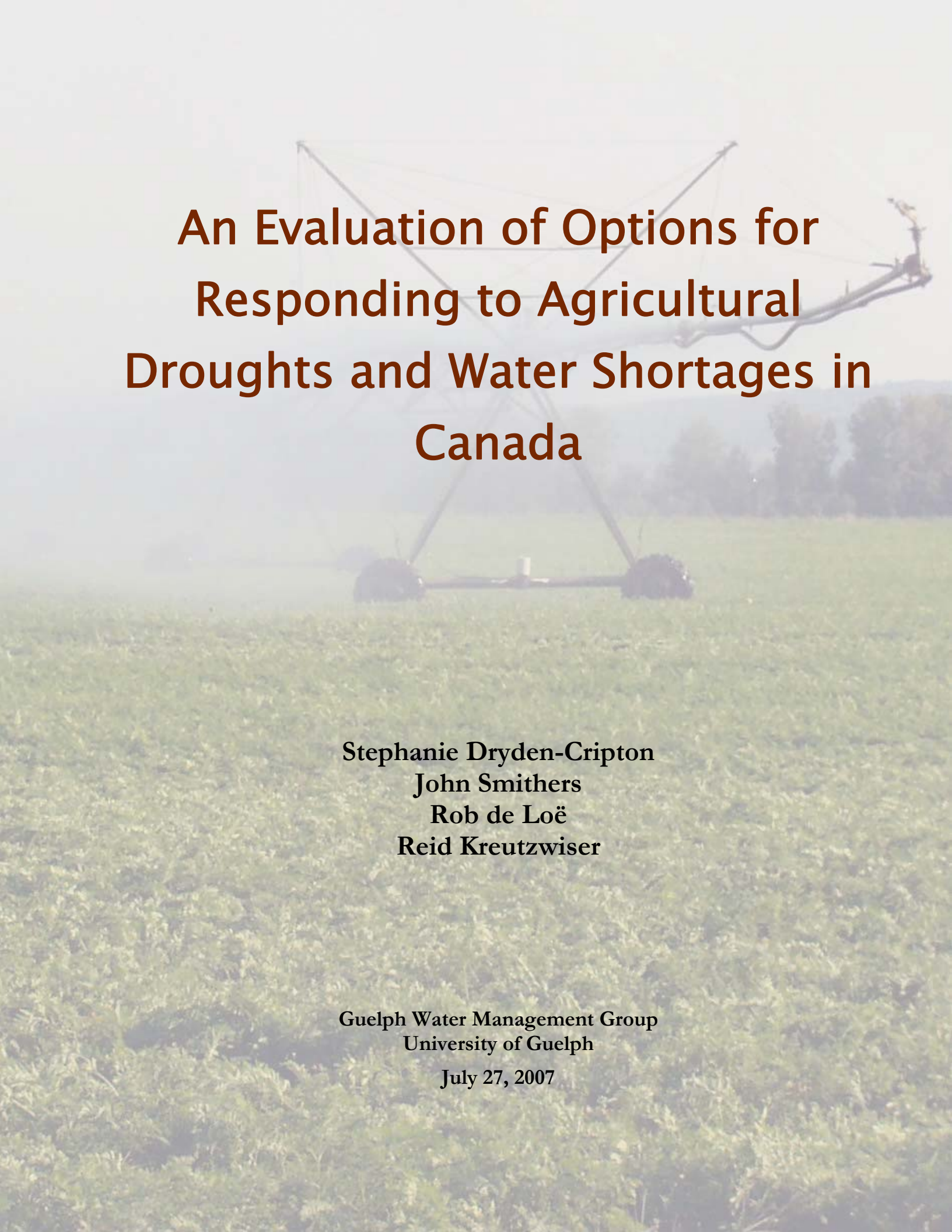

An Evaluation of Options for Responding to Agricultural Droughts and Water Shortages in Canada

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The aim in the project was to investigate alternative approaches in planning for, and responding to, limitations to water availability for agriculture in Canada. This report synthesizes findings from the study.

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Executive Summary

The prospect of an altered climatic regime which features an increase in the frequency and severity of drought and water shortages, as widely posited by climate change researchers in Canada and elsewhere, suggests that challenges to agriculture will increase in the future. This will necessitate adaptation planning at a variety of scales in both the private and public sectors. Public programs and institutional arrangements fundamentally affect both agricultural production strategies, approaches in agri-environmental management and agricultural access to water in Canada. The link between these themes currently is not well understood, especially in terms of the relative ability of various *types* of government programs and arrangements to enhance the adaptive capacity of farmers and the farm sector (Bryant et al., 2000; Smithers and Blay-Palmer 2001; Smithers and Smit, 1997). This research responds to the challenge posed by agricultural drought and water shortages by assessing the effectiveness and practicality of selected strategies for managing these challenges in farming (Wilhelmi and Wilhite, 2002). In the face of both climatic and institutional change there is a need for research that assesses the degree to which different forms of drought response and agricultural water management are climate adaptive.

The purpose of the project was to document and assess the effectiveness of selected structural and non-structural responses to droughts and water shortages in farming systems in Canada. The work assessed the extent to which specific responses permit the agriculture sector to better respond to droughts and water shortages at scales ranging from the farm enterprise to agricultural communities and regions. Four case examples, which served as examples of response types, were used as a basis for identifying certain strengths and limitations associated with particular forms of response and suggesting lessons and opportunities for improved program design.

The project was organized around three objectives:

1. Inventory structural and non-structural responses to droughts and water shortages across a range of spatial scales extending from the farm to the regional level.
2. Evaluate selected illustrative responses in terms of the manner and extent to which they enhance prospects for preparing for and responding to droughts and water shortages at the farm, community and regional levels.
3. Identify lessons that can be learned and applied to cope with future drought conditions and water shortages in Canada as climate changes with specific reference to strategies shown to be effective at the farm, community and regional scales.

The research combined an extensive inventory and categorization of drought- and agricultural water management-related public programs from across Canada with an analysis involving detailed and systematic examination of four initiatives. Data for the former (Objective 1) were derived principally from a search of web-based policy and program documents across a wide assortment of national and provincial institutions and organizations known to have interest in, or responsibility for, drought management and agricultural planning. Data for the latter (Objectives 2 and 3) were derived from a series of detailed key informant interviews with program managers associated with each of four selected cased examples. Additional data and supplementary detail were provided by published in-house documents and recent literature. An analytical framework was devised to guide the case studies and incorporated seven criteria: i) Promotes Preparedness; ii) Promotes Self-Reliance; iii) Promotes Strategic Change; iv) Lessens Vulnerability; v) Social and Political Acceptability; vi) Legal and Institutional Feasibility; vii) Financial and Technical Feasibility. Case study findings are presented in relation to the manner and degree to which each of the examples performs regarding the evaluative criteria used in the analysis. Hence the presentation of results is organized around each of the 7 criteria and related indicators of performance. In so doing, it provides some insights on strengths and limitations associated with certain types of approaches and highlights some possible lessons for program design and delivery as perceived by practitioners in the field. Importantly, the evaluation was not intended or presented as a critique of the specific cases examined.

A cross-Canada inventory of structural and non-structural programs and other initiatives pertinent to agricultural drought led to the identification and categorization of 84 initiatives at the national, provincial and/or regional scale. Referred to as "responses", these infrastructure projects, programs, policies, statutes and other arrangements directly or indirectly facilitate and constrain agricultural responses to droughts and water shortages. Some of these initiatives were designed with agriculture's water needs in

mind, while others were judged to be indirectly (or incidentally) pertinent. For example, across Canada numerous projects have been constructed specifically to increase the reliability of water supplies for agriculture. These often are purposeful responses to drought and water shortages. In contrast, programs exist that were designed for purposes such as habitat conservation or water quality protection, but which have implications for agricultural producers during times of water shortage and drought. These were classified as incidental. Specific initiatives inventoried were characterized according to eight key characteristics:

- *Response Type.* Initiatives may be usefully differentiated according to basic characteristics such as the form they assume (e.g., structural, financial, etc.).
- *Scale.* Initiatives may be developed for uptake at a variety of scales. In the case of agriculture, pertinent scales include the farm, but also the community, the region and provinces.
- *Coverage.* Depending on their form and origin, initiatives will vary in their coverage or the spatial unit to which they apply (e.g. local, provincial, national).
- *Initiator.* Policies and programs may be conceived at, and delivered from one or more "levels" within the public sphere.
- *Eligibility.* Specific initiatives may be differentiated in terms of their inclusiveness of the degree to which they strategically target certain actor groups.
- *Intent.* Distinctions can be drawn between actions (policies, programs) on the basis of their intentionality recognizing that some initiatives may have an explicit focus and purpose relating to adaptation in the agriculture sector and others may have an incidental benefit without actually being developed for the purpose of agricultural water management.
- *Timing.* An important distinction exists between initiatives with respect to whether they are continuing (mainstream) in nature or whether they are temporary.
- *Outcomes.* A fundamental distinction exists between measures or initiatives that lead to the preservation/protection of current patterns of activity versus those that have the effect of precipitating a change.

The inventory (Appendix A) confirms that current experience in planning for and responding to agricultural droughts and water shortages in Canada implicates a wide variety of approaches. These range from the provision of infrastructure to deliver water to measures designed to monitor and understand better hydrologic data in planning, to the incorporation of water efficiency measures in farm system design among numerous others. Almost all responses surveyed were of the 'on-going' variety – suggesting perhaps a systemic movement away from co-called *ad hoc* programs or arrangements. Several observations regarding response type, intent, scale and outcome are notable. For example, it was found that almost two-thirds of the initiatives recorded were judged to have incidental benefits rather than being directly designated for drought planning or management. Amongst those measures recognized as "drought-directed" in their purpose, approximately half were designed to secure and deliver water for agriculture. Far less common are responses directed toward water conservation or efficiency in water use. The data on response type and intent call into question the extent to which climate change has been 'mainstreamed' in the agricultural sector.

The research explored, in detail, four initiatives as examples of different forms of response. The purpose of the analysis was not to rank or otherwise rate response options, but rather to assess the ways in which different forms of response performed in relation to the criteria noted above – recognizing that not all of the example initiatives were designed with drought in mind. The following initiatives were selected for detailed investigation based on known characteristics, available information sources and evident diversity in their form and function:

- South East Kelowna Irrigation District (SEKID) Metering Program -- British Columbia
- Irrigation Water Management Study (IWMS) -- Alberta
- Ontario Low Water Response (OLWR) -- Ontario
- Environmental Farm Plan (EFP) -- Ontario, New Brunswick, Prince Edward Island, Alberta, British Columbia

A major data collection effort on the four case studies was conducted using academic literature, government and industry publications, and media articles. The results of this secondary data review of the responses were compiled and assessed for components requiring further investigation. Key stakeholders and agencies were identified and recruited for participation in in-depth interviews organized around a set of key research questions (Appendix B). Fieldwork and supplementary data collection was undertaken in several Canadian provinces to assist in the evaluation of the selected responses, and included interviewees from British Columbia, Alberta, Ontario, New Brunswick, and Prince Edward Island. The interviews incorporated practitioners and staff ranging from federal and

provincial governments, to farm organizations and related industry. In the analysis and reporting of gathered data, emphasis is placed on the manner in which each of the selected initiatives reflects, or has an inherent potential to reflect, each of the evaluative criteria. Hence, results are presented in relation to each of the following measures of effectiveness:

Promoting Preparedness: A key element in responding to droughts and water shortages is preparedness. Preparedness involves activities that are undertaken in advance of a drought or water shortage which either raise the degree of readiness for the hazard, or improve the operational and institutional capacity to respond to it; early warning systems are an example of a measure that promotes preparedness (Wilhite 2000).

- Knowledge, planning and ongoing monitoring clearly promote preparedness, and is evident to varying degrees in the four responses examined. For instance, in the case of the SEKID metering program and the IWMS, advance understanding of relevant stakeholders, characteristics, or influencing factors associated with the response, combined with ongoing monitoring, enabled accurate and targeted planning and management of response activities.

Promoting Self-Reliance: Self-reliance is a measure of the capacity of a community to respond to droughts and water shortages. It involves the extent to which a community manages, collaborates and participates in decision making-processes concerning its water resources (Ivey et al. 2004).

- Community and stakeholder awareness, engagement and participation in planning and management activities at the local level, along with the adoption of incentives are important in promoting self-reliance among the responses. This is evident, for example, in both the EFP and the SEKID metering program where farmer education and understanding of issues and outcomes associated with the responses relate directly to farm-level decision making that enhances the ability of farmers to respond to droughts and water shortages.

Promotes Strategic Change: An important element of the response to droughts and water shortages is strategic change that enables efficient planning and decision making at all scales. Strategic changes utilize non-drought related investment programs, as well as planning and decision-making efforts associated with other activities, such as infrastructure decisions, plan revisions, or research and development investments, in order to address targets of opportunity to adapt to climate change.

- Promotion of strategic change is strongly associated with the provision of additional or independent benefits and outcomes, utilization of targets of opportunity, and transferability. 'No regrets' outcomes are evident across all four responses, where a range of economic, social and environmental benefits are identified. Strategic use of existing mechanisms is key as is clearly demonstrated in the OLWR which builds upon existing institutional and regulatory measures while integrating activities among agencies, enabling sharing of resources and responsibility. Transferability is clearly identified in the EFP where variations in program delivery and farm-level decision-making occur successfully across the country.

Lessens Vulnerability: Effective response to droughts and water shortages requires adaptation measures that lessen vulnerability. In order to limit impacts in any individual sector, adaptation mechanisms should recognize a broad range of uncertainties (Smith and Lenhart 1996). In order to reduce exposure and minimize losses associated with climate change, it is also important to reduce sensitivity to impacts (de Loë et al. 2001). Reduced social and economic vulnerability can be achieved through careful planning and implementation in this way.

- Flexibility, impact reduction, improved supply, and demand reduction are clearly associated with lessening vulnerability. Benefits of the combination of these factors are most evident in both the SEKID metering program and the EFP. Demand reduction and improvements in water use efficiency in particular is important among three cases, where improved water management, largely through efficiencies, generates greater supply availability, resulting in both impact reduction and enabling greater overall flexibility. The EFP has clear potential for this purpose.

Social and Political Acceptability: The uptake and success of a response may be influenced by the public and political support that is expressed within a community or region. High levels of social and political acceptability provide greater legitimacy of an adaptation measure and influence the ease of implementation. It is important that a response to drought be consistent with the social, economic and environmental goals and objectives of a community (Ivey et al. 2001).

- Transparency, political support, equitability and public/stakeholder understanding are highly associated with the acceptability of a response. For instance, the facilitation of stakeholder and public understanding and trust of the both the response and associated decision-makers and delivery

agents in the EFP and SEKID metering program greatly lessened opposition, enabling easier implementation and higher rates of uptake.

Legal and Institutional Feasibility: Regulatory and institutional arrangements impact capacity to respond to droughts and water shortages, in terms of decision-making, coordination of activities, and enforcement. Institutional provisions that align with existing laws and regulations are most appropriate (Dolan et al. 2001). Effective regulatory measures must be readily available or easily accessible to implementing agencies (Smit and Pilifosova 2001). Authority to utilize regulatory tools and to actively enforce a response is also important (Ivey et al. 2004).

- Legal and institutional feasibility is clearly tied to government support, collaboration and coordination, and alignment with regulatory measures. This is illustrated to varying degrees across the four responses. Clearly defined leadership and roles associated with multi-agency involvement was critical in both the IWMS and the OLWR (e.g. minimizing redundancy), while regulatory measures were significant to all responses in terms of influencing the direction or nature of activities taken, and enabling enforcement of objectives

Financial and Technical Feasibility: A final consideration in the acceptance and implementation of a response to a drought or water shortage concerns the availability and appropriateness of financial and technical resources. An ideal measure will be inexpensive because it is difficult to justify excessive expenditures for an issue associated with unpredictable climate change (Smith et al. 1996). Economic efficiency of a response is also an important consideration where the economic benefits associated with the measure relative to its implementing costs help determine financial feasibility (Dolan et al. 2001).

- Sufficient and secure funding, staff, and technologies are crucial to response feasibility. This is evident in all four cases. Adequate staffs are necessary to implement the OLWR at various scales, and particularly in locations where resources are limited. Technical expertise and secured funding were critical to the IWMS due to the detailed nature of the study and evaluation of complex components.

List of Abbreviations

AAFC	Agriculture and Agri-Food Canada
AAFRD	Alberta Agriculture Food and Rural Development
AEFP Co.	Alberta Environmental Farm Plan Company
AENV	Alberta Environment
AIPA	Alberta Irrigation Projects Association
APANB	Agriculture Producers Association of New Brunswick
APF	Agricultural Policy Framework
BCAC	British Columbia Agriculture Council
BCMAFF	British Columbia Ministry of Agriculture Food and Fisheries
BCMOE	British Columbia Ministry of Environment
BMID	Black Mountain Irrigation District
BMP	Beneficial Management Practice
CA	Conservation Authority
CAFSP	Canada-Alberta's Farm Stewardship Program
COWSEP	Canada-Ontario Water Supply Expansion Program
ECSWCC	Eastern Canada Soil and Water Conservation Centre
EFP	Environmental Farm Plan
IAC	Irrigation Advisory Committee
IWMS	Irrigation Water Management Study
KJWC	Kelowna Joint Water Committee
OLWR	Ontario Low Water Response
OMAFRA	Ontario Ministry of Agriculture, Food and Rural Affairs
OMMAH	Ontario Ministry of Municipal Affairs and Housing
OMNR	Ontario Ministry of Natural Resources
OMOE	Ontario Ministry of the Environment
OSCIA	Ontario Soil and Crop Improvement Association
OWDC	Ontario Water Directors' Committee
PEIFA	Prince Edward Island Federation of Agriculture
PFRA	Prairie Farm Rehabilitation Administration
PTTW	Permit To Take Water
SEKID	South East Kelowna Irrigation District
SSRB	South Saskatchewan River Basin
SWMC	Surface Water Monitoring Centre
WEBS	Watershed Evaluations of BMP Sites
WRT	Water Response Team

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1. Introduction

Recent droughts in Canada and elsewhere have called attention to the importance of water for agriculture, and to the risks to agricultural production associated with disruptions in the availability of water due to drought. Indeed, drought has long been recognized as a principal form of environmental risk in crop-based agricultural systems and much effort has been devoted to developing mechanical and biological responses to lessen the impacts of water shortage (Smithers and Blay-Palmer, 2001). While successful drought response strategies exist, current production systems remain sensitive to shortfalls in water, and water-related impacts on production continue to be experienced periodically by Canadian farmers.

