

Initiative Name, Lead Agencies and Partners	Sector(s) targeted	Description	Results and Effectiveness
Sydney Water Utility Demand Management Strategy Sydney Water Utility To meet water conservation targets laid out in Sydney Water's operating license, the	Connected water users	The program involves a mix of education, incentive, regulation and support approaches. Some of these initiatives are listed here <ul style="list-style-type: none"> ▪ Go Slow on the H2O: outdoor water conservation campaign encouraging customers to adopt water efficient gardening and outdoor water use practices ▪ Rainwater tank rebates ▪ Washing machine rebate 	One in every 7 households in Sydney Water's supply area has participated in the indoor retrofit program, with 34, 588 receiving the retrofit in 2002/3. Water savings are estimated in the range of 20 900 litres per household per year. Average saving of \$30-100 in utility bills per year per

corporation developed a demand management strategy in 1995.		<ul style="list-style-type: none"> ▪ Every drop counts indoor retrofit program: one of the largest residential water efficiency incentive programs offered anywhere in the world. Costs \$22 (retail value \$130) and a licensed plumber installs efficient showerheads, tap-flow regulators, toilet cistern flush arrestors and repairs any minor leaks. ▪ Every drop counts business: ▪ Leakage reduction program ▪ Water recycling: increasing use of recycled water for irrigation schemes at golf clubs, agriculture, University of Western Sydney and some residential areas. Also being used at BHP's Port Kembla steelworks, Sydney Water's largest customer ▪ Support of a number of regulatory measures including pricing for demand management, outdoor water use conditions, appliance rating, labeling and minimum performance standards, urban planning regulation and building codes 	household
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Sources:

- Water Conservation and Recycling Implementation Report 2002-2003. [Online]. Available: <http://www.sydneywater.com.au/Publications/index.cfm#Reports>

VICTORIA (AU)

Water Supply and Demand Overview

Water and Related Legislation and Policies

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Water Act 1989</i>	Department of Sustainability and Environment (DSE)	Establishes water rights and obligations, provides mechanisms for the allocation of water, governs the statutory powers and functions of all water authorities outside the metropolitan area, and provides for integrated management of the water resource and for environmental and consumer protection. <i>Section 8</i> recognizes that individuals adjacent to a watercourse or bore can extract water without a license for domestic and stock use. <i>Section 22</i> outlines the role of the Minister in ensuring that a continuous program of the assessment of water resources of the state is undertaken. The program must provide for the collection, analysis and publication of water availability and use/re-use data amongst other things. The Minister may also set permissible annual extraction volumes for an area. <i>Section 27</i> provides for the establishment of water supply protection areas by the Minister. A committee is appointed and is responsible for drafting a management plan according to Minister guidelines. The management plan may prescribe any number of requirements, including metering and reporting requirements, licensing restrictions, etc. The plan is binding on every person. <i>Section 170A</i> requires water suppliers to prepare and submit permanent water saving plans to the Minister. These plans set out use restrictions or prohibitions. <i>Section 171</i> empowers water suppliers to make by-laws implementing these plans.
<i>Water Industry Act 1994</i>	DSE	Introduces a number of reforms to the Victorian water industry to facilitate its long-term development and to extend the application of commercial practices.
<i>Catchment and Land Protection Act 1994</i>	DSE	Establishes a framework for the integrated management and protection of catchments and outlines processes to encourage and support community participation in the management of land and water resources. The Act also establishes the Victorian Catchment and Land Protection Council, Regional Catchment and Land Protection Boards and the Pest Animal Advisory Committee.
<i>Environmental Protection Act 1970</i>	DSE	Establishes the Environment Protection Authority and makes provision for the Authority's powers, duties and functions. These relate to improving the air, land and

		water environments by managing waters, control of noise and control of pollution.
<i>Melbourne and Metropolitan Board of Works Act 1958 (MMBW)</i>	DSE	This Act creates the MMBW to administer water, sewerage, drainage, flood protection, stream management and development of water resources in the metropolitan and designated areas.
<i>Melbourne Water Corporation Act 1992</i>	DSE	Establishes the Melbourne Water Corporation through the corporatisation of the MMBW. The Act establishes objectives for the Corporation, defines the relationship between the Corporation, the Minister and Parliament, sets out the role of the Corporation's Board of Directors, and makes provision for the monitoring of the Corporation's performance. In the state of Victoria, water services to residential, commercial and industrial customers within the Melbourne metropolitan area are supplied by four state-owned businesses. Melbourne Water, a statutory corporation owned wholly by the state government, is the wholesale supplier of water to these businesses. These businesses also collect sewage for treatment by Melbourne water.
Policies and Guidelines		

Sources:

- Department of Sustainability and Environment. DSE Legislation. Available: <http://www.dse.vic.gov.au/dse/dsencor.nsf/FID/-D4B2460290EC3DA54A2567820022E0C7?OpenDocument>
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Water Conservation and Related Program Initiatives

State

Most utilities are required by law to have drought contingency plans in place. In Victoria, drought contingency plans are being revised across the state, so they are uniform with four different restriction levels.

Initiative, Lead Agencies and Partners	Sector(s) targeted	Description	Results and Effectiveness
Our Water Our Future Department of Sustainability and Environment	All	<p>Goal: In the agricultural sector, the goal is a 25% increase in the efficiency of irrigation water use by 2020. In the domestic sector, the goal is a 15% reduction in the use of drinking water from 1990s levels by 2010.</p> <p>In the urban sector, the government outlines the following actions for increased water efficiency and conservation:</p> <ul style="list-style-type: none"> Preparation of water supply-demand strategies by water authorities. To be prepared every 5 years with a 50 year outlook. Progress reports will be required on an annual basis. Water authorities shall be required to determine water conservation targets for incorporation into strategies. Rising block tariff structures for domestic users in Melbourne starting Oct 1 2004. Implementation of permanent water saving measures by urban water authorities. Recommended measures include lawn watering, car washing, pool filling, construction industry and pavement cleaning restrictions. Implementation of legislation implementing the national water efficiency labeling scheme in 2005. Introduction of mandatory water efficient plumbing measures such as water 	

		<p>conserving showerheads and taps for all new houses and other buildings and all new fittings in existing buildings from July 1 2004.</p> <ul style="list-style-type: none"> Continue to support the Water Smart Gardens and Homes Rebate Scheme Preparation of Water Sensitive Urban Development guidelines to assist developers, local governments etc achieve the govt target for new development to achieve a 25 percent savings in water use. Government will require improved water efficiency in government buildings. All govt departments are currently required to implement EMS, and to report on progress annually. Local water authorities required to work with industry towards improved water management outcomes Water authorities required to report annually on their water conservation programs with industry, and to provide details of water saved Funding will be provided to support the extension of local government water conservation plans across regional Victoria, water authorities will be required to assist in the development of these plans 	
<p>The Victorian Smart Water Fund</p> <p>A joint initiative between the Department of Sustainability and Environment and the four metropolitan water businesses (City West Water, Yarra Valley Water, South East Water and Melbourne Water)</p>		<p>The aim of the fund is to generate and implement ideas on saving or recycling water.</p>	
<p>Water Smart Gardens and Homes Rebate Scheme</p> <p>The rebates scheme is administered by the Victorian water businesses on behalf of the Government, in partnership with the Department of Sustainability and Environment.</p>	Residential	<p>The Victorian government has committed \$10 million over the next four years to a water conservation rebate program for the garden and home. Water efficient products eligible under the scheme are marked with a special label and include products like rainwater tanks with connection to toilet, grey water systems, washing machines, dishwashers, efficient dual flush toilets, shower heads, high pressure cleaning devices, water conservation home audits, and a basket of garden products including mulch, flow control valves, wetting/moisture agent, moisture/rain sensor, garden tap timer, drip watering system etc.</p>	<p>Since it commenced in January 2003 more than 63, 000 rebates have been approved. During October and November 2003 alone, over 13, 600 rebates were provided to customers for the purchase of water efficient washing machines. Estimated savings from the uptake of water saving products through the program is in the order of 680 megalitres per year.</p>
<p>Water Conservation Assistance Pilot Project</p> <p>The program is administered and funded through local government-owned water suppliers.</p>		<p>This program is designed to provide a means to increase the participation of low income Victorians to participate in water conservation. The program provides a one-off grant of \$500 for the assessment, repair, maintenance and replacement of water related plumbing fixture in homes in six nominated local government areas over a two year time period. You must be the holder of a specific type of concession card to be eligible.</p>	
<p>The Savewater Alliance</p>	Residential, Institutional, Commercial, Industry	<p>The alliance is not-for-profit and aims to accelerate water conservation behaviour change and product purchasing preferences in line with Government and water industry</p>	

Conceived and developed by Yarra Valley Water, a government owned water company, and the Centre for Design at RMIT University.		<p>needs. The alliance carries out the following functions:</p> <ul style="list-style-type: none"> Manages the savewater.com.au website Conducts major water conservation exhibitions like the various state Home Shows and Royal Agricultural Shows on behalf of Government and suppliers Manages the savewater! Awards in Victoria Undertakes programs like the savewater! efficiency service for businesses and schools, the ongoing savewater! competitions and prize giveaways and various other marketing activities <p>Savewater! initiatives are designed to:</p> <ul style="list-style-type: none"> Provide independent expert advice Provide a one-stop shop for information on water conservation Provide access to water conserving products Present real life examples of water conservation in action Encourage use of local knowledge, experience and products 	
<p>Permanent Water Saving Plan</p> <p>Drafted by Yarra Water Authority</p>	Residential, Institutional, Commercial, Industry	<p>The following restrictions are identified::</p> <p>Private gardens and lawns</p> <ul style="list-style-type: none"> A watering system must not be used to water a garden or lawn except between the hours of 8 pm and 8 am All automatic water systems installed from 1 December 2004 must be fitted with either a rain sensor or soil moisture sensor as part of the control system All existing automatic watering systems must be fitted with either a rain sensor or soil moisture sensor as part of the control system by 1 December 2005 A hand-held hose fitted with a trigger nozzle, a watering can or a bucket can be used at any time <p>Motor Vehicle cleaning</p> <ul style="list-style-type: none"> A hose used to clean a vehicle by hand must be fitted with a trigger nozzle <p>Paved Areas – cleaning</p> <ul style="list-style-type: none"> A paved area must not be cleaned with water from a hose unless cleaning is required as a result of: <ul style="list-style-type: none"> An accident, fire, health hazard etc. <p>Swimming pools</p> <ul style="list-style-type: none"> Before a pool or spa with the capacity of 2000 litres or greater is filled for the first time, an application which includes details of measures that will be undertaken to provide water savings to offset the volumes used in filling, must be lodged with and approved by the water authority. <p>A person may apply to the authority for temporary or permanent exemptions from these restrictions, however, exemptions shall only be granted under special circumstances identified in the plan. Penalties for non-compliance, including fines and imprisonment, are also outlined.</p>	<p>The next step is for Melbourne's three water retailers (Yarra Valley Water, South East Water and City West Water) to review their <i>Permanent Water Saving Plans</i>, taking into consideration the feedback received. Once the Plans have been finalized, they will then be submitted to the Minister for Water for approval.</p>
Werribee Irrigation District Recycled Water Scheme	Agriculture	Melbourne's largest commercial recycled water project aims to provide a sustainable future for both Werribee vegetable growers and the natural environment. The project will deliver	

Project team consists of members from Melbourne Water, Southern Rural Water, the Department of Sustainability and Environment and the Department of Primary Industries. EPA Victoria and the Department of Human Services are also involved to assist in providing advice regarding compliance with extensive state guidelines.		up to 10 600 million litres of Class A recycled water from Melbourne Water's Western Treatment Plant (classified safe for use on irrigation for food crops) a year to more than 100 farmers in the area. The project will increase the reliability of water supply for local growers and has significant environment benefits to the area. The recycled water is scheduled to begin flowing at the end of October 2004.	
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Sources:

- Department of Sustainability and Environment. 2004. Securing Our Water Future Together. Our Water Our Future [Online]. Available: <http://www.dse.vic.gov.au/dse/nrenlwm.nsf/LinkView/BF55F9AC10B3871FCA256EA200255F883018EEC1F535E3A84A2567D7000B1794>
- Department of Sustainability and Environment. Water Conservation Assistance Pilot Program. [Online]. Available: <http://www.ourwater.vic.gov.au/ourwater/pilotprogram.htm>
- Blake Dawson Waldron Lawyers. 2004. Draft Permanent Water Saving Plan for Yarra Valley Water. [Online]. Available: http://www.yvw.com.au/NR/rdonlyres/7EF3A090-720B-403E-9AD5-EB4C88092CE8/0/PermanentWaterSavingPlan_YVW_9November2004.pdf
- Melbourne Water. Werribee Irrigation District Recycled Water Project. [Online]. Available: http://www.melbournewater.com.au/system/mainFrameset.asp?path=/current_projects/current_projects.asp

EUROPEAN UNION (EU)

Water Supply and Demand Overview

The European Environment Agency (EEA) reports that less than one quarter of Europe's average annual renewable supply is abstracted. At the same time, water availability varies dramatically among countries. Annual average runoff from rain ranges from 3,000 mm in western Norway to less than 25 mm in southern and central Spain. Large areas of Eastern Europe see only 100 mm of rainfall runoff in a typical year. Freshwater availability per capita is generally lowest in the Eastern European and Mediterranean countries and highest in the Scandinavian countries.

Large areas of Europe have experienced recurring droughts over the past 50 years. The more severe and prolonged droughts of recent years have alerted governments, the public and business of the need to take stronger and more coordinated mitigative action.

The average distribution of water use by sector across all European nations is:

- All forms of power production and industrial cooling – 38%
- Agriculture – 30%
- Public Supply – 18%
- Industrial non-cooling uses – 14%

Sources:

- European Environment Agency. 2000. Sustainable Use of Europe's Water: State, Prospects and Issues. Environmental Assessment Series Report No. 7.

Water and Related Legislation and Policies

Historically, water management practices have varied widely among European countries. In more recent years, a series of EU-driven Water Management Frameworks have started to consolidate water management on a basin or catchment level and harmonize state policies and practices. The frameworks address both quality and quantity issues.

Name	Agency	Description, Roles and Responsibilities
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Legislation and Regulations		
<i>Integrated Pollution Prevention and Control Directive (1996)</i>		<p>Sets out a common set of permitting rules for industrial installations in the EU. All installations identified in Annex 1 of the directive are required to obtain a permit from the relevant authority. Without this permit the installation is not allowed to operate. With the intention of minimizing pollution and achieving a high level of environmental protection as a whole, permits must be based on the concept of Best Available Techniques (BAT).</p> <p>Water use efficiency is an important component of BAT. Best Available Techniques are identified through an exchange of information between member states and the industries concerned, organized by the European Commission. This exchange of information occurs within Technical Working Groups, comprised of nominated experts from EU Member States, European Free Trade Association countries, Accession countries, industry and environmental NGOs. Through this process, BAT reference documents (BREFS) are produced following a predetermined BREF outline and guide. Member states must take these reference documents into account when determining best available techniques generally or in specific cases.</p> <p>The directive applies to new or substantially changed installations outlined in its Annex 1, with effect from October 1999 and no later than October 2007 for existing installations.</p>
<i>Water Framework Directive (2000)</i>		<p>Aims to: protect and improve the quality of aquatic ecosystems, promote sustainable water use based on water management for the long term and to ensure that the right amount of water is available where and when it is needed. The directive is legally binding and is applicable to all waters in Europe. It identifies the river basin as the management unit and requires the development of a "river basin management plan" for every basin unit in the EU. This plan must be updated every 6 years.</p> <p>In accordance with the Directive, river basin plans must outline the water quality and quantity objectives of the basin. Plans must include an analysis of the river basin's characteristics, a review of the impact of human activity on the status of waters in the basin, an estimate of the effect of existing legislation on these waters, a description of "gaps" in current management strategies that may hinder the achievement of river basin objectives; and a detailed action plan for bridging these gaps and achieving the objectives. One additional component is that an economic analysis of water use within the river basin must be carried out. It is essential that all interested parties are fully involved in this discussion, and indeed in the preparation of the river basin management plan as a whole.</p> <p>Although the primary objective of the Directive is to clean up European waters, and to keep them clean, the maintenance of water quantity in river basins will play an important role in achieving enhanced water quality. Concerning water conservation, the cost-recovery pricing requirement of the Directive is considered an important driver. Member states will be required to ensure that the price charged to water consumers - such as for the abstraction and distribution of fresh water and the collection and treatment of wastewater - reflects the true costs including environmental protection costs.</p>
Policies and Guidelines		
<i>EU Common Agricultural Policy</i>		<p>The aim is to provide farmers with a reasonable standard of living and to provide consumers with quality food at fair prices. Key concepts of the policy are food safety, preservation of the rural environment and value for money.</p> <p>The Common Agricultural Policy is increasingly moving towards direct payments to farmers as the best way of guaranteeing farm incomes, food safety and quality, and environmentally sustainable production. Eligibility for these payments is linked to compliance with rules on the environment, animal welfare, hygiene standards and preservation of the countryside. Many of these rules are outlined in the Council Regulation (EC) No 1257/1999 of 17 May 1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) and amending and repealing certain Regulations [Official Journal L 160 of 26.06.1999]. The aim of this regulation is to promote farming methods that are compatible with environmental protection, environmental planning in farming practice, the conservation of farmed environments with high natural value and the upkeep of the landscape. To do this financial support may be granted to farmers who, for at least five years, use agricultural production methods designed to protect the environment and maintain the countryside (agri-environment).</p>

		Aid is calculated on the basis of income forgone, additional costs and the financial incentive needed to encourage farmers to make agri-environmental undertakings. However, such aid may not exceed EUR 600 for annual crops and EUR 900 for specialized perennial crops. Aid for all other land uses may not exceed EUR 450 per hectare per year.
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Sources:

- IPPC. Available: <http://europa.eu.int/comm/environment/ippc/index.htm>
- European Commission. 2003. Introduction to the new EU Water Directive Framework. [Online]. Available: <http://europa.eu.int/comm/environment/water/water-framework/overview.html>
- EEA. 2000. Sustainable Use of Europe's Water?

ENGLAND AND WALES

Water Supply and Demand Overview

The Water Resources for the Future publication concludes that water is a scarce resource in much of England and Wales. Despite perceptions that England and Wales is quite wet, the climate is naturally extremely variable and the country often suffers from extreme climatic events such as floods and droughts. Another important factor is that of population. Government projections indicate an increase of 3.3 million households in England and Wales between 1996 and 2016, and the total population is set to increase by 2.8 million over the same period. This leaves relatively little water available to each person. In fact, it is estimated that up to 700 Ml/d of current licensed abstractions must be recovered. In most agricultural areas, little summer water is available.