Persistent concerns for the availability of water in the current climatic regime in Canada are augmented by increasing evidence that climatic conditions are changing (IPCC 2007). Included amongst the many potential implications of an altered climate is an increased variability in the patterns of precipitation upon which all agriculture, but especially cropland, depends. While Canadian farmers have been innovative and highly successful historically in the development of production systems well adapted to regional moisture conditions, the prospect of greater variation and uncertainty in water availability is a cause of significant concern for producers, agricultural planners and water managers alike.

Compounding the uncertainties of climate is the proliferation of other forms of development in many of Canada's rural regions – development that has emerged as a competitor for water in selected regions. These other interests include not only the demands of primary sectors such as forestry and fisheries, but also the increasing arrival of secondary and tertiary activities in an increasingly economically diversified countryside, and the impact of significant exurban residential development in many of Canada's agricultural regions. Hence, Canadian farmers, like their counterparts in many other parts of the world, are facing a double dilemma: greater competition for a water resource that is (at least partially) known in its volume and distributional characteristics, and an uncertain understanding of how that resource may be affected by unfolding atmospheric changes that are systemic in nature and beyond any form of near term control.

In light of the above, increasing attention is being given to the need to plan for uncertainty in the agriculture-water dynamic. While farmers are the most obvious and immediate group of actors who have a role in responding to the agricultural impacts of water shortage, recent scholarship in the field of climate adaptation planning has also noted the important (and arguably increasing) role of public sector agencies and local organizations in working to implement or promote adaptation strategies in farming. These efforts have traditionally incorporated risk reduction and utilization of compensation schemes (such as pipeline water or crop insurance etc.), but more recently are expressed through a wide array of initiatives designed to promote greater resiliency, capacity and self-reliance (Smit and Skinner, 2002; Bryant et al. 2000). Adaptive capacity, as a concept, is viewed in terms consistent with the increasingly widely accepted definition embedded in the climate adaptation literature (Kelly and Adger, 2000; Smit and Pilifosova, 2001; Yohe and Tol, 2002). Hence, the vulnerability of Canadian farming systems is conceptualized in light of their potential exposure to water shortages, and their capacity to cope with, or adapt to, these conditions. In turn, adaptive capacity is defined as an ability to respond effectively in the face of a climate-related stressor via the use of technological, economic, human and knowledge-based resources. These resources may derive from human and economic capital at the farm scale or from the supporting function of private sector actors (e.g., the research and development community), industry groups (commodity organizations) and organizations and institutions both public and private.

Agricultural production, agri-environmental management, and agricultural access to water are fundamentally affected by public programs and institutional arrangements that operate at a variety of spatial and organizational levels. Understanding this diversity and the potential strengths and limitations of different forms of public action is an important step in ensuring a constructive contribution to adaptation planning in the agriculture sector. The research presented in this report reflects a particular interest in the intersection of farm-level strategies designed to enhance adaptive capacity, boost self reliance and lessen vulnerability, and the role of government programs and institutional arrangements in achieving adaptation to variations (notably shortages) in water supply for agriculture. As a point of entry, it is important to note that public sector programs and institutional arrangements vary widely in not only their origin and function but also with respect to many structural characteristics. These include the scale of their application, the timing of their implementation, and degree to which they work to preserve current patterns of activity or promote new ones.

This document reports on findings deriving from an investigation of alternative approaches in planning for, and responding to, limitations to water availability for agriculture in Canada. More specifically, the research addresses the challenge posed by agricultural drought and focuses on assessing the effectiveness and practicality of selected strategies for managing water shortages in farming and improving the resilience and self-reliance of farming systems (Wilhelmi and Wilhite, 2002). Interest in the concept of self-reliance is linked, in this instance, to the evolving nature of government support for farming and recognizes recent and likely changes in the traditional function of government programs as safety nets during periods of stress in farming. In the face of both climatic and institutional change there is a need for research that assesses the degree to which different forms of drought response are climate adaptive, reduce vulnerability, and increase local self-reliance.

As noted above, a central feature of the research is the recognition of the wide variation in how public programs and institutional arrangements are organized and delivered in support of climate adaptation. This project serves as a preliminary attempt to systematically recognize (and classify) these distinctions and to explore differences in intention and outcome as they relate to a selected sample of specific approaches.

1.1. Research Objectives

The purpose of the project was to document and assess the effectiveness of selected structural and non-structural responses to droughts and water shortages in farming systems in Canada. The work assessed the extent to which specific responses permit the agriculture sector to better respond to droughts and water shortages at scales ranging from the farm enterprise to agricultural communities and regions. In so doing, it provides some insights on strengths and limitations associated with certain types of approaches and highlights some possible lessons for program design and delivery as perceived by practitioners in the field.

The research was organized around a set of linked objectives designed to extend understanding of the nature and process of drought management and preparedness, as well as document approaches and circumstances that promote success:

1. Inventory structural and non-structural responses to droughts and water shortages across a range of spatial scales extending from the farm to the regional level.
2. Evaluate selected illustrative responses in terms of the manner and extent to which they enhance prospects for preparing for and responding to droughts and water shortages at the farm, community and regional levels.
3. Identify lessons that can be learned and applied to cope with future drought conditions and water shortages in Canada as climate changes with specific reference to strategies shown to be effective at the farm, community and regional scales.

1.2. Outline of the Report

The remainder of this report summarizes outcomes relating to the objectives of the research – with the majority of effort devoted to Objective 2 in the form of a detailed exploration of selected approaches from across Canada. Chapter 2 outlines the methodology used in the collection and compilation of data for the inventory of responses (Objective 1), and in the selection and analysis of the four case study initiatives or responses pertinent to Objective 2; a brief synopsis of each initiative is provided in the chapter. Chapter 3 presents the results of the case study evaluation. Chapter 4 offers reflection on lessons learned from the research (Objective 3), and presents conclusions and recommendations.

The material presented in the body of the report is a distillation of a much wider array of data relating to both the inventory or known response types and each of the four case studies. Appendixes A and C synthesize some of this additional information in considerably more detail.

2. Study Approach

This study explores options for responding to agricultural drought and water shortages in Canada. It had two major phases, which were completed between September, 2004, and March, 2007. In the first phase, response options from across Canada were inventoried according to a common set of characteristics. This phase of the study provided a database that was used to conduct the second phase, an exploratory evaluation of the extent to which selected measures enhance the ability of the agriculture sector to respond to droughts and water shortages.

2.1. Objective 1: Inventory of Response Options

Both for purposes of ascertaining the types of approaches to responding to agricultural droughts and water shortages that exist, and as a basis for selecting case studies for Objective 2, the first stage of the research involved an inventory of public and private sector initiatives with an overt or incidental linkage to water use planning and management in agriculture. This effort was conducted at a reconnaissance level and was designed to establish the diversity of approaches currently in existence, and to suggest the main distinctions amongst them such that they could be organized according to some key features. Hence, the inventory stands as an independent product of the project (Appendix A). Importantly, this step in the research involved an attempt to capture experiences from each of the regions of Canada. A significant effort went in to the survey of a range of programs, actions, and regulatory measures across Canada concerning drought and water management.

As noted above, the inventory allowed for the inclusion of not only programs or initiatives that were fundamentally (and explicitly) oriented toward drought and water management, but also captured selected programs that were judged to serve as *de facto* responses to water shortages and drought even if that was not a stated objective of the initiative. Data for this exercise were drawn from an exhaustive search of several hundred web-based policy/program documents through provincial government portals and amongst known agricultural and water management organizations (e.g. commodity groups in the case of the former and conservation authorities and irrigation districts in the case of the latter).

The 84 initiatives inventoried were characterized according to eight key characteristics:

- *Response Type.* Initiatives may be differentiated according to their basic form. Distinctions are commonly noted in the literature between measures on the basis of characteristics such as the form they assume (structural, financial, regulatory etc.), the manner in which they are delivered (voluntary, required etc.) and whether they are applied to a general phenomenon or a clearly articulated issue (general vs. strategic).
- *Scale.* Public sector initiatives may be developed for uptake at a variety of scales. In the case of agriculture, pertinent scales include the farm, but also the community, the region and provinces.
- *Coverage.* Depending on their form and origin, initiatives will vary in their coverage or the spatial unit to which they apply (e.g. local, provincial, national). An important consideration in the coverage of designed initiatives is the degree to which they are either spatially targeted or delivered in a spatially undifferentiated manner.
- *Initiator.* Policies and programs may be conceived at, and delivered from one or more "levels" within the public sphere (federal, provincial, local, private, public/private, intergovernmental). Similarly, initiatives may have their origins at one level, based for example in the articulation of a local resource problem, but be operationalized at another level because of the authority that resides at different administrative levels.
- *Eligibility.* Specific initiatives may be differentiated in terms of their inclusiveness or the degree to which they strategically target certain actor groups (crop agriculture, livestock agriculture, any agriculture, rural non-farm).
- *Intent.* Recent research has drawn useful distinctions between actions (policies, programs) on the basis of their intentionality recognizing that some initiatives may have an explicit focus and purpose relating to adaptation in the agriculture sector and others may have an incidental benefit without actually being developed for the purpose of agricultural water management. Thus, they may be purposive or incidental.
- *Timing.* An important distinction exists between initiatives with respect to whether they are continuing (mainstream) in nature or whether they are temporary (on-going, ad hoc).

- *Outcomes.* A fundamental distinction exists between measures or initiatives that led to the preservation/protection of current patterns of activity versus those that have the effect of precipitating a change to some altered state in either the nature of farming systems or the functioning of local structures (resists change in agricultural system, facilitates change in agricultural system, or both).

Notwithstanding the scope and rigor of this work, the resulting inventory of initiatives is acknowledged to be a sample of current experiences and makes no claim to form a complete listing of all current approaches to agricultural drought and water management across Canada. Further, it was beyond the scope of the project to engage in detailed fashion with each of the initiatives identified via direct consultation with key informants. Hence, this emerges as an opportunity for subsequent research. However, the inventory does represent a significant accounting of current experience and activity and served well in its ability to reveal and confirm some notable distinctions in response types. Programs are reported on a national and then province-by-province basis and are presented in tabular form in Appendix A.

2.2. Objective 2: Evaluation of Selected Responses

Selection of Evaluation Criteria

The systematic application of evaluative criteria to measure specific system characteristics is broadly consistent with the approach advocated in the Adaptation Policy Framework (Burton et al. 2005). It has been used successfully by the research team in a variety of contexts, including research on: adaptation to climate change in the water sector (de Loë et al. 2001, Ivey et al. 2004); land use regulation (Kreutzwiser and Slaats 1994); capacity for drought contingency planning (Durley et al. 2003); agri-environmental management systems (Smithers and Furman 2003); frameworks for assessing sustainability in agriculture (Smithers et al. 2002); and capacity for groundwater protection (de Loë et al. 2002).

The seven broad criteria that were selected to evaluate the four case study response options include the following:

- Promotes Preparedness
- Promotes Self-Reliance
- Promotes Strategic Change
- Lessens Vulnerability
- Social and Political Acceptability
- Legal and Institutional Feasibility
- Financial and Technical Feasibility

The first four criteria can be broadly described as impacting the effectiveness of the response. The remaining three relate to the capacity to implement the response. A discussion of each criterion, including a rationale for its importance and pertinence to this study, is presented in Section 3.2.

Selection of Case Studies

The completed inventory of water management approaches and responses to drought enabled a selection of four distinct case studies for detailed evaluation. These provide examples of actual and potential structural and non-structural types of responses to agricultural drought and water shortages, reflecting a range of scales (from farm to regional) across various jurisdictions within Canada. The specific responses identified were the South East Kelowna Irrigation District (SEKID) Metering Program; the Irrigation Water Management Study (IWMS) in Alberta; the Ontario Low Water Response (OLWR); and the Environmental Farm Plan (EFP) (which exists in various forms across Canada). The following synopses provide an overview of the four responses.

Case 1: South East Kelowna Irrigation District (SEKID) Metering Program (British Columbia)

Irrigation water for agricultural purposes in the Okanagan Valley is provided by several irrigation districts. Increased domestic and agricultural pressure on these districts has led to the development of strategies to address water supplies. Situated within a watershed of only 65 square kilometers and servicing approximately 36 square kilometers, the South East Kelowna Irrigation District (SEKID) has regularly faced a limited water supply. Heavy reliance on upland storage reservoirs, with inadequate and costly groundwater sources, has also impacted the district's ability to cope with dry seasons. Options for developing new water supplies have been limited and expensive.

In cooperation with the British Columbia Ministry of Agriculture, Food and Fisheries (BCMAFF) the irrigation district began a pilot project in 1995 that used metering and irrigation scheduling to reduce water use. This demand management strategy included the installation of meters to all agricultural users connected to the district's water system. Water use was monitored through regular meter readings and data reporting. Concurrently, irrigation scheduling techniques were promoted to water users and meters were used to educate landowners about agricultural water use. The pilot project served to educate growers about the amount of

water they were using as compared to actual crop requirements, and assisted in transferring knowledge on more efficient water use practices such as irrigation scheduling. The meters also provided important data toward the development of a longer-term demand management strategy.

Although initially the meters were used as a data collection and educational tool, the district has since introduced an incentive program that has assisted in the regulation of water consumption by applying a metered rate penalty system. An inclined block rate structure requires growers who exceed their annual water use allotment to pay the district for excess use. This rate structure operates by applying greater penalty to greater water use excess, and is intended as a disincentive for unnecessary water consumption. The program has provided the irrigation district with greater control over water demand, more efficient use of existing water supplies, and has improved agricultural users' awareness of the importance and techniques for matching their actual water requirements with consumption.

Case 2: Alberta's Irrigation Water Management Study (IWMS)

Irrigation is an essential element of agriculture in the largely semi-arid region of southern Alberta, and has placed a high demand on limited water resources. Water supply shortages, greater public environmental awareness, and increased pressure on irrigation districts in the South Saskatchewan River Basin (SSRB) prompted the province to develop policy measures concerning water management in the region in the 1980's. Efforts eventually led to the development of the 1990 SSRB Water Management Policy which provided guidelines concerning water use and conservation, user priorities, and expansion of irrigation. The province also established the 1991 *South Saskatchewan Basin Water Allocation Regulation*, which put in place a moratorium to restrict the amount of water allocated to irrigation districts in the Basin. Limitations in available data at the time the *Regulation* was implemented led to a commitment to its review and refinement in 2000.

In 1996, a cooperative effort to provide up to date, scientific data concerning water requirements and opportunities of irrigation districts was undertaken. Participants included the Alberta Irrigation Projects Association (AIPA) which represents the province's thirteen irrigation districts, Alberta Agriculture, Food and Rural Development's (AAFRD) Irrigation Branch, and Agriculture and Agri-Food Canada's (AAFC) Prairie Farm Rehabilitation Administration (PFRA). Alberta Environment (AENV) provided liaison and resource services. The four year Irrigation Water Management Study (IWMS) involved extensive field research, data collection and analysis, and focused on five key areas including: on-farm water use; characteristics of irrigation district distribution systems; development of irrigation demand models; irrigation water shortage impacts; and analysis of current and future scenarios for irrigation.

The product of the research was a five-volume report, *Irrigation in the 21st Century*, consisting of four technical reports and a summary report. The results of the study have contributed to the SSRB water management planning process and have provided an account of the state of the province's irrigation industry. It has also identified opportunities for more efficient irrigation water use and expansion. Although the study was completed in 2000, the AAFRD continues to update its databases regularly and some individual irrigation districts have since developed similar district-specific studies to guide their agricultural water management activities.

Case 3: Ontario Low Water Response (OLWR)

Over the past decade, low water and drought conditions have gained increased attention in Ontario. Impacts have been felt particularly in the southwestern and eastern regions of the province where agriculture is a predominant land use. As a consequence of water shortages farmers have required support in the form of direct assistance payments and crop insurance payouts. Groundwater sources are relied on heavily by farm operations in Ontario, and impacts associated with reduced water resources to the agricultural sector, as well as to industrial and domestic uses, have highlighted the importance of reliable water supplies.

In response to the drought-like conditions experienced in 1998 and 1999, the Province of Ontario developed a set of guidelines specifically aimed at dealing with low water conditions. The Ontario Low Water Response (OLWR) is a response plan intended to ensure preparedness in the event of drought, and has been active in Ontario since 2000. It provides overall direction and coordination of drought response, while promoting a planning approach to drought that is watershed- or community-based. Coordination of policies, science and information, and emergency support is provided by the province, while emphasis at the local level includes data collection, policy interpretation, program development and emergency response.

Based on indicators, the guidelines identify three levels of low water conditions and associated responses. The first level is an indication of a potential problem and involves the development of a local Water Response Team (WRT) which represent local water users, and the promotion of voluntary conservation measures for a

10% reduction in water use. The second level suggests potentially more serious conditions and incorporates increased emphasis on conservation with an additional 10% targeted reduction in water use (20% total) while imposing non-essential water use restrictions. A level three condition indicates a failure of water supply to meet demand, and thus, further promotes conservation, continues water use restrictions, and emphasizes water use regulation and enforcement. Restrictions at this level may be implemented through changes to water allocation measures, such as the Permit To Take Water (PTTW) program, while the guidelines act as a model for determining priority among users.

Case 4: Environmental Farm Plan (EFP)

Increased attention to environmental quality over the last few decades has led to greater scrutiny of agricultural activities that have the capacity to impact the environment. As such, improvements to the environmental impact of farm practices have gained increased recognition and support in Canada from government and producer groups for some time. The Environmental Farm Plan (EFP) was developed in Ontario in 1994 based on the U.S. Farm Assessment System (Farm*A*Syst) program. Since then, several Canadian provinces have adopted variations of the program.

An EFP is a comprehensive tool utilized by farm operators to assist in systematically identifying the actual and potential environmental risks and benefits associated with their agricultural operation. It supports farmers in developing achievable goals to improve environmental conditions on their farm in compliance with existing laws and regulations. The program assists farmers to voluntarily address identified concerns associated with their farm operation through the development of a personalized plan of action. A variety of funding sources are available to help farmers offset monetary costs in implementing individual plans. In addition to dealing with specific environmental concerns, the program increases awareness and knowledge of environmental issues and encourages Beneficial Management Practices (BMPs) that assist in the achievement of environmental objectives on the farm.

A wide range of issues is addressed by the EFP, from manure management to enhancing wildlife habitat and biodiversity. Among these are a variety of opportunities within the program to target the management of water quality and supply. While action plans associated with water use are intended largely to minimize negative impacts on the environment, there is a strong potential for this program to assist farm operators to enhance water supplies or, at a minimum, improve their own practices concerning water use. More efficient water use on the farm can be beneficial both in terms of reducing water contamination and in improving water resources on the farm. Thus, while responding to drought is not the specific intent of an EFP, actions associated with the program can enhance farmers' capacity to cope in times of water shortage.