Abstraction for public water supply by far outweighs any other use (45.4% of abstracted water). Electricity generation is next at 32.1%. Direct abstraction by industry (supplied by public water supply) accounts for 7.7% of abstracted water. Abstraction by industry is fairly evenly split between public water supply sources (typically used in-process and in building themselves) and direct abstraction sources (used for by primary industry and in manufacturing sector for cooling processes).

Sources:

- Environment Agency. 2001. Water Resources for the Future: A Strategy for England and Wales. [Online]. Available: <http://www.environment-agency.gov.uk/subjects/waterres/137651/?version=1&lang=e>

Water and Related Legislation and Policies

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>Water Resources Act (1991)</i>	Environment Agency	<p>Under this Act, the Environment Agency regulates the abstraction and impounding of water. A license is required for almost all water takings, although some uses are exempt. Section 201 gives the agency power to require abstractors to provide information on the abstraction. License holders for most significant abstractions are required to monitor and report abstracted volumes regularly to the agency.</p> <p>In addition to authorizing water abstraction and impoundment licenses, the agency is also responsible for monitoring and enforcing them, for setting out the agency's plan for managing the abstraction region of each catchment in the Catchment Abstraction Management Strategies process, setting out the agency's role for managing droughts, regularly reviewing water company water resource plans and drought plans, setting out the agency's vision for the long term management of water resources in each Region, and setting out the agency's vision for the long term management of water resources throughout England and Wales.</p> <p>The Water Demand Management (WDM) Department of the Environment Agency deals specifically with the science and practice of water demand management in England and Wales. Its mission is to: provide a focus for information and expertise to ensure acceptance of water conservation throughout society. It provides technical and practical advice to both the Environment Agency and external bodies. The activities of WDM fall under four broad categories: advice, promotion, technical development and research. WDM works closely with key players in the national and international water industry, including the Government, water</p>

		companies, regulators, universities and academics, and trade bodies. WDM also supports policy-makers in the Agency's Head Office Water Resources Team.
<i>Water Act (2003)</i>	Environment Agency	<p>Incorporates a stronger conservation ethic than the Water Resources Act of 1991.</p> <p>Sections 81 to 83 of the Act outline water conservation requirements. These clauses are summarized here:</p> <p>81: Duty to encourage water conservation</p> <p>The relevant authority (in England this is the Secretary of State, in Wales it is the Assembly) must, where appropriate, take steps to encourage the conservation of water. After the period of three years beginning with the date on which this section comes into force, and after each succeeding period of three years, the Secretary of State must prepare a report about the steps taken by him under this section, and about any steps which he proposes to take. This report must be laid before Parliament.</p> <p>82: Water conservation: requirements of relevant undertakers.</p> <p>Water companies are now required by law to demonstrate water conservation.</p> <p>83: Water conservation by public authorities</p> <p>In exercising its functions and conducting its affairs, each public authority shall take into account, where relevant, the desirability of conserving water supplied or to be supplied to premises.</p> <p>Public water supply in England and Wales is provided by private water companies.</p> <p>Under the Act, water companies are responsible for:</p> <ul style="list-style-type: none"> ▪ Water resource plans, that outline how the company intends to manage water resources over the next 25 years, submitted to the Environment Agency and reviewed annually ▪ Drought plans outlining the various responses to different drought situations ▪ Promoting the efficient use of water to its customers <p>In particularly sensitive environments, the law also allows the authorities to set lower minimum exemption thresholds than the standard of 20m3/day. If existing licenses are determined to be damaging the environment, the authorities may vary or revoke the license with out compensation (after 2012).</p>
<i>Water Industry Act (1991)</i>		<p>Economic regulation of water companies is carried out by the Director General of Water Services through the Office of Water Services (OFWAT). The Director's general duties are laid out in <i>Section 2</i> of the Act. OFWAT requires water companies to produce plans outlining how they are going to manage their water supply systems and the Director General sets the prices companies can charge to their customers for water supply. This is necessary so that companies have the income they need to carry out the parts of the plans the Director General considers to be justified, including water conservation and efficiency actions.</p> <p>Prices are reviewed every 5 years. 2004 is a year of periodic review. By November of this year OFWAT will publish price limits for the period 2005-2010.</p>
<i>Water Supply (Water Fittings) Regulations 1999 under the Water Industry Act</i>		<p>Local water by-laws have been replaced by these regulations. Made under section 74 of the <i>Water Industry Act</i>, the regulations set requirements for the design, installation and maintenance of plumbing systems and water fittings with the objective of <i>preventing the waste, misuse, undue consumption, contamination and erroneous measurement of drinking water</i>. They are enforced by water companies in their respective areas of supply.</p> <p>The Regulations set minimum standards for the water consumption of Water Closets (WCs), washing machines, dishwashers and washer driers. They also contain requirements to ensure the durability and leak tightness of water fittings and guidance on minimizing the length of pipe runs to reduce the run-off necessary to get hot or cold water at the tap. The Regulations reduced the maximum flush volume of new WCs to 6 litres (a reduction of 20%) and permitted more efficient dual flush systems. In 2001 a performance specification for WC suites was introduced, with which all newly installed suites must comply.</p>
<i>Environment Act 1995</i>		<p>Promotes the conservation and enhancement of the natural environment. Placed a duty on water companies to promote the efficient use of water by their customers. This duty is enforced by the Director General of Water Services. <i>Section 41</i> allows for the application of annual abstraction charges.</p>

Policies and Guidelines		
Directing the Flow – Priorities for Future Water Policy	Department for Environment, Food and Rural Affairs (DEFRA)	<p>Policies outlined in this document that are particularly relevant to water conservation and efficient use include the following:</p> <p>4.63: We will continue to use the twin track approach of demand management and development of resources to achieve sustainable management of water resources. Many actions for water conservation and efficient use of water in England and Wales are set out in the document.</p>
Initial guidance from the Secretary of State to the Director General of Water Services 2004 periodic review of water price limits	DEFRA	<p>Policies that cover the fourth periodic review of water company prices are published in this document. Some of the policies intended to guide water companies on the principles their water resources plans should be founded upon, and which are relevant to water conservation and efficient use are outlined here:</p> <p>All companies should maintain adequate security of supply, but during droughts customers should be expected to reduce their demand for non-essential uses.</p> <p>Government expects the management of water resources to follow the “twin track” approach of managing demand and developing sustainable water resources where needed. Companies should look first at the full range of possibilities for reducing demand for water, including reducing their own leakage and helping customers to reduce demands. Only where demand management is clearly insufficient or unjustified in terms of cost should companies decide to develop new resources.</p> <p>Government believes that increased water efficiency will be necessary, and water companies are expected to promote water efficiency to their customers “with vigour, imagination and enthusiasm”. Government expects companies to set themselves realistic but challenging water efficiency targets.</p> <p>Water metering has a role to play alongside other measures in managing demand; companies have opportunities to use metering to influence demand once measured charges are the established basis of charging for a property.</p>
Water Resources Planning Guideline	Environment Agency	Sets out the framework for water company resource plans, required by the Water Act 2003.
Drought Plan Guideline	Environment Agency	Sets out the framework for water company drought contingency plans, as required by the Water Act 2003.

Sources:

- Environment Agency. 2004. Water Conservation in Force. Demand Management Bulletin, issue 65. [Online]. Available: www.environment-agency.gov.uk/savewater
- DEFRA. (2002). Water Supply (Water Fittings) Regulations 1999. <http://www.defra.gov.uk/environment/water/industry/wsregs99/index.htm> Last modified 2004.
- Department for Environment, Food and Rural Affairs. 2002. Directing the Flow: Priorities for Future Water Policy. [Online]. Available: <http://www.defra.gov.uk/environment/water/strategy/>
- DEFRA. 2003. Initial Guidance from the Secretary of State to the Director General of Water Services 2004 Periodic Review of Water Price Limits. [Online]. Available: <http://www.defra.gov.uk/environment/water/industry/review/>
- Environment Agency and Ofwat. 2003. Water Resources Planning Guideline. [Online]. Available: http://www.environment-agency.gov.uk/subjects/waterres/408371/481122/?version=1&lang=_e
- Environment Agency. 2002. Drought Plan Guideline. [Online]. Available: <http://www.environment-agency.gov.uk/commondata/105385/dplans.pdf>
- EEA. 2000.

Water Conservation and Related Program Initiatives

National

All ICI customers are metered, 20% of domestic properties are metered.

Initiative, Lead Agencies and Partners	Sector(s) targeted	Description	Results and Effectiveness
Water Resources for the Future – A Strategy for England and Wales (2001) Environment Agency	All	The strategy looks some 25 years ahead and is based on forecasts of water demand and supply under four different socio-economic scenarios. A variety of different supply management and demand management actions are evaluated using a risk and uncertainty framework, a sustainability appraisal and	

		<p>a costing exercise, and a set of specific actions are recommended for the long term. Specific water efficiency and water use minimization recommended actions include:</p> <ul style="list-style-type: none"> ▪ Active promotion of water conservation and efficiency by water companies to ICI customers ▪ Increased metering of households and application of tariffs that encourage water efficiency ▪ Encouragement of farmers to adopt good practice in water use around the farm ▪ Agency dialogue with supermarkets and food processors to encourage understanding and consideration of their crop requirements on farmers use and management of water resources 	
<p>Catchment Abstraction Management Strategies (CAMS)</p> <p>Environment Agency</p>	All	<p>Launched in April 2001, the CAMS process sets out a six-year programme to develop a CAMS for every catchment in England and Wales. The document 'Managing Water Abstraction' provides a national framework for the CAMS process. CAMS will be produced on a six-year cycle, to correspond with the EU Water Framework Directive, which requires the preparation of River Basin Management Plans on a six-year cycle. The process is based on the development of a water budget for each of the designated catchments, and a sustainability appraisal of potential management options, with the objective of quantifying the water available for sustainable abstraction.</p>	
(The Environment Agency)	All	<p>The agency has published a number of guides, bulletins and resource materials focusing on water conservation in a variety of different sectors. These include:</p> <ul style="list-style-type: none"> ▪ The Demand Management Bulletin ▪ Harvesting Rainwater for Domestic Users, 2003 ▪ Waterwise on the Farm: A Simple Guide to Implementing a Water Management Plan, 2002 ▪ Waterwise: Good for Business and Good for the Environment, 2001 ▪ Conserving Water in Buildings, 2001 	
<p>Savewater – the hotels water efficiency project</p> <p>Environment Agency</p>	Commercial	<p>The project, involving eight hotels, ran between June 2000 and April 2003. In the first stage of the project, the hotels received free water audits to identify problem areas. Common problems included leaking taps, wasteful toilet flushes, taps left running and weak showers. Water meters were then installed in each hotel, and water consumption was recorded for a year. A year later, repairs were carried out and water-saving devices installed. After another year's monitoring, the team calculated the amount of water saved.</p>	<p>Each of the eight hotels in the project cut its water-use by an average of 25 per cent per day per guest. In six of the hotels, overall water consumption fell, in spite of occupancy increases of up to 70 per cent. These figures translated into financial savings ranging from £139 to £1,605.</p>
<p>The Water Efficiency Awards</p> <p>Environment Agency</p>	Agricultural, commercial, industry, community, public	<p>The water efficiency awards recognize, highlight and celebrate good practice in water conservation in the various sectors. The first awards ceremony was held in 2001, and a competition has been held every two years since.</p>	
<p>Envirowise</p> <p>Envirowise is jointly funded by Department of Trade and Industry (DTI) and</p>	Commercial, industry	<p>Offers free advice and support to businesses and organizations concerning waste minimization, water efficiency, energy efficiency and pollution abatement etc. Its objective is to help make UK business more competitive and profitable. Program components include:</p>	

Department of Environment, Transport and Regions (DETR) and is run on behalf of the Departments by the partnership of AEA Technology plc and NPL Management Ltd.		<ul style="list-style-type: none"> A national help-line (free) The dissemination of authenticated examples of technology and techniques suitable for replication in industry and commerce through the publication of guides and case studies Organization of workshops, seminars On-site consultancy for SMEs <p>Envirowise has also recently launched the Big Splash campaign, challenging UK businesses to save £10 million from water bills by March 2005. Companies register to receive free support from Envirowise, which includes an on-site visit to review water use, water minimization workshops, on-line support and free helpline, and an Envirowise "buddy" to help with questions. The campaign is scheduled to end March 31 2005.</p>	
The Water Technology List DEFRA and Inland Revenue, in partnership with Envirowise	Commercial, Industry	The list identifies products that encourage sustainable water use and rewards businesses that invest in them. Businesses investing in the products on the Water Technology List can claim tax relief through the Enhanced Capital Allowance (ECA) scheme, which may provide a cash flow boost. Businesses can offset 100% of the cost of products on the Water Technology List against their taxable profits. All businesses that pay corporation and income tax in the UK are eligible for the tax allowance.	
England Rural Development Programme (ERDP): The Rural Enterprise Scheme (RES) Funding for the scheme is provided through national and EU money.	Agriculture	<p>The RES is part of the ERDP, which provides the framework for the use of EU Common Agricultural Policy funding for agri-environment, forestry and other rural development objectives.</p> <p>The RES provides targeted financial assistance to support the development of more sustainable, diversified and enterprising rural economies and communities. The scheme covers a broad range of potentially eligible activities, however, a specific project category is that of Agricultural Water Resources Management. The following activities in this category are eligible:</p> <ul style="list-style-type: none"> The construction of reservoirs for the collection and storage of winter rainfall for subsequent agricultural use Fixed piping and pumps associated with a new reservoir to provide the core distribution network Other systems to provide sustainable agricultural water resource management whilst providing environmental benefits <p>Mainstream agricultural equipment closely associated with production such as irrigators and other irrigation equipment, is not funded.</p>	
The Market Transformation Program	All	The Market Transformation Program is an initiative that researches, identifies and promotes products using less energy, water and other resources. The program supports a structured, public domain sector review process, conducted in partnership with business, consumers, experts and other bodies. The Internet is used to encourage public awareness and scrutiny of current policy thinking.	
The Watermark Project Watermark is a government-funded initiative	Public sector	The objective of this project has been to develop water consumption benchmarks across the range of building categories in the public sector. Since April 2000 the Watermark team has carried out a massive data gathering exercise in conjunction with a large number of public sector organizations, including the Department for Transport, Local Government and	As the benchmarking analysis was carried out the potential saving figures were calculated, based on an estimated number of sites in each building category. It is

The project was initiated in response to a lack of data on water consumption benchmarks in the public sector, making the setting of performance indicators and targets very unreliable.		the Regions and the Department for Education and Skills (DTLR, DfES), Wiltshire county Council and with the support of the Sustainable Development Unit of DEFRA. Water consumption data was collected and organizations were asked to complete site-specific questionnaires. Over 3000 questionnaires were submitted allowing the project to set benchmarks for 17 different building categories, including general office buildings through to prisons and laboratories.	estimated that if all sites within the relevant building categories were to achieve or better the recommended benchmark more than £140 million could be saved per annum!
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Sources:

- Environment Agency. 2002. Managing Water Abstraction: The Catchment Abstraction Management Strategy Process. [Online]. Available: http://www.environment-agency.gov.uk/subjects/waterres/564321/309477/321271/?lang=_e
- Environment Agency. 2004. Savewater: The Hotel Water Efficiency Project. [Online]. Available: http://www.environment-agency.gov.uk/subjects/waterres/286587/651262/?version=1&lang=_e
- Water Efficiency Awards. Available: http://www.environment-agency.gov.uk/subjects/waterres/286587/487004/?version=1&lang=_e
- Envirowise. Available: www.envirowise.gov.uk
- Water Technology List. Available: www.eca-water.gov.uk
- DEFRA. 2004. Rural Enterprise Scheme: Guidance Notes for Applicants. [Online]. Available: <http://www.defra.gov.uk/corporate/regulat/forms/erdp/res/guidance.pdf>
- DEFRA. The Market Transformation Program. Available: <http://www.mtprog.com/Index.aspx>
- 2003. Watermark scoops ISB efficiency award. [Online]. Available: http://www.ogc.gov.uk/embedded_object.asp?docid=1000810

Sectoral

In compliance with their statutory duty to promote the efficient use of water to customers, water companies are pursuing a variety of conservation strategies. Water resource plans were first developed by water companies in 1999. On an annual basis since this time, companies have submitted water supply and demand info to the Environment Agency. This is to enable the Agency to quickly spot any emerging issues and discuss these with companies. By April 2004, Water companies were required to submit new water resource plans for the 2004 periodic review. These plans are evaluated by the Agency to ensure that companies are making adequate provision for their customers' needs in a way that is environmentally and economically sustainable. Ofwat uses the plans in assessing the supply/demand balance and quality enhancement elements of price limits for water companies.

Water companies were requested by Government to agree drought plans with the Environment Agency by the end of March 2000. All the water companies of England and Wales have produced these plans. This was the first time companies had produced these plans in a consistent format, and for external review.

Despite the efforts identified here and in the matrix below, however, many questions remain concerning the effectiveness of measures undertaken within a privatized industry. In her book, *The Meaning of Water*, Veronica Strang discusses the inherent conflict of interest in the privatized water industry, suggesting that, "water users are unlikely to limit their usage or accept vastly increased water charges from a privatized industry," and that in the end the only solution to increased water efficiency is to "reconsider public ownership in some form".

Initiative, Lead Agencies and Partners	Sector(s) targeted	Description	Results and Effectiveness
Water Company Initiatives in England and Wales	All	Nine companies are currently involved in a study looking at different controls that can be attached to toilets to help reduce the amount of water used in a single flush. The results are expected to assist companies to prepare for larger studies of the sustainability of savings and logistics of free water-saving devices. All water companies have customer awareness campaigns, targeting various users, and supported by leaflets, press campaigns and offers of free water-saving	Despite these efforts, in the Environment Agency's advice to Ministers on the final water company resource plans, it is reported that, "we are concerned that many plans are still dominated by resource development..." and that "these plans underestimate the role that demand management can

		devices. Many companies offer free water efficiency advice and/or audits to commercial users.	play in managing water resources for the next 25 years."

Sources:

- Environment Agency. 2004. The Meaning of Water. *In* Demand Management Bulletin, Issue 66

FRANCE

Water Supply and Demand Overview

France's average renewable water supply is estimated to be about 191 billion m³/year. The country's five largest rivers - Seine, Rhone, Rhine, Loire, and Garonne - account for 65% of annual discharge. The natural water storage capacity in the nation is exceptional due to mountainous regions and large underground water tables, providing potential resources of 3600 m³/per inhabitant/year.