Evaluation of Responses

The seven broad criteria were used to evaluate the four selected initiatives in terms of their ability to increase preparedness and self-reliance in the face of drought and water shortages. An extensive review of the use and application of criteria and associated indicators from a range of related academic subject areas enabled the development of a defensible series of questions for each criterion. These questions were piloted to the specific responses prompting the development of more detailed research questions that address each of the relevant criteria (Appendix B), and which were subsequently applied to each case study.

A major data collection effort on the four case studies was conducted using academic literature, government and industry publications, and media articles. The results of this secondary data review of the responses were compiled and assessed for components requiring further investigation. Key stakeholders and agencies were identified, informed of the research, and recruited to participate in detailed interviews organized around the questions that were developed; 28 in-depth, key-informant interviews were conducted. Fieldwork and supplementary data collection was undertaken in several Canadian provinces to assist in the evaluation of the selected responses, and included interviewees from British Columbia, Alberta, Ontario, New Brunswick, and Prince Edward Island. The majority of the interviews were conducted in person, with some carried out over the telephone or through correspondence. The interviews incorporated practitioners and staff ranging from federal and provincial governments, to farm organizations and related industry.

The results of the key-informant interviews were combined with the secondary research results and compiled as answers to the questions posed under each of the seven broad criteria (Appendix C). Drawing on these data, the evaluative criteria were applied systematically to each of the selected responses. Based on the information collected, the degree to which each response satisfied the key questions posed under the broader criteria was determined. The rationale providing the basis of these general evaluations is presented in Chapter 3 of this report, followed by an overall statement of performance of each of the responses per criterion.

3. Responding to Agricultural Drought

3.1. Overview of Response Types

During the first phase of the research, a cross-Canada survey and inventory of 84 structural and non-structural initiatives pertinent to agricultural drought and water shortages was completed. Referred to as "responses", these infrastructure projects, programs, policies, laws and other arrangements *directly* or *indirectly* facilitate and constrain responses to droughts and water shortages in agriculture. As noted earlier, some of these initiatives were designed with agriculture's water needs in mind, while others were judged to be indirectly pertinent. For example, across Canada numerous projects have been constructed specifically to increase the reliability of water supplies for agriculture. These often are purposeful responses to drought and water shortages. In contrast, programs exist that were designed for purposes such as habitat conservation or water quality protection, but which have implications for agricultural producers during times of water shortage and drought. These were classified as incidental.

In examining the table presented in Appendix A, the reader is reminded that the research design in this project did not allow for detailed interaction with program officials to confirm all aspects of the program or the interpretations drawn by the research team. Hence, the entries in certain categories (most notably "Outcome") should be read as provisional and preliminary.

The inventory (Appendix A) confirms that current experiences in planning for and responding to agricultural droughts and water shortages in Canada reflect a wide variety of approaches. These range from the provision of infrastructure to deliver water when and where needed, to measures designed to monitor and better understand climatic and hydrologic data in planning, to the incorporation of water efficiency measures in farm system design among numerous others. Many of the responses inventoried represent collaborative initiatives among public agencies and private stakeholders. Almost all of the responses are on-going, rather than *ad hoc*, programs or arrangements and the vast majority apply to any kind of agricultural activity. An exception, in terms of eligibility, is crop insurance.

Several observations regarding response type, intent, scale and outcome are particularly notable. While great diversity in responses to droughts and water shortages in agriculture is evident in Appendix A, almost two-thirds of the responses inventoried are incidental, rather than purposeful. Of those responses that are purposefully directed to agricultural droughts and water shortages, over one-half are structural measures designed to secure the supply of water for agriculture. Much less common are responses directed toward water conservation or efficiency in water use, which makes the SEKID case study detailed in Section 3.2 a particularly interesting one. Purposeful responses to agricultural droughts and water shortages are particularly limited east of Ontario, which is not surprising given the distribution of agricultural activity and water supplies across the country. The data on response type and intent calls into question the extent to which climate change has been mainstreamed in the agricultural sector. Only a handful of cases explicitly acknowledge the finite nature of water supply, e.g., the moratorium on new water licenses in the SSRB, Ontario's water permit requirements in high-use watersheds, and Prince Edward Island's groundwater extraction rules. There is even less evidence that the agricultural drought responses inventoried accommodate the prospect of an increasingly variable climate and likelihood of reduced water supplies in some regions.

Not surprisingly, Appendix A shows that the majority of responses to droughts and water shortages in agriculture are directed to the farm scale, or farm/community scale. In only several instances are responses directed to a watershed scale. The OLWR and the IWMS, both detailed as cases in Section 3.2, are two such instances, as are the Quebec National Water Policy and New Brunswick's Watershed Protection Program. However, the last two are only incidental to agricultural drought and water shortages. Purposeful responses to drought, directed to the watershed scale, are found almost exclusively in Ontario, which has a long history of water management organized around watersheds. Importantly, while numerous initiatives were identified in each province, there was little evidence that these are carefully coordinated, for instance, to address potential cross-scale conflicts.

Finally, and perhaps most importantly, Appendix A demonstrates that the vast majority of responses (almost three-quarters) work to sustain current practices, rather than facilitate change in agriculture to make it better able to respond to droughts and water shortages. Only two of the inventoried responses specifically facilitate change. About one-fifth of the responses may facilitate change or sustain current practices – but most of these are likely to do the latter. There are important implications in this observation, as adaptive capacity can be enhanced by actions that facilitate changes.

While beyond the scope of this study to assess the performance characteristics of the full spectrum of approaches documented in Appendix A, a key goal of the research was to systematically explore the manner in which a selection of approaches function with respect to certain tenets of successful adaptation. It is to this task that the balance of this report is devoted.

3.2. Evaluation of Case Studies

The main goal of the second phase of the research, under Objective 2, was to evaluate ways in which selected responses enhance prospects for preparedness and self-reliance in the face of droughts and water shortages at the farm, community and regional levels. Four responses, discussed in Section 2.2, were chosen for this evaluation. For each response, a detailed evaluation structured around the seven broad criteria and related questions and sub-questions was completed (see Appendix B).

The follow sections, which are organized around the seven criteria, synthesize results from this evaluation. Each section begins with a discussion of key concerns relating to the criterion. These establish the basis for the questions and sub-questions posed. Results of the analysis are presented in summary form in each section. Readers interested in the detailed evidence (with support from literature and key informant interviews) should consult Appendix C.

Criterion 1: Promotes Preparedness

A key element in responding to droughts and water shortages is preparedness. Preparedness involves activities that are undertaken in advance of a drought or water shortage which either raise the degree of readiness for the hazard, or improve the operational and institutional capacity to respond to it; early warning systems are an example of a measure that promotes preparedness (Wilhite 2000). Appropriate preparation facilitates a more effective drought response, as well as improving the success of coordination efforts and the timeliness of activities associated with risk management (Durley and de Loë 2005). Substantial reduction of negative social, economic and environmental impacts associated with droughts and water shortages may be achieved through preparedness (IPCC 2001).

Effective response to drought requires a clear understanding of its characteristics, timing, and potential impacts. Often considered as the most complex natural hazard, drought can be interpreted through various definitions and indicators (Wilhite 2000), resulting in both regional and local discrepancies in determining the onset and presence of a drought (Durley and de Loë 2005). It is therefore extremely important for decision makers to have a sufficient grasp of the nature of drought and its associated risks so as to enable the most appropriate response (Magalhães 1996).

In order to minimize negative outcomes and address irreversible or catastrophic impacts associated with drought, response options should be anticipatory and proactive (Smith and Lenhart 1996, Mizina et al. 1999). Reactive responses tend to be less effective, more costly, and often fail to take in to account unexpected outcomes and events (Burton 1996). Proactive responses occur prior to there being evidence of any impacts associated with drought as opposed to reacting to changes that arise (Klein and MacIver 1999) and anticipatory measures incorporate planning and foresight (Abildtrup and Gylling 2001). By preparing in advance, decision makers may seek the best options and strategies to deal with drought and remove barriers to their implementation (Burton 1996).

Changes over time in population and income can impact demand on water resources. As a result, drought responses should incorporate long-term planning to enable future generations to adjust to these changes. Decisions that may impact future water supply resources and development also require consideration in anticipation of drought to avoid unforeseen problems in the longer-term (Smith and Lenhart 1996). On-going monitoring and evaluation will assist in determining the success and effectiveness of responses to drought (Smith 1996), and over time, will provide opportunities to improve technologies and methods (Fankhauser et al. 1999), as well as enable more efficient and appropriate planning outcomes.

To address these concerns, we posed three questions that explored the extent to which responses promote preparedness:

- Does the response incorporate a clear understanding of agricultural drought?
- Is the response proactive and anticipatory?
- Does the response contribute to long-term planning?

SEKID Metering Program

The metering program used in the SEKID is intended to address both drought and water shortages, currently and in the future. It incorporates knowledge of water conservation and understanding of agricultural water use and management under water shortage conditions. Regular monitoring of climate data is coupled with recognition of the importance of determining site- and crop-specific water requirements over time. A combi-

nation of continuous monitoring of climate conditions and on-farm water demand, with an ongoing penalty system for excess water use allows both farmers and the irrigation district to actively adjust water consumption.

In addition to adopting a proactive approach of securing funding in advance of implementing the program, it encourages ongoing evaluation of activities through annual data collection and assessment. This information permits consideration and adjustment over time to the allotment of water and penalty rates. Longer-term planning is considered largely from a development perspective, as funding for future growth is collected specifically toward augmenting or increasing the district's water supply. Despite enabling short-term demand modifications, the program model is reliant on a dependable water supply and the irrigation district may become vulnerable if future water supplies become reduced or unreliable.

In terms of preparedness, the South East Kelowna Irrigation District metering program shows appropriate use of knowledge concerning its water supply management, and ongoing monitoring and evaluation to enable adjustment of activities.

Irrigation Water Management Study (IWMS)

The IWMS was intended to develop adequate knowledge of the pressures associated with current and future water supply in order to facilitate long-term agricultural water management. Agricultural drought was addressed indirectly through the general promotion of improved water management techniques. Regional water deficit risk was recognized through various components of the study including simulation modeling, the development of an agro-climatic database, identification of supply and demand scenarios, and improvements in irrigation efficiencies. The results provided an opportunity to examine the advantages of more efficient water use and to highlight the benefits across the irrigation districts.

The study was undertaken in order to facilitate long-term planning through improved knowledge and updated databases on water supply and demand. Ongoing information development and monitoring have become a part of normal operations for the irrigation districts and AAFRD, contributing to forecasting and planning activities. Four years of data collection and analyses are incorporated in the study, enabling assessment of current and future water supply vulnerability, and providing a solid basis of understanding for future water management planning.

The Irrigation Water Management Study demonstrates preparedness through a detailed evaluation of the structural system toward improved understanding of regional water supply and demand in relation to the irrigation district's capabilities, and long-term planning goals.

Ontario Low Water Response (OLWR)

The intent of the OLWR program is to prepare communities and agencies in the management and coordination of droughts and low water levels. The guidelines include a clearly stated definition of drought from a generalized perspective. OLWR does not address agricultural drought specifically. Instead, it refers to drought in the context of low water levels and adverse climatic conditions in a watershed. Drought indicators and thresholds are used alongside weekly data collection to monitor watershed levels.

While the plan is readily available, the guidelines are only implemented on a voluntary basis once the risk of a water supply deficit is identified; thus it is a reactive measure. The plan incorporates an operative warning system which indicates early signs of stress by classifying an impending drought using a system of predetermined levels. Although the plan provides guidelines for addressing water supply deficits, specific emergency response measures for responding to drought conditions are absent. Furthermore, a Level III designation calls for mandatory water user reductions, but this has yet to be tested.

The program lacks a built-in plan review process. However, it does encourage an on-going evaluation of the response through meetings between WRTs and the Ontario Ministry of Natural Resources (OMNR), which highlight drought program challenges, lessons and experiences. Continuous development and adjustment of local level response activities is undertaken based on feedback from the WRT and its identification of specific local needs.

Preparedness is demonstrated in the Ontario Low Water Response largely in terms of ongoing review and adjustment of response activities, and to a certain degree in terms of an understanding of water supply indicators and monitoring.

Environmental Farm Plan (EFP)

The EFP was not specifically intended to address drought or water shortages in agriculture. Instead, it focuses on identifying environmental impacts associated with farming practices through a preliminary farm assessment, and promotes methods of environmental stewardship via incorporation of a site-specific action plan. Several of the BMPs encouraged through the program are associated with management of water quantity and/or quality at the farm scale. The adoption of these practices may contribute directly or indirectly in reducing vulnerability of agricultural operations to drought or low water conditions. A proactive approach

is reflected through a deliberate and systematic review of individual farm operations, which provides an opportunity to develop a predetermined plan of action to address any identified issues or problems.

Long-term farm-scale planning is facilitated by the EFP program though the self-assessment process, improved understanding of sustainable farm stewardship practices, and through the process of envisioning the farm in the future. Evaluation of the workbooks that are used by farmers to assess their farms assists in improved understanding of the impacts of their agricultural activities, and in developing improved practices. Many provinces have revised the material in the workbooks through several editions based on feedback from participants, program delivery teams, and education experts. A national committee for BMPs acts as a forum for annual evaluations and potential improvements to the practices, including applications for changes to BMPs incentive programs, suggested additional practices, and proposed changes concerning eligibility under practices.

The Environmental Farm Plan establishes preparedness through its potential for long-term planning via a future vision at the farm-scale and through its recognition of the impacts of farm water management on the external environment.

Criterion 2: Promotes Self–Reliance

Self-reliance is a measure of the capacity of a community to respond to water shortages. It involves the extent to which a community manages, collaborates and participates in decision making-processes concerning its water resources (Ivey et al. 2004). Capacity to respond to droughts and water shortages is reflected in the presence of mechanisms that enable community participation and conflict management protocols (Durley and de Loë 2005). Self-reliance is promoted through public and stakeholder awareness and understanding of water quantity issues (Ivey et al. 2004) which is reflected in local support for the adoption of response measures and their success (Smith and Lenhart 1996).

The delegation of authority from larger jurisdictions to smaller more local entities is becoming increasingly evident in many jurisdictions (Durley and de Loë 2005). Adequate drought response suggests that local communities ought to be involved in drought alleviation talks with government and local elites. If adaptation measures surrounding climate change and drought are not discussed and agreed upon by various levels and societal groups, then adaptation policies may fail (Magalhães 1996). Thus, the devolution of responsibility from senior to local governments permits increased community involvement in adaptation activities, and therefore a greater sense of ownership and commitment to success (Durley and de Loë 2005). Self-reliance at the farm-scale also reduces reliance on government assistance programs and encourages adoption of appropriate planning and management of farm activities while also avoiding the support of potentially unsustainable practices (Haylock and Ericksen 2000, Wilhite 2004).

A major determinant of self-reliance and the adoption of risk management practices at various levels is the degree to which stakeholders are provided with incentives to reduce the risks and impacts of droughts and water shortages (Rush and de Loë 2002). Increased levels of education and capacity are associated with increased levels of community empowerment (Rich et al. 1995), which can generate support networks and partnerships (Durley and de Loë 2005). A lack of public knowledge surrounding drought and water supply issues can result in a lower adoption of local conservation measures. Education programs, provided on behalf of agencies and government, are seen as beneficial mechanisms to provide risk management training in the area of water conservation and drought planning (Rush and de Loë 2002). Thus, in order to successfully respond to drought conditions, there is a need for a moderate level of societal and stakeholder awareness to ensure adequate capacity building. Since the results of climate change affect all levels of community, climatic variability and the impacts of climate change are topics which need to be further studied and understood by the public and policy makers (Smith and Lenhart 1996).

To address these concerns, we posed three questions that explored the extent to which responses promote self-reliance:

- Is self-reliance promoted by the response?
- Does the response improve societal/stakeholder awareness?
- Does the response promote risk management?

SEKID Metering Program

The SEKID metering program incorporates monitoring of on-farm water use, and farmer education concerning both agricultural water use practices and crop-water relationships. By providing information and improving understanding, this enables farmers to monitor individual agricultural operations and increases their decision-making capacity. At the community scale, the irrigation district is capable of monitoring water use through district-wide data collection and by regulating demand through its own bylaws and metered rate system. Greater efficiencies in matching water demand with actual crop requirements, and determination of appropriate and regulated water allocation, can assist in

limiting crop losses and ultimately dependence on disaster assistance.

Stakeholder awareness concerning on-farm water management has been a key element of the metering program, has contributed to its success. Public and stakeholder consultation at the program's inception provided an opportunity to highlight local opinions and concerns. Throughout the program, emphasis on stakeholder engagement has largely targeted agricultural practitioners by providing opportunities to take part in meetings, field days, and educational activities. Water-use reports and climate information have also been made available to farmers.

Risk management was facilitated at the program's inception. The irrigation district implemented metering and promoted water conservation due to limited alternative measures, potential financial savings, uncertainty of climate change, senior government support, and the success of a pilot program. Landowner adoption of more efficient on-farm water use has been realized through an educational component which assists with comprehension of the benefits of water conservation and provides specific on-farm practices to achieve this. An inclined block rate structure, combined with predetermined water allocations, provides another incentive by financially penalizing landowners in excess of their allotment; these people may also face discontinuation of water service for non-compliance. In addition, the distribution of reports containing data that compares an individual property's water use to that of the similar operations within the district may compel some landowners to adjust consumption.

Self-reliance is promoted through the South East Kelowna Irrigation District metering program in terms of engaging stakeholders in water supply issues, enabling farmers to monitor and adjust individual water use, and through strong incentives derived at the local scale.

Irrigation Water Management Study (IWMS)

Regulatory changes combined with enhanced data gathering and analysis from the IWMS contributed to increased decision-making autonomy of irrigation districts and enabled them to work together toward targeted issues. These factors also prompted individual district studies that specifically address local characteristics of water supply and use. Improvements in data and the use of detailed irrigation scheduling tools has enabled agricultural producers to more effectively manage their water use at the farm scale, incorporate higher value crops, and potentially reduce their reliance on disaster assistance mechanisms.

The study provided stakeholders with a greater awareness of the importance of irrigation water efficiency through irrigation district media publications and publicity throughout the region. The five-volume report associated with the study contains in-depth information that contributes to the SSRB planning process as well as supporting improved public knowledge. Public participation was not encouraged in the development of the study, which had a largely technical focus, and data collection did not incorporate stakeholder or public input. Rather, the emphasis of information sharing was toward decision makers and elected officials.