Per capita water consumption in France is estimated at 150-200 L/day. Sixty percent of the demand for drinking water is satisfied by ground water (94% of the 33,250 drinking water catchments are of underground origin), 30% by surface water and 10% a mix of ground and surface water. With rain hardly falling below 600 mm per year in the least watered areas of France, providing up to 100 km³ of water available for the taking each year, it is not surprising that France is considered a water rich nation.

Total freshwater withdrawals were estimated to amount to 32 billion m³ / yr in 1999 with 85% coming from surface water sources. Distribution by major sector was:

- Thermal-electric power production: 19.2 billion m³ (60%)
- Agriculture: 3.8 billion m³ (12%)
- Public water supply: 5.8 billion m³ (18%)
- Industry: 3.2 billion m³ (10%)

The volume of these takings not returned to the aquatic environment (total net consumption) in the same year was estimated to be about 4 billion m³ (approximately 12.5%). Consumptive water use is divided as follows between the following sectors:

Agriculture (irrigation): 68%
Food and drinking water: 24%
Industry: 5% (mainly food processing, pulp and paper, metallurgy)
Power: 3%

In spite of the perceived abundance of supply, recent hot and dry summers in France have raised serious water quantity concerns. The summer of 2003 in particular lead 77 regional water departments to implement measures limiting water takings; an effort never experienced before in France. Up until this time, no real drought management planning or guidance had been developed.

The use of water for irrigation purposes also continues to increase in France, further straining low water levels in summer months. In the Adour-Garonne river basin, abstraction for irrigation purposes has been on the rising trend, with +75% between 1981 and 1994. The French Institute for Environment has recorded that the irrigated land surface in France has tripled in 25 years – 539 000 ha in 1970 to 1 620 000 ha in 1995. This increase has been most significant in the western and southwestern parts of France.

Sources:

- Agence de l'eau. [Online]. Available: <http://www.eaufrance.com/uk/eau/phys.php?lien=1>
- Agence de l'eau. [Online]. Available: <http://www.eaufrance.com/uk/eau/donne.php?lien=2>
- European Commission General Directorate XVI and the Institute for Prospective Technological Studies. Towards a Sustainable/Strategic Management of Water Resources: Evaluation of Present Policies and Orientation for the Future. [Online]. Available: <http://www.fao.org/iccd/object/doc/sustwater.htm>
- European Environment Agency. 2000. Sustainable Use of Europe's Water? State Prospects and Issues. Env. Assessment Series, No. 7.

Water and Related Legislation and Policies

The role of the state in water management is limited to water law enforcement (withdrawal and discharge authorizations) and to guarantee public health and safety. Communities are responsible for organizing potable water supply and storm and wastewater collection and treatment. These communities may either entrust the management of these services to a private industry, or manage them directly through the creation of a Water Authority. The majority of potable water supply in France (75%) is managed by private industry.

The Environment Ministry, more specifically its Water Department, looks after:

- Knowledge, protection, management and upgrading of aquatic environments and river systems,
- Water protection,
- Programming and coordination of State intervention in the sectors of water, fresh water fishing and aquatic environments,
- Policing the waters and policing fresh water fishing.

Many of these responsibilities are carried out through decentralized regional Ministry offices, known as Regional Environment Divisions (DIREN). Regional offices play a major role in the water sector, ensuring implementation of European Community and National legislation with regard to water and assuming a policing role in the management and development of water resources.

Other state ministries with water management responsibilities include:

- Departmental Directorates of Agriculture and Forests (DDAF)
- Departmental Directorates of (Community) Facilities (DDE)
- Departmental Directorates of Health and Social Affairs (DDASS)

Once again, the regional directorates of these departments carry out the relevant actions at the local level.

These departmental and/or regional agencies are also responsible for reviewing and authorizing water withdrawals applications.

Source:

- Agences de l'eau. [Online]. Available: <http://www.eaufrance.com/uk/agences/parten.php>

EU Directives

Name	Agency	Description, Roles and Responsibilities
Legislation and Regulations		
<i>The Water Law (1992)</i>	Environment Ministry	<p>Originally established in 1967 in response to water pollution concerns. The river basin was identified as the ideal unit for identifying and responding to pollution. Six great hydrographic catchment areas were identified and the river basin committee and water agency were created. All withdrawal of water for non-domestic purposes must be authorized.</p> <p>The river basin committee is made up of as many as 200 elected stakeholders, including state government representatives, local government and other water users. Its role is to consult with regional and local councils to determine the water management objectives in the basin (the water policy), to develop and approve the SDAGE for the basin, approve the Water Agency intervention programme and to monitor the implementation of the basin plan.</p> <p>A financially independent state water agency within each basin is responsible for implementing the policy defined by the basin committee. These agencies offer technical advice to elected representatives, industry and farmers and provide financial aid for the works necessary to fight water pollution and to protect water resources. Funds are raised by charging all water users for the volume of water extracted, and for any pollution caused by their operations. These funds are then reallocated in the form of financial aid (loans, subsidies) to local communities, industry and farmers for works to be undertaken. The eligibility of projects for funding is dependent upon the priorities of the current 5-year plan.</p>

		<p>The 1992 amended law requires the development of master water management and development plans (SDAGEs) for each of the large basins. These plans set the general trends for 10-15 years to be followed in the management and protection of water and aquatic environment resources in the basin.</p> <p>Each SDAGE adopts all the obligations laid down by the law, and by European directives and takes account of State programmes in progress. The SDAGE also outlines quantitative and qualitative objectives for the water, minimum regulations for physical and technical coherence at basin level and defines the guidelines for the development of local water improvement and management plans (SAGES). These objectives are identified through the development of water budgets or atlases for the basin outlining the state and condition of the resource, its uses and the ecosystem.</p> <p>Water improvement and management plans (SAGES) are another recommended component of the Law, to be developed at the sub-watershed level after the development and implementation of the master plan. Local water commissions, made up of community representatives, user representatives and state representatives, prepare and implement the scheme. These plans set quality objectives and timetables, allocate water between categories of users, identify sensitive natural habitats, and define other actions required for management/protection of the water resource. The state, regional and local governments must take these plans into consideration in all decisions concerning water and aquatic environments. Any financial assistance granted by them must contribute to the implementation of projects compatible with the plans.</p> <p>Wastewater reuse was also for the first time ever acknowledged as an alternate solution to wastewater discharge.</p>
<i>Agricultural Law (1999)</i>		<p>Redefines the legal framework for land management in line with the Common Agricultural Policy of the EU. The law extends responsibilities of landscape and environmental management to farmers. A <i>contrat territorial d'exploration</i> binds the farmer and state for 4-5 years, with the objective of protecting natural resources and managing the landscape in an environmentally responsible way. The contract specifically defines and remunerates missions aimed at conserving the environment, including water resources.</p> <p>The contract will also include a special clause on water management for basins experiencing water shortages. The contract rules concerning quality and quantity are based on the local SAGE.</p>
1995 Order by the Ministry of the Environment	Ministry of the Environment	Encourages the use of alternative solutions to the discharge of wastewaters in sensitive environments, where tertiary treatment is not affordable. The reuse of treated wastewater is recommended particularly for seaside resorts and tourist areas.
Policies and Guidelines		
Wastewater Reuse Guidelines (1991)	National Council for Public Health	<p>These guidelines serve as a provisional regulation. It builds upon wastewater reuse guidelines developed by the WHO. Additional requirements on irrigation management and the prevention of health risks associated with human exposure to wastewater make these provisional regulations more stringent than those of the WHO. For example, the guidelines state that vegetables to be eaten raw can be irrigated with quality A water (nematode egg content < 1/1, faecal coliform content < 1000/1000mL) however, methods that minimize contact of water with foods are highly recommended.</p> <p>Irrigation of public spaces with quality "A" water is also allowed, provided it is done using short-range sprinklers more than 100 m from houses, sports and recreational areas. Irrigations should also take place outside opening hours.</p> <p>Each wastewater reuse project must be approved by the Ministry of Health and be monitored on a permanent basis. Between 1981 and 1999, 19 projects had been developed.</p>

Sources:

- Loire-Bretagne Water Agency. The SAGES, Water Improvement and Management Plans. [Online]. Available: http://www.eau-loire-bretagne.fr/english/b/fr_b6angl.htm
- Faby, J.A., Brissaud, F. and Bontoux, J. 1999. Wastewater Reuse in France: Water Quality Standards and Wastewater Treatment Technologies. *Water Science and Technology*. 40:4-5, pp. 37-42.