The study involved irrigation district boards made up of the citizens of a particular region. Because of the locality of the study, there was an incentive to have a water management program which was viewed as responsible and transparent. There was very little scope beyond the districts themselves.

Evidence of self-reliance is illustrated in the Irrigation Water Management Study through greater decision-making capacity and effort at the district level and to a certain degree through improved awareness on the part of the decision-making community.

Ontario Low Water Response (OLWR)

The importance of local level authority is not emphasized under drought conditions within the guidelines of the OLWR program. Local WRTs, established by the Conservation Authorities (CAs), undertake coordinating and communicating activities, and make recommendations regarding the response. However, beyond the implementation of local-level tools such as by-laws, the teams lack authority and rely on senior agencies to monitor and enforce reductions. While dependence on disaster assistance may be reduced through this program, this lack of authority can result in uncertainties concerning protocols and other drought response actions.

The program incorporates the availability of hazard information and some education to the public. Information supplied to the public includes, graphs or maps on weather and flow conditions and vulnerable or susceptible areas to drought. WRT representatives are responsible for informing the local public about any water conditions, as initiated by this program. Additional information is available to the public through district offices and websites, and public involvement is sometimes enabled. While the community is represented on a local WRT by its municipal officials, emphasis is generally geared toward major water users.

The primary incentive to stakeholders to conserve water associated with the program concerns penalties for non-compliance by water allocation permit holders. However, friction among users concerning water allocation that is perceived to be inequitable may result in disincentive to reduce water use. There is some educa-

tion of users although it is not a strong component of the program. At the agency level the incentive to promote the program is largely related to conflict avoidance among water users and mitigation, as improved water supplies during low water conditions can affect equity related decision-making and water allocation. There is also a vested interest among agencies where the program demonstrates relevance to respective political agendas and legislative tools.

Self-reliance can be identified in the Ontario Low Water Response through the availability of relevant data to the public and some local level regulatory measures.

Environmental Farm Plan (EFP)

The EFP program is largely based upon a self-assessment system by independent agricultural operations and (potential) assessment by a peer review committee, thus authority is delegated to the local level. Decisions and planning activities tend to occur at the farm scale, with input from external expertise. While farmers can theoretically implement changes to their agricultural practices at their own cost, in many cases there is reliance on government assistance programs to undertake on-farm projects. Self-reliance can be promoted by the program through adjusting practices that improve on-farm water use efficiency and storage, and reduced water contamination, resulting in an overall improved local water supply.

Hazard information concerning water quantity is incorporated into each province's program at varying levels. For example, an increased emphasis on water efficiency in British Columbia is due to a high level of irrigation agriculture. Other information is available and accessible publicly through media sources. However, since it is primarily focused on educating farmers, there is little to no publicizing of the program outside the agricultural community. Farmers are actively engaged in the program throughout the entire process. They participate by attending information workshops, developing an action plan, undergoing peer or technical expert review, and implementing the plan. They may also be involved in suggesting changes or improvements to the program.

Environmental farm planning does promote risk management, which occurs mostly at the farm-scale. Farmers involved in the program are provided with financial, educational and technical incentives to adopt conservation practices. There are a variety of agricultural cost share programs in place to assist farmers implement action plans, but access to these is often dependent on completion of an EFP. An additional incentive to adopt conservation measures relates to public perception of farming, where individual farms can use a farmgate sign to advertise themselves as environmentally conscious.

The Environmental Farm Plan encourages self-reliance through farm-level adjustment of practices, engagement of farmers in the process, and especially through the promotion of localized risk-management.

Criterion 3: Promotes Strategic Change

An important element of drought response is strategic change that enables efficient planning and decision making at all scales. Strategic changes utilize non-drought related investment programs, as well as planning and decision-making efforts associated with other activities, such as infrastructure decisions, plan revisions, or research and development investments, in order to address targets of opportunity to adapt to climate change (Smith 1996). Planned adaptations to climate-related risks such as drought that are derived as components of or modifications to existing resource management programs or strategies are also more likely to be implemented (Smit and Pilifosova 2001).

A drought response mechanism is viewed more positively if it provides additional benefits beyond the reduction of risks and susceptibility associated with climate change (Dolan et al. 2001, Mizina et al. 1999). Furthermore, adaptations should be justifiable in the context of existing circumstances, independent of climate change (Smith and Lenhart 1996). Measures associated with water conservation provide an ideal example, where future climate change vulnerability can be minimized through addressing current water resource concerns (de Loë and Kreutzwiser 2000). The net benefits of an adopted strategy that occur regardless of the intended purpose of the response provide "no regrets" measures (de Loë and Kreutzwiser 2000, Smith and Lenhart 1996).

An additional element of strategic change concerns the ability to implement the approach under a variety of regional characteristics. Initiatives that can be replicated or utilized under a range of conditions are more desirable than ones where their effectiveness is limited to strict boundaries. A response that is transferable among alternate circumstances may ultimately reduce vulnerability associated with drought (Stratus Consulting n.d.).

To address these concerns, we posed three questions that explored the extent to which responses promote strategic change:

- Does the response address targets of opportunity for strategic change?
- Does the response provide independent benefits?

- Can the response be utilized elsewhere?

SEKID Metering Program

The SEKID metered rate penalty system and the savings associated with reduced water use have allowed the district to put off expansion of infrastructure projects. Funds associated with future growth have also been collected to increase water supply and enhance the district's water distribution system. These are collected through the purchase of water rights by developers for un-serviced irrigation district land that has not been serviced.

In the absence of drought, there still exists a variety of benefits associated with the conservation of water through this response. These include energy savings through reduced operational costs, prolonging the duration of existing water supplies, and protection of the environment and water quality. Additional benefits include improving irrigation efficiency and water use planning and management at the farm scale, equitably resource distribution among landowners, elimination of waste, improving water resources, and providing some financial return and savings to the irrigation district. There are also benefits associated with reduced resources being utilized toward investigation of misuse of water, use of collected data toward future planning, and utilizing the opportunity to upgrade district infrastructure.

The metering program is not limited to specific social, economic or environmental attributes. The flexibility and range of metered rate options available permits tailoring in order to reflect a variety of local irrigation district characteristics. The program takes into consideration the diverse range of farm conditions that can exist and annual water use allotments are adjusted accordingly. Education, technical assistance, and regulatory measures are also important components to the program and can be transferred to reflect local circumstances.

Considerable evidence of strategic change in the South East Kelowna Irrigation District metering program is demonstrated through investment in future growth and water supply, provision of multiple benefits, and its transferable characteristics.

Irrigation Water Management Study (IWMS)

The original motivation behind the IWMS was that there were insufficient scientific data available in the region surrounding water quantity and trends. With this study, the results ensure that appropriate measures can be taken to promote responsible irrigation expansions in the SSRB and to provide appropriate information toward its water management planning.

Improvements in irrigation efficiency can be positively reflected in crop production and overall farm success. Through both forward and backward linkages, these outcomes create additional economic benefits for an operation. On a larger scale, improved irrigation infrastructure has regional environmental, economic and social benefits for participatory communities.

Strategic change can be found in the Irrigation Water Management Study through the provision of additional benefits generated at the farm and community scale.

Ontario Low Water Response (OLWR)

The OLWR program largely builds upon other water management activities as a means for achieving water conservation mechanisms. In many Ontario watersheds there are multi-stakeholder committees associated with water management which can be combined with the program's results to further develop Water Response Teams. These collaborations assist in reducing water consumption and promoting sharing of allocated water resources, thus enhancing the effectiveness of the program.

There are several benefits associated with the response which stem from adopting locally-relevant strategies that improve overall water supplies. Non-agricultural stakeholders benefit from the program in that any shared water resource player is represented through water allocation and monitoring. The program has the potential to become a useful tool in public education of water resource management, which may assist in cooperation regarding other initiatives. It also provides a forum to limit water allocation conflicts, as well as contributing to other water monitoring related programs.

Certain attributes of the program are important in ensuring the effectiveness of the response. The program was designed to operate on a watershed basis, using existing conservation authority mechanisms. It was also intended to operate under a system where the government retained the right to intervene. Yet the response also permits a range of variations that reflect local characteristics and resources in order to achieve locally relevant strategies.

The Ontario Low Water Response demonstrates strategic change through sharing of administrative, management and decision making resources, and through the provision of various community benefits.

Environmental Farm Plan (EFP)

Aside from improving farmers' environmental stewardship, the implementation of BMPs associated with the EFP program have substantial benefits in terms of reducing human impacts on the environment, ranging

from the reduction of water contamination to protecting environmentally sensitive areas. There are also economic benefits for farmers who choose to engage in the program due to the potential for more efficient operating costs. Since it addresses a wide range of issues associated with farming practices, the program is also beneficial to other non-drought related initiatives.

Environmental farm planning has successfully been implemented in several provinces across which there is a wide range of social, economic, physical, and environmental attributes. While the general foundations of the program are common across the country, the process of how it is delivered can vary provincially. The program is flexible enough to address a wide range of farming activities that exist within the agricultural sector, providing a diverse set of actions that may be implemented by farmers. Individual provinces also have some flexibility in determining the organizational structure of the delivery of their program, which can help alleviate differences in program delivery capabilities between provinces.

Environmental and farm-scale economic benefits illustrate strategic change in the Environmental Farm Plan, as does its wide-ranging utility under alternative social, economic and environmental conditions.

Criterion 4: Lessens Vulnerability

Effective response to droughts and water shortages requires adaptation measures which lessen vulnerability. In order to limit impacts in any individual sector, adaptation mechanisms should recognize a broad range of uncertainties (Smith and Lenhart 1996). Potential responses to droughts and water shortages should be screened based on a variety of criteria in order to minimize unforeseen impacts (Smith et al. 1996). In order to reduce exposure and minimize losses associated with climate change, it is also important to reduce sensitivity to impacts (de Loë et al. 2001). Reduced social and economic vulnerability can be achieved through careful planning and implementation in this way.

A significant challenge, particularly in water management, is ensuring that activities associated with adaptation do not needlessly impact the environment (de Loë et al. 2001). An adaptation may otherwise harm an ecosystem and cause irreversible damage, further increasing environmental vulnerability (Smith et al. 1996). Rather, responses that reduce vulnerability through increased environmental benefits should be adopted.

Adaptation programs in response to climate change and drought can have the effect of reducing supply/demand shortfalls in water. Reducing the demand for water can result in increased supplies, allowing for a greater safety margin under future drought conditions. While allocation of water can reduce demand, it can also improve the resiliency and robustness of a water supply system, enabling a more rapid response to fluctuating supplies (Smith 1996). Increased efficiency in water use, such as through adoption of improved irrigation technology, reduces dependence on natural water systems, with the added benefit of lowering consumption of water without negatively impacting crop production (Smith and Lenhart 1996). Poor water quality effectively reduces readily available water supply. Thus adaptations that assist in improving water quality and protection are more desirable (Smith 1996).

Since the local impacts of climate change are uncertain, there is a need for flexibility within any adaptation system. Flexible adaptation enables a response to function effectively under various climatic conditions (Dolan et al. 2001). The flexibility of a response may be determined through its robustness (i.e., can it be adapted to changes in a variety of conditions), its resilience (i.e., can it be easily and quickly repaired or adapted) (Smith and Lenhart 1996) or its reversibility (i.e., the response can be altered should newer a more appropriate direction become evident) (de Loë et al. 2001).

To address these concerns, we posed four questions that explored the extent to which responses lessen vulnerability:

- Does the response reduce social and economic risks associated with drought?
- Does the response reduce environmental vulnerability to drought?
- Does the response reduce demand/supply shortfalls in water?
- Does the response incorporate flexibility?

SEKID Metering Program

By reducing water consumption in the district the SEKID metering program resulted in irrigators avoiding the potential for serious crop losses during hot and dry conditions, whereas other areas in the region faced severe reductions in their water supply. Over the long term, the response has the potential to extend the period of time over which a farm can cope with water supply deficits or drought, thus minimizing social and economic impacts. Additional impacts can also be avoided through reduced water consumption across the district. As a result of metering, demand for additional water supply expansion, and subsequently its treatment, is lessened. This can result in a reduction of impacts to the environment regarding both water quality and quantity.

The metering program has resulted in extensive data collection that better reflects actual water requirements for the irrigation district. While education of farmers concerning farm water management assisted in improving water use efficiency, the combination of an allotment system, which is based on a required volume of water under drought conditions, and penalties for exceeding that allotment, contributed to reduced overall demand. Greater control over demand ultimately enhances the district's supply management capability, and the potential to redirect water resources to irrigation expansion.

Adjustments can be made to the metered rate structure with relative ease providing there is support from regulatory agencies in order to make bylaw amendments. This adjustability enables influence over local irrigation water demand and has the potential to increase revenues for the district, while still facilitating ongoing water monitoring. While the education component of the program contributes to positive long term impacts on farmer perceptions and activities concerning conservation and water management, the response can be reversed if necessary by ceasing metering, although this might have a short-term impact on revenue generation for the district. Resilience is also demonstrated through metering as the irrigation district has been able to adjust to drought conditions, and with fewer water resources, than some non-metered districts. It is expected that due to the program, the district could manage demand through multiple years of successive drought.

By minimizing the risk of farm-level economic impacts, increasing control over demand, and by utilizing a flexible metered rate structure, the South East Kelowna Irrigation District metering program reduces vulnerability associated with drought.

Irrigation Water Management Study (IWMS)

The IWMS provided a key system overview, identified areas of demand management flexibility, and assisted in improving the efficiency of the distribution system, resulting in greater overall fine-tuning. The study is not directly responsible for reducing farm vulnerability associated with drought. However, it enables operators to be more readily prepared to respond to drought situations through access to data and a better overall understanding of the system, thus potentially reducing vulnerability associated with water supply shortages.

Aside from water conservation, there are few environmental benefits as a result of increased efficiency of infrastructure and irrigation systems. Some environmental and recreational groups have opposed improvements in water system efficiency due to the impacts these changes may have on artificially created wetland habitat stemming from canal seepage.

Each district was assessed individually in terms of supply and demand levels because of the uniqueness of hydrological and climatic characteristics and infrastructure in each area. The study has prompted various programs to reduce waste and improve return flows through water management and infrastructure improvements, thus increasing the overall supply.

A reduction in vulnerability to drought is shown in the Irrigation Water Management Study through greater efficiencies in the irrigation distribution systems and overall water supplies.

Ontario Low Water Response (OLWR)

The OLWR, when implemented at the onset of scarce water conditions, has the potential to reduce pressure on individual agricultural operations. While water use restrictions are often implemented on a standardized basis by the local WRT, the economic risks to different areas and stakeholders may be considered to ensure that one area is not impacted more than others.

The response effectively reduces water demand by both voluntary and imposed water-use restrictions. Through increased community awareness and understanding of water resources, the program has the potential to make it easier for regions/municipalities to implement water-use restrictions and by-laws with less opposition.

There is a degree of regional flexibility associated with the program because response measures are designed at the local level and for local conditions. Roles and duties of stakeholder representatives may be adjusted in order to allow for variations in the structure of the program. The use of a WRT also provides flexibility where the most appropriate communication networks can be individually determined depending on ministry structure. However, the resilience and adaptability with which the response can be adjusted to changing water demands can be impeded by a high volume, lengthy and imprecise water allocation program.

Through controlled reduction in water consumption and flexibility in local level design and implementation, the Ontario Low Water Response somewhat lessens vulnerability associated with drought.

Environmental Farm Plan (EFP)

Actions undertaken as a result of an EFP can lessen the impacts of on-farm drought through adjustments in operating practices. By utilizing BMPs that address on-farm water supply in advance of low water conditions, operators can potentially maximize their water use efficiency through better access and storage. These measures have the capacity to extend water supplies long enough to reduce the impacts of drought, thus minimizing personal losses.

The program is intended to reduce the environmental impacts of agricultural operations by addressing the environmental awareness of farmers, by promoting improved farm practices, and by solving identified problems on the farm. As farmers become more aware of their impacts on the environment and of the benefits of the adopting BMPs, they are more likely to incorporate practices that utilize water more efficiency, ensure cleaner water sources. They are also more likely to adopt specific practices that improve water resources in the environment such as through wetland restoration, which can help alleviate environmental vulnerability to drought.

Development of increase water supplies and reduced demand can be achieved through a variety of practices promoted in the program. Direct actions taken can include expanding water wells and storage, and improving efficiency of water delivery systems. Indirect activities can also improve water supplies such as though reducing evapo-transpiration by using cover crops, and addressing water quality issues.

The program is highly flexible and can be adapted to a range of regional characteristics. The program permits variation in both the design and implementation of site-specific projects, as well as in its organizational and delivery structure which could prove useful in the event of water supply deficits and resultant impacts on the farm. At the farm scale, environmental farm planning allows for self-assessment and evaluation of current BMPs, thus creating a wide range of potential adaptive measures.

The Environmental Farm Plan lessens vulnerability through more efficient farm-water use, greater environmental and on-farm water quality, improved farm-water supplies, and adaptability to farm and regional characteristics.

Criterion 5: Social and Political Acceptability

The uptake and success of a response may be influenced by the public and political support that is expressed within a community or region. High levels of social and political acceptability provide greater legitimacy of an adaptation measure and influence the ease of implementation. It is important that a response to drought be consistent with the social, economic and environmental goals and objectives of a community (Ivey et al. 2001).

Social perceptions of a response to drought and water shortage may be influenced by varying degrees of understanding and experience with drought impacts and risks. Social attitudes toward response mechanisms may also depend on awareness or opinions concerning the availability of water resources within a particular region (Rush and de Loë 2002). The implementation of a response may be dependent on public and stakeholder consensus that resources, such as water, are in fact vulnerable to climate change. Furthermore, actors need to agree that proposed adaptation mechanisms are reasonable and appropriate for the situation (Smith 1996).

Access to necessary resources is an important consideration when determining an appropriate adaptation measure. Limited availability or inadequate access to a resource by individuals or groups can result in inequities (Smit and Pilifosova 2001). To minimize inequity, there is a need to limit and resolve conflicts over water resources, and to promote cooperation and shared responsibility amongst stakeholders (Stratton 2005). In addition to ensuring all stakeholders are represented, it is also important to minimize socio-economic risks associated with a response (Kelly and Adger 2000). Equity considerations may be addressed through spreading risk across sectors, which can help alleviate impacts to those who are more vulnerable (Yohe and Tol 2002)

An increasing role of local and non-state actors in Canadian public policy decision making (de Loë and Kreutzwiser 2007) requires acknowledgement of the importance of designing responses that are socially respected. However, if local administrative or political representatives are opposed to an adaptation, the capacity to manage and respond to drought is considerably decreased (Kelly and Adger 2000). The lack of available resources to implement a response, and uncertainty associated with the benefits of implementing a response can create barriers to political support. Alternately, adaptations that are compatible with existing structures of management, policy frameworks, and development goals ultimately have a greater chance of securing political support (European Environment Agency 2007), and thus being adopted and maintained over time.

To address these concerns, we posed three questions that explored the social and political acceptability of responses:

- Is the response socially acceptable?
- Is the response equitable among key stakeholders?
- Are there the necessary political conditions?

SEKID Metering Program

The SEKID metering program was initially met with strong resistance from the agricultural community due to concerns over incurring higher water costs and potentially losing water to development in other sectors. Distrust toward the irrigation district, evident through public consultation, prompted the incorporation of a five-year window where no rates would be applied.

This permitted time for the district to educate irrigators on water conservation techniques and benefits, resulting in a ten percent reduction in overall district water demand. The district also eventually chose to only penalize excessive water use rather than based on total volume of use per property, which likely contributed to the shift among water users toward more positive perceptions of and support for program. Similar initial resistance has been met by other districts considering adopting the program.

Annual irrigation district water allotment is based upon the district's weighted average drought year requirement, which is determined through the collection of district information reflecting an analysis of diverse farm soil characteristics combined with climate data. In its development of the program, the district recognized that applying a uniform allotment across varying farm conditions has some difficulties, where some farm soils demand water in excess of the allotment. The inclined block rate has provided a rate structure that results in minimal penalties to such lands and increases penalties only as water is increasingly wasted, ultimately reducing inequities among water users. In terms of stakeholder representation, agricultural interests have historically been strongly accounted for in the district. This is currently shifting to an increase in residential representation on the district Board which may impact farm access to water resource access in the future.

From a strategic perspective, metering was a politically difficult choice for municipal representatives due to the initial lack of support from the agricultural community, but this has shifted over time as the program has proven itself and gained stakeholder support. Provincial support has been evident from the program's inception.

The strong educational component of the South East Kelowna Irrigation District metering program fostered social and political acceptability, despite its strong initial public rejection, while the metered rate structure enabled equitable distribution of water supplies.

Irrigation Water Management Study (IWMS)

Due to a commitment to review regional water allocation regulation, there was support from various ministries in the province to undertake the IWMS. As a result, pressure was applied to the agricultural industry to adequately represent itself from a technical standpoint as well as to create a positive impression of the industry. With the support of elected political representatives, there was also an incentive to attain the required knowledge to move forward with irrigation development.

Political acceptability of the Irrigation Water Management Study can be attributed to commitment and support from political representatives.

Ontario Low Water Response (OLWR)

On the local and provincial scale, the various ministries and CAs involved with the OLWR are well established, and their role is acknowledged by the public. While the program is not widely publicized and does not involve extensive communication with the public, the end goal of managing limited water resources addresses a number of public concerns and offsets the associated risks while doing so. Thus, by tackling issues such as environmental, social and economic concerns in water management, the program reflects public values.

The program is not equitable among all stakeholders. The guidelines do not recognize the unique requirements of water management in the agricultural sector under low water conditions. The absence of an effective water use monitoring system leads to uncertainty regarding the actual number of water users and fails to recognize users who already utilize conservation measures in times of low supply. Accountability and equality among water resource stakeholders is also reduced as attendance by representatives for the various stakeholder group meetings does not appear to be mandatory.

Political support for the response at the provincial scale is illustrated through the participation of several government ministries. At the local level, skepticism may exist due to limited funding for the implementation of the program, particularly in municipalities where water management is not a considerable priority. In addition, the popularity of elected officials can be affected during public adjustment to new water restriction by-laws implemented in association with the response.

Through addressing public values and concerns related to water supply and engaging various government ministries, the Ontario Low Water Response demonstrates some social and political acceptability.

Environmental Farm Plan (EFP)

The government agency responsible for implementing the EFP at the federal level is both established and nationally recognized. The various delivery agencies across the provinces are often directly associated with stakeholder groups and also have strong ties to federal and provincial governments. Thus, there is a high degree of legitimacy surrounding public perception of the involved agencies. While farm-scale support and adoption of the program has in some cases been variable, over time the program has become widely adopted, participants have increasingly recognized the benefits

of the program to the environment. The anonymous and voluntary nature of the program, combined with incentive funding for farm plan implementation, have also been a significant factors in the program's uptake.

The program provides farmers interested in participating with adequate and equitable access to technical resources and information. Workshops are generally offered at no cost to participants, and are provided at various times throughout the year and at a range of locations to ensure accessibility. Farmers are free to choose the most beneficial and relevant cost-share programs to their operation. Inequity may be perceived on farms where improvements were identified and addressed prior to the availability of the program without retrospective financial assistance. Higher risk operations will also tend to benefit more from cost-sharing than those needing minimal adjustments. Efforts to accommodate a wide range of farming practices is evident in provinces where there are numerous commodity groups which can offer support and stability for all aspects of farming.

Stakeholder approval for the Environmental Farm Plan is derived from its equitability, the anonymous and voluntary nature of the process, the legitimacy attributed to delivery agencies and organizations, and its ability to address a public value such as environmental health.

Criterion 6: Legal and Institutional Feasibility

Regulatory and institutional arrangements impact capacity to respond to droughts and water shortages, in terms of decision-making, coordination of activities, and enforcement. Institutional provisions that align with existing laws and regulations are most appropriate (Dolan et al. 2001). Effective regulatory measures must be readily available or easily accessible to implementing agencies (Smit and Pilifosova 2001). Authority to utilize regulatory tools and to actively enforce a response is also important (Ivey et al. 2004). Thus a key element in developing a strategy to respond to drought is in identifying statutes, agreements, regulations or policies that either impede or support it. Since regulatory measures may require changes to facilitate implementation and compatibility across boundaries (Smith 1996), understanding of current arrangements is necessary.

Successful response to droughts and water shortages not only requires jurisdictional authority and power, but also the identification of lead agencies to implement and enforce measures, and clearly defined roles among all actors. Clear understanding of roles and responsibilities across agencies influences capacity to manage water resources (Ivey et al. 2002), and helps to avoid overlap, redundancy, and ensure consistency in responding to water supply variability (Ivey et al. 2004). Distinguishing the responsibility of various actors and decision-makers ensures that all critical aspects of the response, ranging from government research to the implementation of new technologies at the farm scale, are addressed (Smit and Skinner 2002). As senior government agency support is also an important component of adaptive mechanisms (de Loë et al. 2001, Ivey et al. 2002) it is important to clearly distinguish responsibilities and define which components of a response require assistance.

In order for communities to effectively address water supply vulnerability, capacity-building interactions among the principal players are critical (Ivey et al. 2004). Inadequate interaction among diverse agency and stakeholder interests associated with a response to drought can lead to poor coordination, communication and collaboration (Litke and Day 1998), and can result in conflicts over water supplies and planning difficulties (Durley and de Loë 2005). An interdisciplinary approach to research, fostering the development of partnerships and translation of information to decision makers, can contribute to more informed choices and objective evaluation of response measures (Meinke 2003). The promotion of synergy across regions also allows for stakeholders to build on the expertise and resources of various sectors. This process of collaboration, in turn, allows the regions to facilitate ongoing learning and evaluation programs to improve adaptation measures (Michaels 2001).

Appropriate response mechanisms are compatible with other adaptation activities and avoid hindering other measures (Smith et al. 1996). Agricultural adaptations with the fewest trade-offs are most desirable, particularly when arrangements are available to promote and assist in their adoption. Alternately, response options are less desirable when institutional frameworks fail to support or sustain implementation (Dolan et al. 2001). Mechanisms adopted in one sector are also more likely to be adopted if they avoid interfering with adaptation activities in other sectors (Smith et al. 1996).

To address these concerns, we posed four questions that explored the legal and institutional feasibility of responses:

- Are there any statutory or regulatory measures influencing the response?
- Do institutional arrangements affect capacity to respond?
- Does the response facilitate communication, information sharing, and coordination among agencies, organizations and stakeholders?
- Does the response impact other adaptation measures?

SEKID Metering Program

The SEKID implements the metered rate structure through the use of bylaws that regulate irrigation water use and set restrictions. Bylaws enable the district to set annual water use allotments, to implement fees against users exceeding allotments, and to discontinue their water service. They also set out the authority of the district's Board of Trustees in terms of the provision and regulation of water.

Guided by the Board of Trustees, the Irrigation District provides the primary source of leadership for the metering program through its water supply management, data collection, reporting, and operation of the metered rate system. The district coordinates its overall water management with four other primary local irrigation districts through a regional coordinating committee, permitting communication and information sharing between the districts.

Moderated demand for irrigation water through the metering program could make other adaptation efforts easier to implement by increasing water resource availability. The educational component of the metering program may also impact other adaptation activities as water users are potentially more willing to adopt other measures if the problems and solutions are understood by them. There is the potential that metering could interfere with non-drought related adaptation activities during a start-up phase as it may require technical and financial resources that might be utilized elsewhere.

Legal and institutional feasibility is evident in the South East Kelowna Irrigation District metering program through utilization of local level regulatory measures and a centralized coordinating body.

Irrigation Water Management Study (IWMS)

Regulatory measures played a significant role in initiating the IWMS. Guidelines concerning southern Alberta's water allocation and management were developed under the SSRB Water Management Policy (1990) and implemented through the *1991 South Saskatchewan River Water Allocation Regulation*, in accordance with Alberta's *Water Act*. Due to data and information limitations at the time the *Regulation* was implemented, a commitment was made to review and refine it in the year 2000. As a result, the *Regulation* is the primary piece of legislation driving the study which was intended to provide an up-to-date account of Alberta's irrigation industry and its current and future water management in order to better assist the allocation guidelines.

Federal, provincial and regional representation across four key agencies provided adequate jurisdictional authority to facilitate the study. Senior level government agencies showed commitment and support for the program and both financial and technical contributions were made at all levels.

The IWMS Steering Committee provided leadership and direction for involved stakeholders and developed working groups to address specific focus areas. The study involved multi-agency support. As a result, cooperative measures and collaboration were essential to its success. While collaboration was strong among both vertical and horizontal linkages at the onset of the study, it was diminished with pressures to complete the research, and potentially due to conflicting priorities.

Since the study is heavily focused on management of irrigation infrastructure, there is no consensus on how its implementation will affect related sectors. On the one hand, the study may enhance further adaptation concerning water shortages in the basin through increased knowledge of its water system. Alternately, the use of improved water efficiencies toward further irrigation expansion may contribute to environmental risk associated with reduced water quantity, as well as reduce water supply to other sectors.

Regulatory measures strongly influenced the legal feasibility of the Irrigation Water Management Study, while senior level support and collaboration efforts reflect institutional capacity.

Ontario Low Water Response (OLWR)

The OLWR was designed to operate within current legislation. Federal level regulatory measures, such as the *Fisheries Act* and *Navigable Waters Protection Act*, and provincial legislation such as the *Ontario Water Resources Act*, *Municipal Act*, and *Conservation Authorities Act*, must be considered when implementing the response.

The guidelines outline specific roles and responsibilities among the different agencies and stakeholders involved in the response. Various agencies at the federal and provincial level possess the authority to utilize legislation in the implementation and enforcement of actions associated with the response. Municipalities and CAs are limited in their authority beyond local boundaries and activities revolve largely around developing recommendations to senior authorities and promoting voluntary conservation to the public. Despite evidence of strong senior level government support for the program through funding, technical support, communication, and infrastructure development, reduced local decision-making authority potentially constrains effective water supply management.

The creation and development of cooperative efforts between local and provincial governments is part of the intent of the program. The overall direction and leadership is provided by the OMNR which collaborates and

coordinates with other sectors. Communication and information sharing takes place across various agencies within the provincial government from different backgrounds and interests through a central committee which provisions for multi-agency representation, as do locally-based WRTs. CAs also provide a link for public and stakeholder interests.

This program has a positive impact on other activities in the watershed through consistent and systematic monitoring of conditions. The information generated within OLWR can also be used to improve funding, infrastructure development and support, thus impacting other adaptive activities locally and elsewhere. The program has the potential to cross-over its coordinating bodies to other initiatives such as toward source water protection. Due to local-level agendas which tend to address multiple concerns, water quantity may not be of primary importance with respect to other issues, and this may result in the program being hindered by conflicts or priorities associated with other issues. Yet, the social capital which is built by the OLWR, while using stakeholder collaboration, may also be used by other programs and can be a beneficial supplement to other sectors.

The Ontario Low Water Response demonstrates legal and institutional feasibility through strong alignment with regulatory measures, cooperative and collaborative efforts across various agencies and stakeholder groups, and its potential to positively impact other adaptive efforts.

Environmental Farm Plan (EFP)

Provincial legislation is associated with a variety of the issues addressed in the EFP. Issues of particular concern may be emphasized through regulatory measures adopted by individual provinces. Costs sharing programs associated with the EFP may also incorporate legislation that reviews project proposals under federal laws. Federal legislation also guides many farming practices, including the *Fisheries Act*, the *Canadian Environmental Protection Act*, and the *Canada Water Act*. At the local scale, farming practices may also be influenced by municipal by-laws

The EFP is one of a number of national programs developed and funded under the Agricultural Policy Framework (APF). Senior government commitment and support have been demonstrated through both technical support and through the provision of a variety of cost-shared programs. Without these programs and support, the promotion and adoption of environmental farm planning would have been nearly impossible to achieve based on the extent of costs involved.

The program has a complex organizational structure. It operates within both a national and provincial jurisdictions, and because it includes multiple levels and departments of government, as well as non-government agency and agricultural industry involvement, the communication network associated with the plan is vast. Coordination and communication is largely achieved through a various provincial and national committees. At the national level, the program is led by AAFC, and provincially, various non-profit agencies and organizations are responsible for delivery in cooperation with federal and respective provincial governments.

Legislative measures associated with adopted management practices, support from senior government agencies, and coordinating and communication activities across a broad network of players provide for the legal and institutional feasibility of the Environmental Farm Plan.

Criterion 7: Financial and Technical Feasibility

A final consideration in the acceptance and implementation of a response to drought or water shortage concerns the availability and appropriateness of financial and technical resources. An ideal measure will be inexpensive because it is difficult to justify excessive expenditures for an issue associated with unpredictable climate change (Smith et al. 1996). A low cost adaptive measure is generally preferable to a high cost one (Smith 1996) because implementation of the response requires fewer resources. If resources are utilized and allocated effectively, costs will be further minimized (Mizina et al. 1999). Economic efficiency of a response is also an important consideration where the economic benefits associated with the measure relative to its implementing costs help determine financial feasibility (Dolan et al. 2001).

Responses that address issues of a public nature, such as drought, that are economically efficient are most suitable (Smith and Lenhart 1996), and are preferable to government as benefits outweigh costs (Dolan et al. 2001). Yet response measures also require adequate and reliable funding (Chang and Desai 2001) and thus the availability of, and access to, financial resources is a limiting factor in the development and implementation of a response (Ivey et al. 2004). There must be commitment on behalf of funding sources to ensure the longevity and success of a program (Ivey et al. 2002).

The availability of appropriate technical resources for a response measure can impact its success. Access to relevant information and technology combined with the skills to utilize the technology are necessary in enabling a response (Smit and Pilifosova 2001). However, limited financial resources may impede adoption of technologies and education toward their use (Smith 1996). Greater opportunity to select appropriate re-

sponse technologies is provided within countries that have access to adequate information concerning climate, population characteristics and socio-economic data (Smith and Lenhart 1996).

Availability of staff resources is also an important consideration in the selection of a drought response measure because an absence of trained personnel may limit its uptake (Ivey et al. 2004). It is preferable to have trained personnel with technical expertise to understand, interpret, develop and implement a response (Toman and Bierbaum 1996), as well as a willingness and opportunity for ongoing staff training (Ivey et al. 2002).

To address these concerns, we posed four questions that explored the financial and technical feasibility of responses:

- Is the response economically acceptable?
- Are financial resources sufficient for implementing the response?
- Is the appropriate information and technology accessible?
- Is appropriate staff available to implement the response?

SEKID Metering Program

The benefits of the SEKID metering program exceed the costs of its implementation. The district achieved a net financial gain in the first phase of the program where the value of surplus water created through metering and improved efficiency was greater than the total cost of implementing the program. This resulted in a 1.53 benefit/cost ratio. Over the longer term the program continues to be an effective method of freeing up water resources, creating further surplus water value.

There is sufficient and appropriate information and technology in place in the metering program. Data collected from each of the irrigation properties, combined with regional weather data, provided adequate information to develop estimates for average drought year requirements which assisted the district in developing annual water allotments and water management. This data, combined with the use of irrometers to measure soil moisture, also provided landowners with the opportunity to more accurately manage their farm water resources.

In terms of financial and technical feasibility, the South East Kelowna Irrigation District metering program illustrates an economically acceptable approach which utilizes detailed local and regional level data and current technologies.

Irrigation Water Management Study (IWMS)

Along with annual federal and provincial funding commitments for the IWMS, financing was achieved through a provincial/district cost share agreement. Financial pledges over a 4-5 year period were made to various initiatives associated with the study in advance based on cost estimates. Funds were also raised by individual irrigation districts by implementing a per acre levy on water users. Ongoing costs associated with collection of data have been absorbed by the districts while the province continues to perform ongoing modeling.

The study entailed computer modeling, and detailed analysis of the distribution system efficiency, and of on-farm irrigation water use. The technology used in the study proved to be adequate and generated extensive databases which are ongoing projects. One challenge that still impacts technical data is the time frame of information collection, which tends to vary from agency to agency (e.g., weekly vs. daily). This has created issues when trying to align data from other areas.

A variety of agencies performed the work for the study, with some infilling between these where shortages arose. On the whole, there was adequate and qualified staffing available for the program. However, some staffing shortage has been identified in terms of individuals with the capacity to understand the technical aspects of the data collection and then interpret the information for those lacking a technical background.

Availability of financial and staff resources, combined with accessible, up-to date technology resulted in the financial and technical feasibility of the Irrigation Water Management Study.

Ontario Low Water Response (OLWR)

Expenditures within the OLWR range from staff training and hours to various administrative costs. Much of these are built upon existing infrastructure which minimizes redundant costs, and which benefit other programs (e.g. through monitoring and data collection). Previously established agencies have adopted many of the activities associated with the response, incorporating them into existing responsibilities. Targeted funding also ensures efficient allocation of resources.