Water Conservation and Related Program Initiatives

Initiative, Lead Agencies and Partners	Sector(s) targeted	Description	Results and Effectiveness
French Public Water Management Policy 2004			
<p>Drought Management Plan (2004)</p> <p>Ministry of Ecology and Sustainable Development</p> <p>In response to the deadly summer heat of 2003, a Drought Action Plan has been proposed</p>		<p>Ten short and medium-term actions are recommended. The first action involves the establishment of a national committee. This independent committee would be mobilized through an official request by the Minister of the Environment by April of a foreseen problematic summer season. At this time the group would be responsible for evaluating the situation and recommending mitigation options. The group would also be responsible for coordinating communication activities, evaluating the management of the crisis and its impacts upon the environment. Committee members would include water users from all sectors and representatives from all the relevant government ministries.</p> <p>Additional actions include the modernization of the water consumption surveillance network (i.e. improved surface water and ground water monitoring devices), the definition of a set of indicators to better identify and evaluate the short term risks of a drought crisis and the development of a guide for regional prefects that outlines a methodology for implementing water-taking restrictions under drought conditions. The objective of the guide is to encourage a uniform approach to restrictions and drought measures across the country.</p>	Expected to undergo review in September 2004.
<p>The Irrimieux Initiative</p> <p>Ministry of Agriculture and Ministry of Environment</p>	Agriculture	<p>Established in the 1990s, the program aims to increase the efficiency of water use for irrigation purposes in France, particularly in areas where irrigation uses of water lead to conflicts or shortages in the summer months. Other initiatives include education and outreach, the installation of volumetric meters, regular distribution of climatic/precipitation information to farmers etc. The initiative supports farmers in best irrigation techniques.</p>	In 2000 in the Basin de l'Adour, the program lead to the installation of 30 electronic regulators and 22 improved irrigation spray guns.
<p>Project financed by regional council, Environment Ministry, water agency and town councils.</p> <p>Initiated in response to water stress, droughts and agricultural pollution</p>	Residential, public, institutional	<p>A major pilot project was initiated in seven cities in Brittany (total population 800 000).</p> <p>Many actions taken including an information campaign (users and professionals), letters to domestic users, tests and installation of various types of water-saving equipment, investigation of leakage in the public distribution system and in private households</p>	<p>Water-saving equipment for municipal irrigation in Brest resulted in a saving of 62%.</p> <p>Water-saving equipment and leakage detection in two cities resulted in savings of 51% and 79% respectively. The installation of meters and water-saving equipment in a community hall in Pontivy resulted in a water saving of 50%.</p>
<p>Water Pricing</p> <p>Charges applied by basin Water Agencies and the State</p>	All	<p>Charging for abstraction at the river basin level introduced in 1964. Charges are split between the amount abstracted (levied by the Water Agency with the agreement of the River Basin Committee) and the amount consumed (levied by the State in the form of a tax) with a consumption coefficient applied according to whether the abstraction is for public water supply, industry, power generation or agriculture. Abstraction charges vary according to volume, area, and water source - groundwater abstractions are charged at 2 to 3.5 times higher than surface water abstractions. Charges are also higher in</p>	

		<p>regions where water is scarce and where water is of a particularly good quality so as to encourage conservation of the resource.</p> <p>Irrigation water is commonly priced by a combination of a volumetric and a flat rate. In 1970, the Societe du Canal de Provence et d'Aménagement de la Région Provençal, which supplies 60 000 ha of farmland and nearly 120 communes, introduced a pricing scheme in which rates vary between peak demand and off-peak periods. The peak period rate is set to cover long-run capital and operating costs. The off-peak rate is set to cover only the operating costs of water delivery. About 50 % of total supply costs (variable and fixed) are subsidized by the State.</p>	
<p>Regional Development Companies</p> <p>These companies include: the Gascogne Development Company in South Pyrenees, the Lower Rhone-Languedoc Company in Languedoc-Roussillon and the Canal of Provence Company for the Riviera coastline.</p>	Agriculture	<p>In some regions of Southern France, Regional Development Companies (SAR) are entrusted with the overall objective of controlling water to ensure and improve water supply in agricultural areas. Although the main approach taken by the SAR is to build infrastructure that would make it possible to irrigate large expanses of farmland, some SARS offer outreach services advising farmers of water conservation measures.</p>	

Sources:

- Ministere de l'ecologie et du developement durable. 2004. Plan d'Action Secheresse. [Online]. Available: http://www.ecologie.gouv.fr/article.php3?id_article=2197
- 2001. Aquadour. Bulletin No. 25. [Online]. Available: <http://www.univ-pau.fr/RECHERCHE/OBSEAU/aquadour/aquad25.pdf>
- Lallana, C., Krinner, W., Estrela, T., Nixon, S. and Leonard, J. 2001. Sustainable Water Use in Europe: Part 2 Demand Management. [Online]. Available: http://reports.eea.eu.int/Environmental_Issues_No_19/en
- The International Office for Water. Organization of Water Management in France. The Integrated Development of Watercourses. [Online]. Available: http://www.oieau.fr/anglais/gest_eau/index.htm

Municipal and Regional

Municipality or Region	Sector(s) targeted	Description	Results and Effectiveness
Drome Sub-Basin		<p>The SAGE for the Drome basin was the first to be adopted in France. The basin suffers from severe low water at the same time local communities need the water for irrigation, leisure activities on the water and drinking water purposes. Three years out of four the water requirements surpass the available water by at least 2 million cubic metres. Several supply and demand objectives for the basin were therefore defined in the SAGE, the demand management objectives including the restriction of irrigation levels to 1995 levels, the setting up of equipment to monitor and control groundwater consumption, and the introduction of incentives to promote methods of irrigation that use less water.</p>	

Sources:

- Piegay, H., Dupont, P. and J.A. Faby. (2002). Questions of water resource management. Feedback on the implementation of the French SAGE and SDAGE plans (1992-2001). Water Policy. 4, pp. 239-262.

Sectoral Examples:

Action	Location	Investment cost	Volume saved	Percentage of water saved
Water-saving equipment for municipal irrigation	Brest	EUR 2 000	43 m ³ /week	About 62 %
Water-saving equipment and leakage detection in individual schools	Brest		2.96 m ³ /year/ pupil	51 %
	Lorient		5 500 m ³ /year	79 %
Installation of meters and water-saving equipment in a community hall	Pontivy		About 1 600 m ³ / year	50 %
Installation of water-saving equipment in apartments	Rennes(43 apartments)		29 m ³ / apartment/year	
	Vannes(47 apartments)	EUR 360		30 % for toilet use
Water-saving equipment in a swimming pool and leakage reduction	Rennes	EUR 180		14 %
	Morlaix (St-Martin-des-C hamps)	EUR 560	2 340 m ³ /year	30 %
Detection of leakage in network	Morlaix (St-Martin-des-C hamps)	EUR 3 800	1 300-1 800 m ³ / year	

APPENDIX B: BEST PRACTICES GUIDES AND MANUALS

Following is a compilation of general and sector-specific water conservation guides and manuals, which are considered current and comprehensive. The focus is on documents which offer guidance going well beyond that usually associated with fact sheets and lists of helpful hints. They contain the depth of information needed in decision-making when more extensive and complex solutions are being promoted or contemplated.

General Purpose

Title / Organization / Date	Pages	Description
Designing a Water Conservation Program: An Annotated Bibliography of Source Materials / US EPA / 1994	92	A comprehensive (if somewhat dated) listing of references organized under the headings of public education, community programs, distribution systems, economics, agriculture, devices/products and suppliers.
Handbook of Water Use and Conservation: Homes, Landscapes, Businesses, Industries, Farms / Amy Vickers / 2001	464	Hardcover text considered by many professionals to be "the most comprehensive, authoritative and state-of-the-art reference ever published on water use and conservation". The book outlines 10 key steps for a successful conservation program, describes water use characteristics of major sectors, details how to conduct a water audit, provides in-depth information on more than 100 water-efficiency measures, gives estimates of expected costs and savings, and lists online links to additional resources.
Florida Water Conservation Initiative / Florida Dept of Environmental Protection / April 2002	170	State-level document describing the outcome of public and stakeholder workshops examining 'ways to improve water efficiency in all categories of water use'. Recommendations (51 in total) cover the areas of agricultural irrigation, landscape irrigation, water pricing, ICI water usage, indoor use, and reuse of reclaimed water.

Public Water Systems

Title / Organization / Date	Pages	Description
Advanced Guidelines for Preparing Water Conservation Plans / US EPA / Aug 1998	42	A step-by-step guide to the preparation of a water conservation plan for public water supply systems serving more than 100,000 people. Topics covered include goal setting, community involvement, system profiling, demand forecasting, identification of possible conservation measures, analysis of benefits and costs, selection of conservation measures, adjustment of supply and demand forecasts, and implementation planning and evaluation.
Basic Guidelines for Preparing Water Conservation Plans / US EPA / Aug 1998	18	A simplified guide to the preparation of a water conservation plan for public water supply systems serving less than 10,000 people. Topics covered include goal setting, community involvement, system profiling, demand forecasting, identification of no regrets conservation measures, and implementation planning.
Cases in Water Conservation: How Efficiency Programs Help Utilities Save Water and Avoid Costs / US EPA/ July 2002	54	Presents case studies describing the water conservation experiences and achievements of seventeen public water supply utilities – sixteen across the US and one in Ontario.
Developing and Implementing a Water Conservation Plan / Maryland Dept of the Environment / 2004	32	Document was developed in response to drought conditions in 1999 and 2002, which severely impacted on many municipal systems in the state. It provides guidance to municipalities of all sizes and based on the US EPA conservation planning guidelines.
Facility Manager's Guide to Water Management / Arizona Municipal Water Users Association / March 2003	151	A comprehensive guide for use by utility managers and ICI customers.
Intermediate Guidelines for Preparing Water Conservation Plans / US EPA / Aug 1998	40	A step-by-step guide to the preparation of a water conservation plan for public water supply systems serving 10,000-100,000 people. Topics covered include goal setting, community involvement, system profiling, demand forecasting, identification of possible conservation measures, analysis of benefits and costs, selection of conservation measures, adjustment of supply and demand forecasts, and implementation planning and evaluation.