The costs of program increase whenever it is implemented due to staffing costs associated with WRT meetings, and communication of low water conditions to the public. Funding for the response is most reliable at the provincial scale, through the OMNR, where it is delivered through existing mechanisms. Access to local resources varies widely. Greater capacity to access drought response resources exists where CA boundaries align with a regional municipality versus with a

county level government, due to variations in operational budget size. Variability also exists between annual CA revenues, thus impacting the availability of resources toward the response. In order to improve implementation of the program and to offset CA program expenditures, a recent change to the program has involved incorporating the distribution of financial assistance on an annual basis to CAs as a regular part of the provincial budget cost.

While regions with more staff and larger budgets can utilize information and technology to a greater extent than areas with fewer resources, the availability of information and technology is largely appropriate. Detailed provincial ministry data is available including regional weather information, flow conditions, and data indicating areas that are susceptible to low water or drought conditions. Information from watershed and hydrogeological studies, water well records, and the PTTW database may also be utilized by local government agencies to facilitate the response, although the permitting records require more sufficient coverage.

Various watersheds have access to trained and qualified staff, consultants, and technical experts from the federal, provincial and municipal levels. Locally, staff availability is associated with the degree of priority attributed water quantity concerns at a given time, where staff may be directed toward addressing other water issues. Ongoing education and training is provided annually by the province to CA staff and active WRT members. Specialized training is also available where a need is identified. Training and support is also provided to ministry staff according to different roles and responsibilities.

Strategic use of financial and technical resources, and ongoing education and training of staff, contributes to the technical and financial feasibility of the Ontario Low Water Response.

Environmental Farm Plan (EFP)

In general, the economic benefits of the EFP program outweigh the costs of its implementation. For a large percentage of the BMPs associated with the EFP, the federal government pays 30% of the cost. If the practice is deemed to be beneficial for the public, the government share is increased to 50%. Thus, the program funding is based on a judgment of the public versus private good of a mechanism.

Sufficient program funding for delivery agencies has been reliable over specified time periods. Funding to the program has been committed based on five year allotments that match the review of the APF. Funding sources to farmers are accessible over these periods through several cost-share programs which can vary from province to province.

The availability of staff to implement the program varies provincially. Some provinces are able to draw on agency partners to supplement staffing requirements. However, the constant training and cycling of new staff in other provinces can be a hindrance for delivery agents who are attempting to build trust and foster relationships with local farm communities.

Financial feasibility is demonstrated in the Environmental Farm Plan through cost-sharing activities and established funding over set time periods.

Summary

Table 1 presents the degree to which each response satisfied the key questions posed under the broader criteria. Three categories of performance were assigned to the responses per question providing a generalized designation. These reflect strong ("Yes") or weak ("No") performance of each response in terms of specific questions posed. In some cases, performance was neither sufficiently strong nor weak in which case it was designated as having 'Moderately' satisfied the question. For some questions, the data available to the responses was either insufficient or inconclusive in which case no designation is assigned.

The table must be interpreted carefully because none of the four responses examined had the central or *sole* objective of addressing agricultural drought. The goal in the study was to reveal ways in which different kinds of initiatives facilitate or constrain responses to agricultural droughts and water shortages. Therefore, an important caveat is critical: Table 1 measures the extent to which the responses evaluated address the criteria devised for *this* study. Thus, whether or not a response received a "Yes" in relation to the questions posed is not a measure of its effectiveness relative to the objectives for which the response was designed. The designers of the responses were not necessarily concerned with agricultural drought, or, in some cases, even water shortages for agriculture. Nonetheless, the initiatives or responses have the potential to be pertinent and effective responses.

The following broad observations can be drawn based on the analysis completed:

- Knowledge, planning and ongoing monitoring clearly promote preparedness, as is evident to varying degrees in the four responses examined. For instance, in the case of the SEKID metering program and the IWMS, advance understanding of relevant stakeholders, characteristics, or influencing factors associated with the response, combined with ongoing monitoring, enabled accurate and targeted planning and management of response activities.

- Community and stakeholder awareness, engagement and participation in planning and management activities at the local level, along with the adoption of incentives, are important in promoting self-reliance among the responses. This is evident, for example, in both the EFP and the SEKID metering program where farmer education and understanding of issues and outcomes associated with the responses relate directly to farm-level decision making that enhances the ability of farmers to respond to droughts and water shortages.
- Promotion of strategic change is strongly associated with the provision of additional or independent benefits and outcomes, utilization of targets of opportunity, and transferability. "No regrets" outcomes are evident across all four responses, where a range of economic, social and environmental benefits are identified. Strategic use of existing mechanisms is key as is clearly demonstrated in the OLWR which builds upon existing institutional and regulatory measures while integrating activities among agencies, enabling sharing of resources and responsibility. Transferability is clearly identified in the EFP where variations in program delivery and farm-level decision-making occur successfully across the country.
- Flexibility, impact reduction, improved supply, and demand reduction are clearly associated with lessening vulnerability. Benefits of the combination of these factors are most evident in both the SEKID metering program and the EFP. Demand reduction and improvements in water use efficiency in particular is important among three cases, where improved water management, largely through efficiencies, generates greater supply availability, resulting in both impact reduction and enabling greater overall flexibility. The EFP has clear potential for this purpose.
- Transparency, political support, equitability and public/stakeholder understanding are highly associated with the acceptability of a response. For instance, the facilitation of stakeholder and public understanding and trust of the both the response and associated decision-makers and delivery agents in the EFP and SEKID metering program greatly lessened opposition, enabling easier implementation and higher rates of uptake.
- Legal and institutional feasibility is clearly tied to government support, collaboration and coordination, and alignment with regulatory measures. This is illustrated to varying degrees across the four responses. Clearly defined leadership and roles associated with multi-agency involvement was critical in both the IWMS and the OLWR (e.g. minimizing redundancy), while regulatory measures were significant to all responses in terms of influencing the direction or nature of activities taken, and enabling enforcement of objectives.
- Sufficient and secure funding, staff, and technologies are crucial to response feasibility. This is evident in all four cases. For example, adequate staffs are necessary to implement the OLWR at various scales, and particularly in locations where resources are limited. Technical expertise and secured funding were critical to the IWMS due to the detailed nature of the study and evaluation of complex components.

Table 1: Summary of Findings

Criterion	Question	Response			
		SEKID	**IWMS**	**OLWR**	**EFP**
Promotes Preparedness	Does the response incorporate a clear understanding of agricultural drought?	Yes	Mod.	Mod.	No
	Is the response proactive and anticipatory?	Yes	-	Mod.	Yes
	Does the response contribute to long-term planning?	Mod.	Yes	Yes	Yes
Promotes Self-Reliance	Is self-reliance promoted by the response?	Yes	Yes	Mod.	Yes
	Does the response improve societal/stakeholder awareness?	Yes	Mod.	Yes	Yes
	Does the response promote risk management?	Yes	-	Mod.	Yes
Promotes Strategic Change	Does the response address targets of opportunity for strategic change?	Yes	Mod.	Yes	-
	Does the response provide independent benefits?	Yes	Yes	Yes	Yes
	Can the response be utilized elsewhere?	Yes	-	Mod.	Yes
Lessens Vulnerability	Does the response reduce social and economic risks associated with drought?	Yes	Mod.	Mod.	Yes
	Does the response reduce environmental vulnerability to drought?	Yes	No	-	Yes
	Does the response reduce demand/supply shortfalls in water?	Yes	Yes	Yes	Yes
	Does the response incorporate flexibility?	Yes	-	Mod.	Yes
Social and Political Acceptability	Is the response socially acceptable?	Mod.	-	Yes	Yes
	Is the response equitable among key stakeholders?	Yes	-	No	Yes
	Are there any necessary political conditions?	Mod.	Yes	Mod.	-
Legal and Institutional Feasibility	Are there any statutory or regulatory measures influencing the response?	Yes	Yes	Yes	Yes
	Do institutional arrangements affect capacity to respond?	-	Yes	Mod.	Yes
	Does the response facilitate communication, information sharing, and coordination among agencies, organizations and stakeholders?	Yes	Mod.	Yes	Yes
	Does the response impact other adaptation measures?	-	Mod.	Mod.	-
Financial and Technical Feasibility	Is the response economically acceptable?	Yes	-	Yes	Yes
	Are financial resources sufficient for implementing the response?	-	Yes	Mod.	Yes
	Is the appropriate information and technology accessible?	Yes	Yes	Yes	-
	Is appropriate staff available to implement the response?	-	Mod.	Yes	Mod.

4. Summary and Insights

The research reported in this document was predicated on a set of working propositions concerning food production and agricultural water management in Canada:

- Farmers seek routinely to accommodate and capitalize upon climatic and hydrologic resources for agriculture through the design and modification of farming systems that combine geography with technology, markets and a suite of policies and programs that establish the institutional framework for agriculture. Each of these works to shape the current agricultural system and intermingles with the signals sent by climatic conditions;
- Water use and conservation in farming occurs largely through the management activities of farm-level decision makers, and the outcomes of private and public sector initiatives designed to achieve efficient and equitable water usage;
- Climate change, if manifested in the manner suggested by current best predictions, will present more severe and more frequent water-related challenges to Canadian farmers in the future, with drought among the most widely anticipated; and
- Efforts to utilize, develop and conserve water for agricultural production take place within locally and regionally distinct social, economic and political contexts that either enhance or challenge chances for success at the local level. In some of these instances agriculture will be a dominant economic and political force while in others farming may be embedded within highly diversified regions where other non-agricultural demands on water resources are pervasive and extensive. Hence there is need to appreciate and involve a multiplicity of interests and actors in the development and delivery of initiatives designed to support wise water use and arbitrate access.

Public programs and institutional arrangements fundamentally affect both agricultural production strategies, approaches in agri-environmental management and agricultural access to water in Canada. However, recent and probably future innovations in environmental management, agricultural development and public administration suggest that the approaches and instruments of governance will be not only be varied in their form but also complex and interconnected in their effects. This calls into question the extent to which integration in drought and agricultural water management is evident, and whether or not further opportunities for integration exist.

In this research, our goal was to document and evaluate different sorts of policy and program initiatives that are operating in the arena of agricultural water planning and management. A key concern was understanding how differing approaches work in support of improved adaptation in the water and agriculture sectors. The project was designed to function at both a reconnaissance level (Objective 1) and at a detailed level through the systematic assessment of selected types of public sector based responses associated with agriculture and water use (Objective 2). Detailed findings were provided in Chapter 3. In the balance of this concluding section we seek to highlight selected broader observations and potential lessons that emanate from the work.

The overview of response types and the case study evaluations offers insights that can be applied to reduce vulnerability of Canadian agriculture to drought and water shortages (Objective 3). These lessons speak to the need, among other things, to better appreciate the implications of climate variability and change for agriculture, both in terms of drought and water shortages.

- Both in terms of the number of initiatives documented and the diversity revealed in their descriptions, it is clear that efforts to better plan for and respond to droughts and water shortages (current or anticipated) in agriculture involve a wide array of approaches, purposes, scales of implementation and models of delivery. Examination of the inventory as presented in Appendix A, by virtue of its diversity alone, makes clear the challenge of achieving integration within and between regions and sectors. However, given the number of incidental connections to agriculture and water management evident in the inventory, this task is important and the costs of non-connectedness seem potentially large. For example, agriculture competes for water with many other uses in rural areas, including the environment.
- As noted above, some of the initiatives were designed with agriculture's water needs in mind, while others were judged to be indirectly pertinent. For example, across Canada numerous projects have been constructed specifically to increase the reliability of water supplies for agriculture. These often are purposeful responses to drought and water shortages. In contrast, programs exist that were designed for purposes such as habitat conservation or water quality protection, but which have implications for agricultural producers during times of water shortage and drought. An important insight is that it is not appropriate or even feasible to place agricultural

water issues exclusively within a suite of initiatives designed to deal explicitly with farming and drought. While some of these programs will be necessary and important, when they exist they will interact with other initiatives and development processes. Furthermore, drought preparedness is compromised when initiatives fail to consider the prospects of increasingly variable, and possibly reduced, water supplies.

- The overview of drought response also demonstrates considerable attention to the farm scale, relative to community or other scales. This is certainly understandable, and there are no doubt advantages to the delivery of some programs, particularly accountability in programs offering financial incentives. However, the inventory revealed several initiatives at the community scale, e.g., where farmers and other water users were able to achieve some consensus on sharing of water during drought conditions, consequently minimizing conflict. Examples are the 2001 water sharing agreement in southern Alberta and the activities of several water response teams under the Ontario Low Water Response. This raises the question of potential benefits to drought preparedness of further attention to community, watershed and regional scales in modifying and developing drought-related initiatives.
- Of those responses that are purposefully directed to agricultural drought, over one-half were found to be structural measures designed to secure the supply of water for agriculture. Much less common are responses directed toward water conservation or efficiency in water use. Purposeful responses to agricultural drought are particularly limited east of Ontario, which is not surprising given the distribution of agricultural activity and water supplies across the country. The data on response type and intent calls into question the extent to which climate change has been mainstreamed in the agricultural sector.
- Only a handful of cases explicitly acknowledge the finite nature of water supply, e.g., the moratorium on new water licenses in the South Saskatchewan River Basin (SSRB), Ontario's water permit requirements in high-use watersheds, and Prince Edward Island's groundwater extraction rules. There is even less evidence that the agricultural drought responses inventoried accommodate the prospect of an increasingly variable climate and likelihood of reduced water supplies in some regions.
- Given the importance and abundance of identified initiatives with incidental benefits concerning water resource management in agriculture, there emerges a sense that many existing initiatives are highly suited to small adjustment so as to maximize their contribution to drought preparedness. For instance, in its continuing development and refinement, the EFP could be adjusted to build resilience and self-reliance at the farm scale through greater attention in its individual planning worksheets/modules to water quantity management and water use. Considerable "value-added" could be achieved in modifying some initiatives.
- While understandable given the degree to which the Canadian agricultural system, for a myriad of sound reasons, has become highly capitalized and specialized, Appendix A demonstrates that the vast majority of responses (almost three-quarters) work to sustain current practice, rather than facilitate change in agriculture. Only two of the inventoried responses specifically facilitate change. There are important implications in this observation, as adaptive capacity can be enhanced by actions that facilitate changes. While it may not be necessary given current water availability to entertain such scenarios on a widespread basis, the potential exists that future changes in climate may necessitate selected strategic shifts in agriculture.

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Appendix A: Characterisation of Pertinent Initiatives

In the context of Objective 1, a comprehensive survey and inventory of initiatives with pertinence for agricultural drought was completed. A total of 84 initiatives was identified, 8 with national scope, and the remainder located in specific provinces. The goal was to identify initiatives that directly or indirectly affect the ability of agriculture to respond to drought. As noted in Section 3.1, in most cases, the initiatives were not designed with agricultural drought in mind. Nonetheless, they were considered pertinent because they have the potential to facilitate or constrain adaptive responses, and influence resiliency and vulnerability of the agriculture sector. Several caveats must be borne in mind:

- While the inventory is comprehensive, it is not complete; numerous other kinds of initiatives exist in all jurisdictions. However, the ones presented here represent the types of initiatives that exist.
- At the same time, it is important to note that data on these initiatives were collected during the study period (September, 2004 to March, 2007). Some of the initiatives have since ended, while others have changed. Thus, the initiatives listed here are characterized based on their status at the time of data collection.
- Finally, the characterization presented here is based on the judgment of the researchers. In many cases it was not clear cut what the appropriate characterization was – especially where the initiative in question was not designed specifically with agricultural drought in mind. Thus, the characterization should be used with care.

Each of the tables in this appendix is organized around the eight characteristics described in Section 2.2.

Initiatives With a National Scope

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Alternate Land Use Services (ALUS)	Financial and technical assistance to structural and strategic initiatives	Farm	Provincial	Public / private	All agriculture	Incidental	Ongoing	Facilitates change
Canadian Agriculture Income Stabilization (CAIS)	Financial	Farm	National		All agriculture	Incidental		Resists change
Crop Insurance (e.g. Agricorp Ontario; Agricultural Financial Services Corp.-AB)	Financial	Farm	Provincial / national	Public / private	Crop	Purposeful (inclusive)	Ongoing	Resists change
Ducks Unlimited Canada (DUC) Drought Response Program (DRP)	Strategic	Farm	Local	NGO	Crop and livestock	Purposeful	Ongoing	Resists change

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Environmental Farm Plan (EFP)	Financial and technical assistance to structural and strategic initiatives	Farm	Provincial / national (Program variation by province)	Public / private	All agriculture	Incidental	Ongoing	Resists and facilitates change
Federal Tax Deferral Program	Financial	Farm	National		Livestock	Purposeful		Resists change
National Water Supply Expansion Program (NWSEP)	Financial and technical assistance to structural and strategic initiatives	Farm / community	National	Public / private	All agriculture, agri-business, and rural enterprise	Purposeful (supply)	Ongoing	Resists and facilitates change
PFRA Rural Water Development Program (RWDP)	Financial and technical assistance to structural and strategic initiatives	Farm / community	- multi-provincial	Public / private	Multiple types of agriculture (limited to certain project types)	Incidental	Ongoing	Resists and facilitates change

British Columbia

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
B.C. Cattlemen's, Livestock Management Water Stewardship Program (LMWSP)	Financial assistance to structural and strategic initiatives	Farm			Livestock	Incidental	Ongoing	Resists and facilitates change
Dealing With Drought Handbook	Voluntary / strategic	Community	Provincial	Province	Multiple sectors	Purposeful	Ongoing	Resists and facilitates change
Groundwater Protection Regulation (GWPR) - 2004	Regulatory	All	Provincial	Public / private		Incidental	Ongoing (incomplete)	Resists change
Livestock Watering Incentive Program	Financial assistance to structural initiatives	Farm			Livestock	Incidental	Ongoing	Resists change

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Municipal Sewage Regulations (1999)	Structural / strategic	Community	Local			Incidental	Ongoing	Resists change
South East Kelowna Irrigation District (SEKID) Agricultural Metering Program	Voluntary / strategic	Farm	Local	Public / private	Irrigation	Purposeful (water supply / conservation)	Ongoing	Facilitates change
Water Act (Revised Statutes of B.C. 1996, Ch.483)	Regulatory	Regional	Provincial	Province		Incidental	Ongoing	Resists change
Water Conservation Strategy for B.C.	Strategic	Farm / community	Provincial	Province	All agriculture	Incidental	Ongoing	Resists and facilitates change
Water Regulation (B.C. Reg. 204/88)	Regulatory	Regional	Provincial	Province		Incidental	Ongoing	Resists change