National Action Plan to Encourage Municipal Water-Use Efficiency / CCME / May 1994	10	CCME sanctioned plan offering higher-level direction to federal and provincial/territorial governments and departments and to municipalities on achieving greater water efficiencies and decreasing infrastructure expansion and operating costs. Actions are based on the principles of leadership, partnership, harmonization, user pay, full-cost pricing and an informed public.
Securing Our Water Future Together / State of Victoria, Australia / 2004	172	Victoria's "pathway to sustainable water management".
Water Conservation Guide for Public Utilities / New Mexico State Engineer Office / 2001	206	Comprehensive guide covering overall program development and design, outreach and education, in-school education, metering, water audits, leak detection and repair, pressure reduction, plumbing fixture and appliance retrofits, landscape irrigation and xeriscaping, wastewater reclamation and reuse, drought planning and response and case studies.
Water Conservation Measures: Appendix A to the (parent) US EPA Water Conservation Plan Guidelines document / US EPA / Aug 1998	20	Divides the range of possible water conservation measures for public systems into three categories or levels. Level 1 measures are recommended for implementation across all size systems while implementation of the more comprehensive Level 2 and 3 measures is encouraged in larger communities.
Water Conservation-Oriented Rates: Strategies to Extend Supplies, Promote Equity and Meet Minimum Flow Levels / AWWA / 2005	144	Discusses pricing structures that encourage conservation including drought demand rates, excess use surcharges, increasing-block rates and seasonal rates. Examines implantation issues, economic issues for the utility, and assistance for low-income households. Includes case studies.
Water Efficiency – A Resource for Utility Managers, Community Planners and Decision-Makers / Rocky Mountain Institute / 1991	120	A detailed but somewhat dated guide to water conservation in municipal systems. Looks at the benefits and costs of alternative measures. Contains case studies.
Water Efficiency Plan / City of Toronto Works and Emergency Services Dept / Dec 2002	86	Toronto's action plan for becoming more water efficient. Document outlines conservation program drivers, objectives, plan development, preferred measures, timetables and costs.

Domestic / Residential

Title / Organization / Date	Pages	Description
Household Guide to Water Efficiency / Canadian Mortgage and Housing Corporation (CMHC) / 2000	69	Modeled on and expanded from an earlier publication prepared by Durham Region in Ontario. CMHC authors consulted with municipalities across the country and designed the guide to be a useful reference for individual homeowners and municipal water-system managers. It covers water-use efficiency opportunities both inside and outside the home.
Water Conservation and Quantification of Water Demands in Subdivisions – A Guidance Manual for Public Officials and Developers / New Mexico State Engineer Office / 1996	42	Guidelines for the preparation of and review of subdivision water supply proposals and water rights applications. Guideline complexity and requirements vary according to 5 size categories ranging from less than 25 lots to more than 500 lots.

Industrial, Commercial and Institutional

Title / Organization / Date	Pages	Description
BC Buildings Corporation Guide to Building Retrofits that Lower Energy and Water Use and Reduce Greenhouse Gas and Waste Generation / 2001	138	Retrofit guidance targeting publicly funded educational and health care institutions and facilities. Focus is on measures that are or become self-financing and produce a net return on investment.
Environmentally Responsible Construction and Renovation Handbook- Second Edition / Public Works and Government Services Canada / March 2000	178	A technical guide for portfolio and asset managers, project managers, leasing agents and property managers on planning and undertaking renovations in an environmentally responsible manner. Topics covered include water and energy conservation, waste reduction and greenhouse gas emissions reduction.
Healthcare EnviroNet		Under the umbrella of the Canadian Centre for Pollution Prevention, this is an online guide to conservation and pollution prevention measures available to health care facilities. Numerous Canadian case studies are cited.
Manual for Conducting Water Audits and Developing Water Efficiency		Detailed guide to designing and conducting water audits with a focus on indoor water usage. Topics covered include characterizing water

Programs at Federal Facilities / Environment Canada, Economics and Conservation Branch /		distribution and use, determining a water balance, identifying alternative water reduction measures, and designing and implementing a plan/program. Audit worksheets and case studies are included.
North Carolina State Agency Water Conservation Initiative		In 2002, the N.C. General Assembly passed a bill requiring all state agencies to manage non-essential uses of water and to achieve water savings of at least 10%. Online guidance is provided to assist departments evaluate current water usage, identify conservation opportunities and develop a comprehensive implementation plan.
Water Conservation Guide for Commercial, Institutional and Industrial Users / New Mexico Office of the State Engineer / July 1999	108	Comprehensive guide covering facility-level program development and design, indoor domestic use, landscape irrigation, cooling and heating, industry-specific operations and case studies.
Water Conservation in the Professional Car Wash Industry / International Car Wash Association / 2002	75	Provides detailed information on conservation measures for both new and retrofitted automatic car wash facilities. Topics include design and operation of wash-water recycling systems, leak correction, efficient spray nozzle design, pressure control, and outdoor irrigation. Presents case studies from throughout North America.
Water Efficiency Manual for Commercial, Industrial and Institutional Facilities / North Carolina Dept of Environment and Natural Resources, Pollution Prevention and Environmental Assistance Division / 1998	129	This is the North Carolina PPEA division's own water-efficiency manual for commercial, industrial and institutional facilities includes information for planning and budgeting, information on new water fixtures and equipment, information for new construction or process modifications, and information for drought situations. It covers specific industry processes as well as water management of domestic waste, food preparation, heating and cooling, and landscaping uses.

Landscape Design and Irrigation

Title / Organization / Date	Pages	Description
Landscape Irrigation Scheduling and Water Management(Draft) / The Irrigation Association / Aug 2004	190	The guide to achieving efficient, water-conserving landscape irrigation. Topics include basic irrigation concepts, scheduling and water management methods, quality rating for systems, landscape water allowance and drought management through deficit irrigation. An extensive glossary of irrigation terms is included.
Low Volume Irrigation Design and Installation Guide / City of Albuquerque, NM	24	User-friendly guide to water-efficient landscape design, low-volume irrigation technologies and system design, irrigation scheduling and maintenance. Tables are provided that indicate average supplemental irrigation water requirements by month for a range of municipalities throughout the state.
Turf and Landscape Irrigation Best Management Practices / The Irrigation Association / Feb 2004	50	Developed for use in a wide range of activities from policy making to lot-level implementation. Intended users are government agencies, water purveyors, system owners, irrigation systems consultants and contractors. BMPS address the areas of design, installation, maintenance, operation and regulator-purveyor-user cooperation and coordination.
Water Efficient Landscaping: Preventing Pollution and Using Resources Wisely / US EPA / Sept 2002	20	A simplified guide to urban-areas landscaping. Topics include the what, why and how of water-efficient landscaping, irrigation system technologies, case studies, and identification of additional resources.
Water Wise Landscaping Best Practices Manual: A Companion Guide to Water Efficient Landscape Design / Design Studios West et al / 2003	71	Prepared for City of Lafayette and Town of Erie, Colorado. Contains chapters on WaterWise Principles and Guidelines, WaterWise Plant Lists, Natural Areas and Native Plants, Understanding Soils and Soil Preparation, Irrigation Design Techniques and Equipment, Water Budgeting, and Additional Resources.

Xeriscaping

Title / Organization / Date	Pages	Description
Complete How To Guide to Xeriscaping / City of Albuquerque, NM	48	Step-by-step guide to xeriscaping design, plant (shrub and tree) selection, planting instructions and landscape care and maintenance.
Xeriscape – A Guide to Developing a Water-Wise Landscape / Cooperative Extension Service / University of Georgia / July 2003	44	A 'why and How To' guide for homeowners, businesses and institutions. Topics covered include conservation drivers, landscape design, xeriscaping principles, soil analysis, plant selection, irrigation efficiency, use of mulches, landscape maintenance and case studies.

Primary Industries

Title / Organization / Date	Pages	Description
Industrial Water Conservation References of Paper and Packaging Manufacturers / California Dept of Water Resources / 1989	76	This report examined 15 (then) current articles on water conservation practices among pulp and paper manufacturers. Pertinent information is extracted on water and cost savings and on technical considerations that had to be dealt with in implementing conservation measures.
Practical Water Management in Paper and Board Mills and Reducing Water Costs in Paper and Board Mills / Envirowise, UK Environment Agency /		Provides detailed technical information on water management technologies and practices for Pulp and paper mills. Focus is on measures that deliver both water and cost savings. Details steps that companies should take in developing an action plan. Includes UK examples.
Water Use in Industries of the Future / US Dept of Energy, Center for Waste Reduction Technologies / 2003	74	This report prepared by CH2M HILL covers six water and energy-use intensive industry sectors, i.e. aluminum, chemicals, forest products, mining, petroleum, and steel. It examines current and emerging practices relating to water use and reuse and the relationships between water and energy flows and balances. In addition to specific coverage on each sector, the report looks at commonalities felt to be helpful in guiding research and development that could lead to "high impact changes and reduction in water and energy use patterns". Nine critical steps for achieving significant water-use savings are identified.
White Paper on Produced Water from Production of Crude Oil, Natural Gas and Coal-Bed Methane / Report for US Dept of Energy / 2004	87	Examines the origin, volumes and quality of produced water. Looks at environmental issues and management options including treatment, disposal, and recycle/reuse for EOR and other purposes. Case studies are included.