Alberta

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
2001 Water Sharing Agreement (Southern Tributaries: St. Mary – Belly – Waterton Rivers)	Strategic	Sub-watershed (impacts individual farms)	Local	Irrigation Districts (under rec. of province)		Purposeful	Ad hoc	Resists change
Agriculture Drought Risk Management Plan (ADRMP)	Strategic and structural	All	Provincial	Federal / provincial	All agriculture	Purposeful	Ongoing	Resists and facilitates change
Alberta Disaster Assistance Loan Program	Financial	Farm	Provincial				Ongoing	Resists change
Canada – Alberta Farm Water Program (CAFWP)	Financial and technical assistance to structural initiatives	Farm	Provincial		All agriculture	Purposeful	Ongoing	Resists change

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Canada – Alberta Water Supply Expansion Program (CAWSEP)	Financial and technical assistance to structural initiatives	Community	Provincial	Public / private	Agricultural groups, communities	Purposeful	Ongoing	Resists change
Community Riparian Program (CRP)	Financial assistance to strategic initiatives	Farm / community	Provincial		All agriculture	Incidental	Ongoing	
Grasshopper Control Program	Financial	Farm	Provincial		Crop		Ongoing	Resists change
Irrigation Districts Act	Regulatory	Regional	Provincial			Purposeful (supply)	Ongoing	Resists change
Irrigation Rehabilitation Program (IRP)	Financial	Farm / community?				Incidental	Ongoing	Resists change
Irrigation Water Management Study (IWMS)	Structural	Regional	Local	Public / private	Irrigation agriculture	Purposeful (supply)	Ad hoc	Resists change
Lethbridge Northern Irrigation District's (LNID) Water Policy	Regulatory (by-law)	Regional (impacts individual farms)	Local			Purposeful	Ongoing	Resists change
Milk River Aquifer Reclamation and Conservation Program	Financial assistance to structural initiatives	Farm / community	Local		All agriculture	Incidental		Resists change
South Saskatchewan River Basin Water Allocation Regulation (AR 307/91)	Regulatory	Regional (impacts individual farms)	Local		All agriculture	Purposeful (supply)	Ongoing	Resists change
Special Areas Water Supply Project (SAWSP)	Structural	Regional	Local			Purposeful	Ongoing	Resists change

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
St. Mary River Project (District)	Structural	Regional	Local		All agriculture	Purposeful (supply)	Ongoing	Resists change
Water (Ministerial) Regulation (205/1998)	Regulatory	Regional	Provincial	Province	All agriculture	Incidental	Ongoing	Resists change
Water Act (Revised Statutes of Alberta 2000, Ch W-3)	Regulatory	All	Provincial	Province	All agriculture	Incidental	Ongoing	Resists change
Water For Life: Alberta's Strategy for Sustainability	Strategic	All	Provincial	Provincial	All agriculture	Incidental	Ongoing	Resists and facilitates change
Water Pumping Program	Structural	Farm / community	Provincial		All agriculture	Purposeful	Ongoing	Resists change

Saskatchewan

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Canada – Saskatchewan Irrigation Diversification Centre	Structural and strategic	Farm / community	Provincial	Public / private		Incidental	Ongoing	Resists and facilitates change
Cypress Lake Reservoir	Structural	Regional	Local		All agriculture	Purposeful (supply)	Ongoing	Resists change
Partnership Agreement on Water Based Economic Development (PAWBED)	Structural	Farm / community	Provincial			Incidental		Resists change
Rural Water Control Assistance	Financial assistance to structural initiatives	All	Provincial		All agriculture	Incidental		Resists change
South Saskatchewan River Project	Structural	Regional	- semi-provincial			Purposeful (supply)	Ongoing	Resists change

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Technical Assistance for Investigation & Development of Domestic / Municipal Water Sources	Financial and technical assistance to structural initiatives	Farm / community	Provincial	Public / private	All agriculture for domestic use (excluding irrigation) Any rural or small urban municipality or similar local governing body	Incidental	Ongoing	Resists change
Water Pumping Equipment Rental	Structural	Farm	Provincial			Purposeful (supply)	Ongoing	Resists change

Manitoba

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
(Rural) Agricultural Area Water Pipeline (AAWP) Program	Financial assistance to structural initiatives	Farm / community	Provincial	Public / private	Livestock (and domestic)	Purposeful (supply)	Ongoing	Resists change
Community Water Source Development Program	Financial assistance to structural initiatives	Community	Provincial		All agriculture	Purposeful (supply)	Ongoing	Resists change
Farm Water Source Development Program	Financial and technical assistance to structural initiatives	Farm	Provincial		All agriculture	Purposeful (supply)	Ongoing	Resists change
Manitoba Crop Diversification Centre (MCDC)	Structural and strategic	Farm	Provincial	Public / private		Incidental	Ongoing	Resists and facilitates change
Manitoba Drought Assistance Program	Financial	Farm	Provincial		Livestock	Purposeful	Ongoing	Resists change
Manitoba Water Strategy (2003)	Strategic	Multiple	Provincial	Province	All agriculture	Incidental	Ongoing	Resists and facilitates change

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Sugarloaf Rural Water Pipeline	Structural	Community	Local	Public/ private			Ongoing	Resists change
Surplus Water Initiative	Structural	Farm				Purposeful		Resists change
Water Licensing Program	Regulatory	All	Provincial	Province	All agriculture	Incidental	Ongoing	Resists change

Ontario

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Big Creek Irrigation Peer Review and Assistance Project (2001-2003)	Voluntary / strategic	All	Local	Public / private	All agriculture	Purposeful	Ad hoc	Resists and facilitates change
Big Otter / Catfish Watersheds Irrigation Options Project (2002-2004)	Financial and technical assistance to structural initiatives	Farm	Local	Public / private		Purposeful	Ad hoc	Resists and facilitates change
Norfolk Water Supply Enhancement Program (Norfolk WSEP)	Financial assistance to structural initiatives	Farm	Local	Public / private	All agriculture	Purposeful	Ad hoc	Resists change
Ontario Low Water Response (OLWR)	Strategic	All	Provincial	Provincial	All agriculture	Purposeful	Ongoing	
Permit to Take Water (PTTW)	Regulatory	All	Provincial	Province	All agriculture	Purposeful (supply)	Ongoing	Resists change
Wetland Drain Restoration Project	Regulatory and structural	Farm / community	Provincial	Public / private	All agriculture	Purposeful (multipurpose)	Ongoing	Resists change

Quebec

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Aqua-Blue Program	Financial assistance to structural initiatives	Farm	Provincial		Aquaculture	Incidental	Ongoing	Resists change
Groundwater Catchment Regulation (R.S.Q. Ch Q-2, r1.3)	Regulatory	Farm / community	Provincial		All agriculture		Ongoing	Resists change
Quality of Drinking Water Regulation (R.Q. Ch Q-2, r18.1.1)	Regulatory	All	Provincial		All agriculture	Incidental	Ongoing	
Quebec Action Plan on Climate Change	Strategic	All	Provincial	Province		Incidental	Ongoing	
Water Resources Preservation Act (R.S.Q. ChP-18.1)	Regulatory		Provincial		All agriculture	Incidental	Ongoing	Resists change
Watercourses Act (R.S.Q. ChR-13)	Regulatory	All	Provincial		All agriculture	Incidental	Ongoing	Resists change
Water-Our Life-Our Future: Quebec Water Policy	Regulatory / strategic	All	Provincial		All agriculture	Incidental	Ongoing	

Nova Scotia

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Agriculture Water Resource Development (AWARD) 2000 Program	Financial and technical assistance to structural and strategic initiatives	Community	Provincial		All agriculture	Incidental	Ongoing	Resists and facilitates change
Farm Investment Fund	Financial assistance to structural initiatives	Farm	Provincial		All agriculture	Incidental	Ongoing	Resists change

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Nova Scotia Environment Act (Statutes of Nova Scotia 1994-1195, Ch 1)	Regulatory	Farm / community	Provincial	Province	All agriculture	Incidental	Ongoing	Resists change
Tech 2000	Financial and technical assistance to structural and strategic initiatives	Farm	Provincial		All agriculture	Incidental	Ongoing	Resists and facilitates change
Water Management Groups (Water Clubs)	Structural and strategic	Farm / community	Local	Public / private		Incidental (supply)	Ongoing	Resists and facilitates change
Water Resources Protection Act (WRPA) (Ch 10 of the Acts of 2000)	Regulatory	All	Provincial	Province	All agriculture	Incidental	Ongoing	Resists change

New Brunswick

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
New Brunswick Clean Water Act (Ch C-6.1)	Regulatory	Farm / community	Provincial	Province	All agriculture	Incidental	Ongoing	Resists change
New Brunswick's Watershed Protection Program	Regulatory	Community	Provincial		All agriculture	Incidental	Ongoing	
Water Well Regulation Section 40, N.B Reg. 90-79	Regulatory	Farm / community	Provincial		All agriculture	Incidental	Ongoing	Resists change
Watercourse and Wetland Alteration Regulation Permit Program	Regulatory	Farm / community	Provincial		All agriculture	Incidental	Ongoing	Resists change

Prince Edward Island

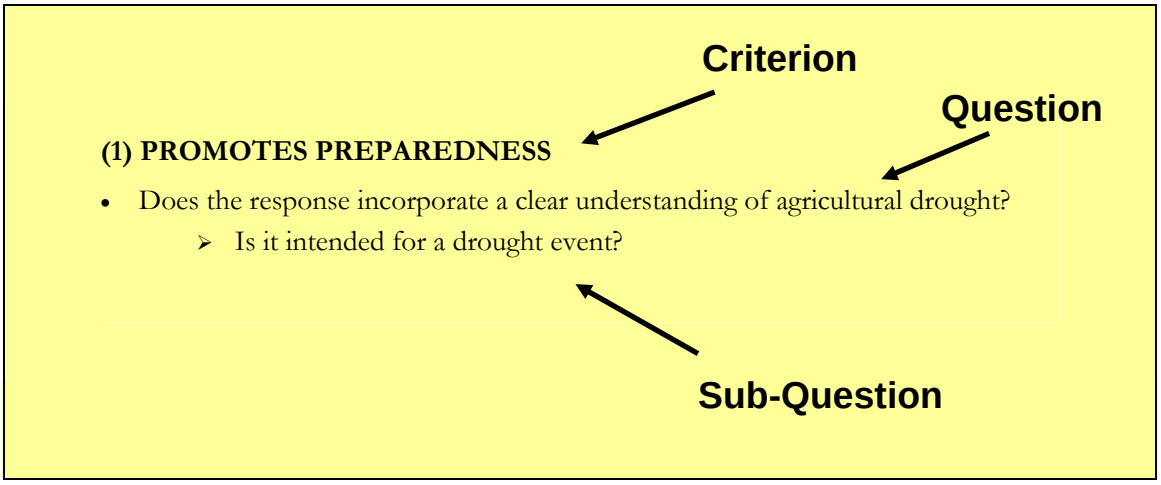
Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Groundwater Exploration Permits (GWEP)	Regulatory	All	Provincial		All agriculture	Incidental	Ongoing	Resists change
PEI Agricultural Irrigation Policy	Regulatory	All	Provincial		All agriculture	Incidental	Ongoing	Resists change
Sustainable Resource Conservation Program	Financial and technical assistance to structural and strategic initiatives	Farm	Provincial		All agriculture	Incidental	Ongoing	Resists and facilitates change
Water Well Regulations (PEI Reg. EC 188/90)	Regulatory	All	Provincial	Province	All agriculture	Incidental	Ongoing	Resists change
Water Withdrawal Fees	Regulatory	All	Provincial		All agriculture	Incidental	Ongoing	Resists change
Watercourse Alteration Permit / Water Withdrawal Permit	Regulatory	All	Provincial		All agriculture	Incidental	Ongoing	Resists change

Newfoundland and Labrador

Response	Response Type	Scale	Coverage	Initiator(s)	Eligibility	Intent	Timing	Outcome
Policy on Land and Water Related Development in Protected Public Water Supply Areas	Regulatory	Farm / community	Provincial			Incidental	Ongoing	Resists change
Registry of Water Rights / Water Use License	Regulatory	All	Provincial			Purposeful (supply)	Ongoing	Resists change
Water Resources Act (Statutes of Newfoundland and Labrador 2002, Ch W-4.01)	Regulatory	Farm / community	Provincial	Province	All agriculture	Incidental	Ongoing	Resists change

Appendix B: Detailed Research Questions

In the context of Objective 2, the four initiatives were evaluated systematically using a detailed evaluation framework comprised of criteria, core questions and a series of sub-questions to allow for elaboration and the detection of important points of context and contingency. The criteria and main questions were introduced in the body of the report. This appendix identifies related *sub-questions*.



(1) PROMOTES PREPAREDNESS

- Does the response incorporate a clear understanding of agricultural drought?
  - Is it intended for a drought event?
  - Does it recognize potential risks and impacts?
  - Does it identify a set of assessment tools?
- Is the response proactive and anticipatory?
  - Is it ongoing and active in the absence of drought or is it implemented following the onset of drought?
  - Are necessary resources identified and secured in advance?
  - Does it include an operative warning system that indicates early signs of stress?
  - Are clear procedures in place to respond appropriately?
- Does the response contribute to long-term planning?
  - Does it encourage on-going evaluation of response activities?
  - Are results of evaluation activities considered in the planning process?

(2) PROMOTES SELF-RELIANCE

- Is self-reliance promoted by the response?
  - Does it delegate authority to the local level?
  - Does it reduce dependence on disaster assistance?
- Does the response improve societal/stakeholder awareness?
  - Does it incorporate the availability of hazard information and education programs to the public?
  - Does it encourage active public and stakeholder engagement in the response process?

- Does the response promote risk management?
    - Are stakeholders provided with incentives to adopt conservation practices?
    - Does it provide incentives to agencies to 'do their part'?

(3) PROMOTES STRATEGIC CHANGE

- Does the response address targets of opportunity for strategic change?
    - Can it utilize non-drought investment, planning or decision making efforts?
    - Can it build upon other drought responses?
- Does the response provide independent benefits?
    - Are there other benefits associated with using this adaptation response?
    - Is its use justified without considering agricultural drought?
- Can the response be utilized elsewhere?
    - Is it targeted at specific social, economic, and or environmental attributes?
    - Does it allow for a range of alternative responses?

(4) LESSENS VULNERABILITY

- Does the response reduce social and economic risks associated with drought?
    - Does it reduce exposure to impacts of drought?
    - Does it minimize personal or insured losses?
- Does the response reduce environmental vulnerability to drought?
    - Does it lessen impacts of drought on the environment?
    - Does it create environmental benefits?
- Does the response reduce demand/supply shortfalls in water?
    - Does it reduce demand for water resources?
    - Does it increase supply of water resources?
- Does the response incorporate flexibility?
    - Is it robust?
    - Is it resilient?
    - Is it reversible?

(5) SOCIAL & POLITICAL ACCEPTABILITY

- Is the response socially acceptable?
    - Is the implementing agency or organization perceived by the public/stakeholders as legitimate?
    - Is there consensus for adoption of the response?
    - Does it reflect societal wants, goals, values?
- Is the response equitable among key stakeholders?
    - Does it provide equitable access to necessary?
    - Does it reduce conflicts concerning access to water resources?
    - Are there mechanisms to ensure all relevant stakeholders are represented?

- Are there the necessary political conditions?
    - Are elected political representatives supportive?
    - Are there any political mandates that impede the?

(6) LEGAL & INSTITUTIONAL FEASIBILITY

- Are there any statutory or regulatory measures influencing the response?
    - Are there any statutes, agreements, regulations or policies preventing the response?
    - Are there any statutes, agreements, regulations or policies supporting the response?
- Do institutional arrangements affect capacity to respond?
    - Is there sufficient jurisdictional authority and power to implement and enforce it?
    - Are the roles and responsibilities of senior and local government agencies clear, consistent, and comprehensive?
    - Have senior government agencies demonstrated commitment and support?
- Does the response facilitate communication, information sharing, and coordination among agencies, organizations and stakeholders?
    - Are effective communication networks in place, between local organizations and senior governments and among local organizations?
    - Is there an agency providing leadership?
- Does the response impact other adaptation measures?
    - Will the response make it more difficult to adapt to drought in other sectors?
    - Will the response make it more difficult to achieve other non-drought related goals?
    - Does it interfere with non-drought related adaptation activities?

(7) FINANCIAL & TECHNICAL FEASIBILITY

- Is the response economically acceptable?
    - Do the benefits of the response outweigh the costs of implementing it?
    - Are resources utilized and allocated efficiently?
- Are financial resources sufficient for implementing the response?
    - Are funding sources accessible and reliable?
    - Are financial resources committed for a sufficient period of time?
- Is the appropriate information and technology accessible?
    - Is the technology feasible at a variety of scales?
    - Does the use of the technology impact other scales/sectors/regions ability to respond to drought or in some other way?
- Is appropriate staff available to implement the response?
    - Is there sufficient staff available with appropriate training and technical expertise?
    - Are ongoing education and training opportunities available to continually upgrade staff skills and resources?

Appendix C: Detailed Responses to Research Questions

This appendix presents the detailed data behind the findings presented in Section 3.2. As noted earlier, for each of the seven criteria a series of questions and sub-questions was posed (see Appendix B). In this appendix, answers to the questions are presented, organized around each of the four case studies, and supported throughout by references to appropriate documents and key informant interviews. References pertinent to each case study are collected at the end of the case study's section.

Data pertinent to every sub-question were not always available; cases where this occurred are clearly identified.

SEKID Metering Program

Criterion 1: Promotes Preparedness

Does the response incorporate a clear understanding of agricultural drought?

The response was initiated as a water conservation measure to promote efficient agricultural water use. Recognition of the region's limited water supply and narrow choice of options for expanding supplies prompted efforts to optimize the use of existing water supplies. The program is intended to address not only drought but also water shortages in general. It is not targeted specifically or exclusively toward a drought event. In terms of indicators, district irrigation water demand was measured via monthly reading of farm meters and tracking water use through monthly water use reports. Actual district water use requirements were determined via individual farm assessments (crop, irrigated area, soil type and irrigation system information), combined with climate data collected from a weather station. This provided information on how much water farmers were using versus how much they actually needed[9].

Is the response proactive and anticipatory?

The response has a regulatory component of the project which is ongoing[10]. Metering occurs all the time, regardless of whether or not drought is occurring. During this time consumption data is accrued and agriculturalists are encouraged to stay within their allotment. In this way, it is proactive. However, when a drought is anticipated or is actually occurring allotments can be adjusted, and thus it is also implemented in response to drought[7, 17].

To ensure its success, goals were identified in advance of the project's initiation that would help reduce water demand and fairly allocate water supplies[10]. The irrigation district also sought funding in advance of the program which was achieved through a verbal agreement in 1993 from the provincial government. Assistance was to be provided through the Canada-British Columbia Green Plan for Agriculture and this was finally secured in 1994[11].