Agriculture

Title / Organization / Date	Pages	Description
B.C. Livestock Watering Manual / B.C. Ministry of Agriculture & Food / April 1990	150	Covers all aspects of livestock water management including animal requirements, regulatory approvals, watering system types and design, operations, and maintenance.
B.C. Sprinkler Irrigation Manual / B.C. Ministry of Agriculture & Food and Irrigation Industry Assoc'n of B.C. / April 1995	140	Covers sprinkler system design (all types), operation and management. Includes section on economic and financial analysis.
B.C. Trickle Irrigation Manual / B.C. Ministry of Agriculture & Food and BC Irrigation Industry Association / April 1999	330	Detailed publication dealing with all aspects of system design, management and operation. Also covers determination of crop water requirements, water quality considerations, scheduling and chemigation.
Profile of the Agricultural Crop Production Industry / USEPA / 2000	184	Contains small sections on the reasons and methods for water conservation and water-use efficiency in crop irrigation in relation to field and range crops and greenhouse production.
Profile of the Agricultural Livestock Production Industry / USEPA / 2000	166	Contains a small section on the reasons and methods for water use efficiency in watering and cleaning operations.
Water Management Best Management Practices / Agriculture Canada et al / 1993	91	User-friendly guide for use by farmers. Includes coverage of water use in the home, barn, and fields. Discusses protection of wetlands, watercourses, woodlots and ponds and contains descriptions of relevant legislation.
Water- More Nutrition Per Drop: Towards Sustainable Food Production and Consumption Patterns in a Rapidly Changing World / Stockholm International Water Management Institute / April 2004	36	Policy-level document looking at global water-use productivity issues in agricultural production. Key policy issues include identifying and influencing unsustainable consumption patterns, closing the productivity gap between what is and can be produced, facilitating the demonstration and use of more productive technologies, establishing minimum ecological criteria for protecting watercourses from unsustainable extractive use, and addressing the use of unsustainable subsidies and trade barriers.
Water-Use Efficiency - An Information Package; Irrigation Insights Pub No. 5 / Land & Water Australia and National Program for Sustainable Irrigation / 2003	73	Document looks at past and emerging trends in Australian crop-irrigation, examines water-use efficiencies and water losses throughout regional systems, evaluates measures for improving efficiencies and presents a number of case studies.
Water Use in Industries of the Future / US Dept of Energy, Center for Waste Reduction Technologies / July 2003	74	Report prepared by CH2M HILL covers water use and management in agriculture and in six resource-use intensive industry sectors. It takes a forward looking examines what companies the integrated conservation

Recreation Industries: Golf Courses, Ski Areas, etc.

Title / Organization / Date	Pages	Description
Committed to Green Handbook for Golf Courses / European Golf Association Ecology Unit / 1997	40	The Committed to Green Environmental Management Program for golf courses operates in 17 European countries and involves the participation of more than 500 courses.
Ontario Snow Resorts Association BMP Manual / OSRA / 2001	27	Focuses on environmental initiatives that improve efficiency and create cost savings in the areas of water and energy conservation and waste reduction. Templates allow the tailoring of measures to suit individual circumstances.
Reuse of Renovated Municipal Wastewater for Golf Course Irrigation / Prince Edward Island Dept of Technology and Environment / Dec 1999	42	Report was prepared by the Centre for Water Resources Studies, Dalhousie University. It provides an overview of regulatory issues, environmental considerations, local soil and vegetation considerations, planning, design and operational issues, and cost considerations. Several case studies are presented involving golf courses from various parts of Canada that are currently irrigating in whole or in part with treated wastewater.
Sustainable Slopes: The Environmental Charter for Ski Areas / National Ski Areas Association (NSAA) / 2000	24	NSAA is a US-based organization whose members include more than 150 ski resorts from across the country and a number of ski-industry organizations. The document outlines the environmental vision, values and principles of sustainability, which are endorsed by NSAA members. The principles address all areas of resort development including planning, design, construction and operations. Water and energy conservation are elements for which guidance is provided on voluntary measures that resort developers/owners/operators and resort visitors can take to increase efficiency. Areas covered include snowmaking, landscape irrigation (i.e. relating to year-round facilities), and indoor uses.
Wastewater Reuse for Golf Course Irrigation / United States Golf Association (USGA) / 1994	304	Prepared for the USGA. Book covers both technical and regulatory aspects of golf course irrigation. Topics include system design, water quality considerations, operations and monitoring, retrofitting of existing systems, and case studies (mainly from the southern U.S.).

Water Reuse and Recycling

Title / Organization / Date	Pages	Description
Code of Practice for the Use of Reclaimed Water – Companion Document to the Municipal Sewage Regulation / B.C. Ministry of Environment, Lands and Parks / 2001	45	Code supports the intent and requirements of the Municipal Sewage Regulation with respect to encouraging the beneficial reuse of classes of wastewaters while ensuring the protection of human health and the environment.
Queensland Water Recycling Strategy / Queensland Environmental Protection agency / 2001	70	Provides the framework for encouraging adoption of safe and sustainable water recycling initiatives and practices. Establishes guiding principles and policies on sources, uses and action plans.

Drought Planning and Response

Title / Organization / Date	Pages	Description
Basics of Drought Planning: A Ten-Step Process / National Drought Mitigation Center, University of Nebraska / 2000	15	Presents a generic approach to effective drought planning and response based on more than 15 years of US and international observation and experience. Outlines 10 steps focused on initiating action at the state level but adaptable to other levels of government. The steps include appointing a Drought Task Force, defining the purpose and objectives of the Drought Plan, seeking stakeholder participation and resolving conflicts, inventorying resources and identifying groups at risk, developing organizational structure and preparing the Drought Plan, integrating science and policy and closing institutional gaps, publicizing and obtaining feedback on the proposed Plan, implementing the Plan, developing education programs, and conducting a post-drought evaluation.
Ontario Low Water Response Plan / Ontario Ministry of Natural Resources et al / July 2003	44	A plan intended to ensure provincial agency coordination and preparedness in guiding and assisting local response in the event of a drought. It establishes criteria for assigning the degree of drought severity, specifies the range of response measures to be taken, and identifies roles, responsibilities and linkages.

APPENDIX C: ONLINE RESOURCES

Websites referenced in the attached table have been found to be particularly useful sources of information on water conservation and water-use efficiency. The list focuses on sites known to have a high degree of recognition and credibility as well as above average content relating to water management practices. Starting an information search with these sites will quickly lead the user to additional print and online resources on water conservation at levels of detail suitable for both the water management professional and the more casual reader.

Government Resources

Jurisdiction and Department	Website
Canada	
BC Buildings Corporation (How to Guidance for New Construction and Retrofits)	www.greenbuildingsbc.com
Canadian Centre for Pollution Prevention	www.c2p2online.com
Environment Canada (Pollution Prevention Success Stories)	www.ec.gc.ca/pp
National Research Council (Design for Environment Guide)	http://dfe-sce.nrc-cnrc.gc.ca/
Ontario Centre for Environmental Technology Advancement	www.oceta.on.ca
Public Works and Government Services Canada (Real Property Services)	www.pwgsc.gc.ca/rps
United States	
Arizona Municipal Water Users Association	www.amwua.org
California Urban Water Conservation Council	www.h2ouse.org/resources
Georgia Dept of Natural Resources (Pollution Prevention Assistance Division)	www.p2ad.org
Maryland Dept of the Environment	www.mde.state.md.us/programs/waterprograms
National Drought Mitigation Center, University of Nebraska-Lincoln	www.drought.unl.edu
National Oceanic and Atmospheric Administration (NOAA), Drought Information Center	www.drought.noaa.gov
New Mexico State Engineer's Office	www.ose.state.nm.us/water-info/
North Carolina Dept of Environment and Natural Resources (Pollution Prevention Division)	www.p2pays.org
North Carolina Division of Pollution Prevention and Environmental Assistance - State Agency Water Conservation Initiative	www.sustainablenc.org/tools.htm
Pennsylvania Dept of Environmental Protection (Water Saving Tips)	www.dep.state.pa.us/dep/subject/hotopics/drought/SavingWater.htm
US EPA (Water Efficiency Program)	www.epa.gov/owm/water-efficiency
US Dept of Energy (Center for Waste Reduction Technologies)	www.oit.doe.gov/bestpractices
US Dept of Energy (Energy Efficiency and Renewable Energy – Industrial Technologies Program)	www.eere.energy.gov/industry
International	
Envirowise Programme, UK Environment Agency	www.envirowise.gov.uk
International Institute for Sustainable Development	www.iisd.org
Our Water Our Future (State of Victoria, AU)	www.ourwater.vic.gov.au/ourwater/dsenowof.nsf/Home+Page/OurWater-OurWater_home?open
Pollution Prevention World Information Network	www.p2win.org
United Nations Environment Programme (Division of Technology, Industry and Economics)	www.unepie.org
World Water Council	www.worldwatercouncil.org

Non-Government Resources (Sectoral and Professional)

Sector or Organization	Website
American Water Works Association (WaterWiser Program)	www.awwa.org/waterwiser
Canadian Water and Wastewater Association (Water Efficiency)	www.cwwa.org/WEED

Experiences Database)	
Committed to Green Foundation (Europe)	www.committedtogreen.org
Conservation Council of Ontario (Green Ontario)	www.greenontario.org
Golf Course Superintendents' Association of America	www.gcsaa.org
Hospitals for a Healthy Environment	www.h2e-online.org/
Irrigation Association	www.irrigation.org
POLIS (U of Victoria)	www.waterdsm.org
Pulp & Paper Industry Association	www.tappi.org
Rocky Mountain Institute	www.rmi.org
Royal Canadian Golf Association	www.rcga.org
University of Minnesota (Technical Assistance Program)	www.mntap.umn.edu
Water Environment Federation	www.wef.org
WaterReuse Association of California	www.watereuse.org
Water Saver Home	www.h2ouse.org
Water Use It Wisely	www.wateruseitwisely.com
WaterWiser: The Water Efficiency Clearinghouse	www.waterwiser.org