Does the response contribute to long-term planning?

Regulatory measures were incorporated in advance and can be utilized in the shorter-term future, but once all water supplies are allocated, longer-term growth will be limited by water availability. While the program provides a useful tool to modify short-term demand, the model relies on a dependable supply of water. Reductions in future water supplies may lead to future problems[7]. However, a unique aspect of this program is that funds are collected for future growth. Some areas of the district are not serviced (e.g. dry land) and developers must purchase water rights for these areas. This money is collected and can only be used for augmenting the current water system and increasing supply (e.g. water reservoirs, dams, diversions)[7]. Thus, long-term planning is considered from a development perspective.

A detailed review and analysis of local demand conditions in Phase 1 provided key information in updating drought year water requirements[9]. Ongoing data collection provides an opportunity for comparison of actual and estimated demand of the system and for development of improvements to the program[8]. In terms of continued evaluation of the response, information on consumption rates is collected annually which permits evaluation of the suitability of the allotment and block rate to changing water availability. Both the allotment and the inclined block rate can be adjusted by amending by-laws[7].

Criterion 2: Promotes Self-Reliance

Is self-reliance promoted by the response?

Management of the program can largely be accomplished through local agencies. Water management and decision making in the Okanagan is often guided by local level authorities[11]. The metering program was initiated by SEKID's elected Board of Trustees and is operated through the improvement district.

SEKID is granted authority under the *Local Government Act* (1996) as an improvement district to pass bylaws which enable it to operate as a water utility[14]. The Board of Trustees is thus capable of determining metered rates and discontinuing water service to landowners. Landowners are ultimately responsible for adopting water conservation measures and are subject to penalties for failure to comply with local bylaws[13]. Farmers themselves are capable of adjusting their own water demand, directly influencing water quantity and resulting in a certain degree of self-reliance[7]. There is also potential for a reduction in dependence on disaster assistance as it is likely that increased water use efficiency and reduced pressure on water supplies ultimately reduces the risk of losses and damages.

Does the response improve societal/stakeholder awareness?

Education was an important component of the program. Field days provided an opportunity to teach farmers to use more efficient irrigation practices and improve soil moisture monitoring. This educational component contributed to the ultimate success of the program as participant compliance with regulations was due in part to knowledge of the program and its benefits[9]. A direct outcome of SEKID has been the availability on the Internet of real-time climate station data on a daily basis. This information can assist with irrigation scheduling. An on-line irrigation scheduling calculator is also in the process of being developed to assist farmers in managing their water use[17]. Originally, water-use reports were provided directly to farmers. However, this has been limited by financial constraints. This information is still available to farmers on an individual basis but it is no longer sent out. Rather farmers must access information through the district office. The irrigation district also currently distributes quarterly reports on water-use to farmers[16].

Water conservation is a significant issue in the Okanagan and the public has therefore been fairly involved in all steps of the metering program. Public consultations were held prior to implementation of the program in order to gauge responses and fears. These meetings were well attended, especially by the agricultural sector. After SEKID decided to go through with the plan, public meetings, field days, and other educational venues were held for agriculturalists[7, 17]. Similar meetings are currently being held by other districts that are considering metering[7, 16, 17].

Does the response promote risk management?

The Board of Trustees of SEKID had various reasons for implementing metering: water conservation meant capital and operating cost savings; alternate options to increase district water supply were limited and expensive; the need to address a threat of unknown climate change implications; availability of senior government grants for the metering program; and favorable results from a pilot metering program that had been initiated in 1990[9].

There were two key incentives to stakeholders to conserve water: education of the benefits of efficient water use; and financial penalties associated with exceeding allotted water amounts[9]. Knowledge gained by landowners through SEKID's educational efforts provided a key incentive to adopting conservation practices at the farm scale. Comprehension of the benefits of water conservation by the majority of landowners in the district has positively influenced their willingness to adjust on-farm water use practices and has been illustrated through more efficient water use under both dry and normal conditions[8]. Financial penalties associated with water consumption beyond assigned water allotments are determined through an inclined block rate structure. Water used in excess of an allotment is fined based on a block rate. Minimal deviations from the allotment do not result in large fines. However, as the consumption increases beyond an allotment, the fines increase incrementally in order to deter water waste. This system is designed as a deterrent to excessive water consumption. In addition, water users also run the risk of discontinued water service if they exceed their allotment. This decision is retained at the discretion of the Board of Trustees of the irrigation district[9]. Failure to comply with allotments for water may also result in discontinuation of water service to a landowner by the district and a 'turn-on' fee may subsequently be applied[13]. An additional incentive may be through peer pressure. Landowners may feel compelled to adjust water use due to distributed water use reports. Through these, landowners can compare their water use to the district's average use for similar operations[6].

Criterion 3: Promotes Strategic Change

Does the response address targets of opportunity for strategic change?

The water savings associated with the use of metering permitted the district to delay infrastructure costs associated with reservoir and dam projects. In one case a dam project has been delayed for over a decade

and is now being considered again[7, 17]. A unique aspect of the program is that it has allowed funds associated with the program to be collected for future growth. Certain areas of the district are not serviced (in 'dry land') and developers must purchase water rights for these. The funds are collected and used to augment the water system and increase supply (e.g. water reservoirs, dams, diversion)[7].

Does the response provide independent benefits?

Additional benefits associated with the program include: ensuring private irrigation systems are functioning optimally; equitable resource distribution; motivates water users to adjust demand according to whatever the conditions are; eliminates waste; enhances district water resources; has provided some financial return; in short-term has avoided expensive cost of developing water storage infrastructure[9]. As well, water conservation has multiple benefits (even in the absence of drought) including: providing energy savings (due to less pumping and electrical use); as a protective means of addressing current and future water supply management; protecting water quality and the environment; and extending the life of existing supplies[9]. Benefits are also realized through the use of water data toward future water requirement planning, updating and improving existing data and district connections, and reducing time spent investigating misuse of water within the district[6].

Can the response be utilized elsewhere?

The approach can reflect a variety of local attributes. Important factors to ensure the best results are that funding and technical assistance is available to implement the program. This approach could be applied to other water use sectors. The metering component is flexible and can be adapted to reflect local circumstances. A variety of metered rate options exist, and the regulatory and educational components are transferable and can also be adjusted to local needs[9].

A wide range of options for rate types are available in the block rate system, including seasonal, flat, uniform, declining block and increasing block rates. The use of an allotment system with inclined block rates has provided flexibility in terms of determining annual allotments. Not only has the allotment of water been deemed necessary to the agricultural sector in the district, but the system also recognizes diverse demand conditions associated with varying soil characteristics[9]. In addition, the inclined block rate increments used in this program, which are currently divided into ten percent increments of water allotment, can be altered. In this particular program, the use of the ten percent increments has provided flexibility in terms of accounting for a range of over consumption of water resources by farmers[8].

Criterion 4: Lessens Vulnerability

Does the response reduce social and economic risks associated with drought?

Despite unusually hot and dry conditions in 2003 which resulted in severe cut backs in water supply to farmers in other areas of the Okanagan, Kelowna continued to operate without any serious problems. This has been directly attributed to the metering program, and without it the district speculates that irrigation would have been ceased in September, resulting in serious crop losses[7, 17].

Does the response reduce environmental vulnerability to drought?

When overall water use is reduced through metering, this allows the deferral of additional expansion of water supplies. This results in reduced demand for water treatment and ultimately lessens negative impacts to the water system, and subsequently, the environment[10].

Does the response reduce demand/supply shortfalls in water?

The use of the metering program allowed the irrigation district to set allotments that more accurately reflected demand. The allotment system provides for adequate agricultural water under drought year conditions and the use of penalties for exceeding an allotment also discourages higher demand rates[7, 17], while avoiding overly penalizing minor excesses[9]. The district experienced drought conditions in 2003, and the program was successful in educating farmers about water conservation and reducing water demand in that year, and potentially through similar successive drought years. The block rate metering system has further reduced water demand through negative financial incentives. Over the course of the program the results show an increase in overall agricultural water use efficiency, even in non-drought conditions[9].

By utilizing an approach that permits increased control over demand, this enhances the potential for supply management. In turn this increases the water utility's potential to achieve revenue goals independent of water consumption[9]. Water conservation also frees up water for further expansion of irrigation areas.

Does the response incorporate flexibility?

The district feels it has reached a point with the metering program where the system is adaptable. With limited supply estimates, the district can equitably distribute water resources amongst growers[7]. The program's flexibility is illustrated in its ability to influence water consumption patterns or increase revenue through adjustments to the rate structure. Water monitoring can also continue under changing water regimes[10].

The program is also resilient, in that it is relatively easy to change the rates used. The rate schedule would have to be changed in the bylaw which would not be difficult providing approval was provided by regulatory agencies[7]. The program has been considered a success because the district has shown resilience beyond that of non-metered communities in drought situations, despite having a lower overall water supply than some other districts[7]. The district has been able to adjust water allotments to landowners depending on the estimated drought year requirement. It was demonstrated in 2003, under a very high moisture deficit, that the program resulted in only a 2.7% increase in average water consumption by farmers compared to the previous ten year average[9]. It has been concluded that the district could maintain itself over multiple years of successive drought[2, 9].

It is also possible to stop metering. Impacts of this would be dependent on the significance of the revenue generated by the program, although rates could be adjusted to compensate[10]. It is likely that the educational component of the program will have had a longer-term impact on farmer perceptions and some individual conservation efforts would continue without it.

Criterion 5: Social and Political Acceptability

Is the response socially acceptable?

At the onset of the program, there was significant resistance and enormous distrust in the agricultural community toward the metering program. When it was first proposed, a petition was signed by growers in opposition of metering[11]. The source of mistrust by the public and growers may have been attributed to a lack of sufficient communication from the district concerning its plans, as well as the initial absence of a biding process toward hiring a meter supplier[11]. The agricultural sector also was concerned that water would be diverted away from farmers toward development in other sectors[16].

During its public consultation phase in 1994, there were elections for two seats on the director's board and the incumbents were voted out in favour of anti-metering replacements[7]. The metering process was halted temporarily until the province intervened. Initially the program was intended to meter all irrigation and new domestic connections. However, as a result of public and grower concern, only irrigation connections were metered[11] and a commitment was made that a metered rate would not be implemented for a five year minimum period[9]. This provided an opportunity to teach stakeholders of the benefits of water conservation through an extensive educational process that was undertaken[9], and which resulted in a shift toward support for the program as stakeholders recognized their role in the equitable management of water supplies[15].

The negative perception of both the district and the program has changed over time as metering has proven itself[17] and as the district has taken steps to appear more transparent and improve its relationship and communication with the public and growers[11]. Gained support for the program has likely also been based on the principle of only penalizing excessive water use, rather than charging fees based on total volume of water consumed[9]. As other irrigation districts consider adopting water metering, they may face similar resistance and distrust[17], although it appears that in other local irrigation districts, such as the Black Mountain Irrigation District (BMID) the public is not as adverse to the idea of metering[5]. This may attributed to the process already having proven itself elsewhere.

Is the response equitable among key stakeholders?

The benefits of the metering program were seen by the agricultural community in 2003 during a very dry season. As the agricultural community in this district compared its situation to farmers in other irrigation districts, they were able to acknowledge that not only did they have a better understanding of their own water requirements and allotments, but that the distribution of water resources within the district was equitable among farmers based on individual requirements[7].

Initially, the response applied the same penalty for excess water use to all users, regardless of the amount of water utilized. This was changed to an inclining block rate system, which addressed the diverse physical demand characteristics across farms. The annual district allotment of water to farms is based on a weighted average drought year district requirement which is determined through a combination of district climate information with individual farm analysis that

includes crop and soil types, irrigated area, and irrigation system. Thus inequities are reduced by taking into account different soil requirements across the district in determining an allotment and using a rate structure that incrementally charges increasingly wasteful water consumption[9]. From a representation perspective, SEKID's five member Board has historically been made up solely of growers. This has since changed and two seats are being represented by residential subdivisions. Growers are now concerned that the presence of non-grower stakeholders on the Board may compromise access to water resources[16].

Are there any necessary political conditions?

While there was a political will to incorporate metering, it was not originally considered politically strategic. SEKID's Board of Trustees suffered a turnover due in part to the issue of adopting a metering program. However, the success of the program over time has made the subject less controversial at the municipal scale. Board members who were voted out in 1994 have now been largely voted back in[3, 7, 17]. At the provincial level, there was strong support from the British Columbia Ministry of Agriculture and Food (BCMAFF) and the British Columbia Ministry of Environment (BCMOE) both in the early 1990s and now[17].

Criterion 6: Legal and Institutional Feasibility

Are there any statutory or regulatory measures influencing the response?

Fines and interruption of water service are consequences associated with a failure to comply with the restrictions[12]. Information associated with changes to bylaws and new metered rate penalties is made available to district landowners via special mailings and district newsletters[9]. District water use restrictions are implemented under the authority of district bylaws. Bylaw No. 579, *Irrigation Water Distribution and Regulation Bylaw* (2003), regulates water used for irrigation. Under this bylaw, annual water use allotments may be set by SEKID's Board of Trustees. The Board also has authority under this bylaw to charge a metered rate for exceeding allotments and to discontinue water service to landowners. Bylaw No. 607, *Water Distribution Regulation Bylaw* (2006), outlines the authority of the Board of Trustees concerning water use regulation, and describes the provisions for water supply and use[14].

Do institutional arrangements affect capacity to respond?

There has been support from senior levels of government toward the program. Program costs were shared between the irrigation district, the BCMAFF, and the Canada-British Columbia Green Plan for Agriculture[11]. The capital cost of the purchase of all the meters and fittings for the program were financed federally at 50 cents per dollar. SEKID paid for the installation of these. At the provincial level, funding was made available for education of farmers and contributions were also made through provincial staff and labour[7].

Additional data required to answer question.

Does the response facilitate communication, information sharing, and coordination among agencies, organizations and stakeholders?

There are several cooperative networks in place to ensure efficiency and effectiveness. The Kelowna Joint Water Committee (KJWC) was formed in 1991 and co-ordinates activities between the City of Kelowna's five primary water districts. The Board of the Whole consists of one representative from each of the five Kelowna water suppliers, and the managers from each supplier make up a technical committee[4]. As a result of SEKID's metering program, some communication and information sharing has also occurred between districts, despite their being a complex dynamic between them[1, 7, 17, 18].

SEKID is the primary agency providing leadership in the metering program. District staff is responsible for reading meters and providing water use reports to landowners. The district also manages the water supply to landowners and implements the rate structure. The districts activities are guided by the district's Board of Trustees[14].

Does the response impact other adaptation measures?

The response likely increases the effectiveness of other adaptations by providing an increased water supply as well as greater awareness and education. It potentially interferes with non-drought related adaptation measures if it ties up limited funding resources in this particular program that might be otherwise applied to alternate responses.

Additional data required to answer question..

Criterion 7: Financial and Technical Feasibility

Is the response economically acceptable?

The total cost in Phase One of the program (1994-1998) was $784,000 which includes meter installation, irrigation scheduling, and data management. Program benefits (i.e., the value of freeing up water rights) in this period amounted to $1,200,000, resulting in a net benefit of $416,000. Thus in Phase One, the Benefit/Cost Ratio was 1.53. In addition to this, increased efficiencies in water use result in savings tied to lower capital and operating costs[9]. Compared to an alternative capital water storage project (Turtle Lake Reservoir), this project had greater benefits of water conservation[8].

Are financial resources sufficient for implementing the response?

Insufficient data.

Is the appropriate information and technology accessible?

Meter readings and tracking of actual irrigation water use provided information on district irrigation water demand[9]. Irrometers were used to indicate soil moisture levels on each metered property, allowing farmers to incorporate optimum soil moisture levels[12]. Additional data collected from each property on crop and soil types, area irrigated, and irrigation system used provided the irrigation water use requirements of the district. Estimates of irrigation water requirements for given periods of time can be calculated from climate information collected from a district weather station[9].

Is appropriate staff available to implement the response?

Landowners may access district staff to assist in understanding the restrictions associated with district water use[12].

Additional data required to answer question..

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Irrigation Water Management Study (IWMS)

Criterion 1: Promotes Preparedness

Does the response incorporate a clear understanding of agricultural drought?

The objective of the study was to develop appropriate knowledge of demands on current and future water supplies in order to facilitate sustainable agricultural water management. Specifically, the study addressed: on-farm water use, characteristics of distribution systems, development of irrigation district computer models, identification of impacts associated with irrigation water shortages, and evaluation of current and future irrigation circumstances[5]. It provided an opportunity to highlight the advantages of more efficient water use and to showcase the benefits of adjusting irrigation techniques to local producers. Although it was not the intention, drought is addressed indirectly through the study's focus on improved water management practices[4].

Is the response proactive and anticipatory?

Insufficient data.

Does the response contribute to long-term planning?

The study itself was an exercise in updating databases and knowledge in order to enable longer term planning initiatives. It was recognized when the 1991 *South Saskatchewan Basin Water Allocation Regulation* was established that the available information on specific water use components was inadequate and needed to be improved in order to better facilitate important decision making initiatives. As a part of this updating process, the intention was also to review and refine the *Regulation* itself in the subsequent decade[5].

Plans are underway to update information in the near future. Return flow, for example, which is water that returns from the districts to watercourses, has been decreasing with improved efficiency. Flow was tracked from the beginning of the study and has been since then[1]. While the modeling has not been updated, the data sets built for the models have been sustained, and this has become part of the normal operations of the irrigation districts and AAFRD[3]. By continually monitoring and adding information, this builds the database further which assists in forecasting and planning activities[1].

The study involved over four years of data collection and analysis, the results of which are incorporated into Alberta's South Saskatchewan River Basin (SSRB) water management planning process[5]. The study provides an opportunity to evaluate risks and vulnerabilities associated with current and future water use. By quantifying the parameters that impact water use, it provides a firm foundation to move forward and develop future projections. In addressing the impacts of climate change on irrigation, planning initiatives can be based on understanding[1].

Criterion 2: Promotes Self-Reliance

Is self-reliance promoted by the response?

As a result of up-to-date data collection from the study, detailed irrigation scheduling tools are available to farmers over the internet. Such tools assist farmers in managing their own soil moisture and enable them to better match crop demands to irrigation methods, further improving their own water use efficiency. In times of persistent drought, the model provides a tool for farmers to better manage their individual water supplies[3].

In 1999, changes to the *Irrigation Districts Act* permitted increased autonomy in decision making to irrigation districts. Through collaboration and collective action in irrigation water management, the districts took on greater responsibility, accountability, and independence from government[5]. From a technical perspective the study has provided valuable information to irrigation districts and farmers[3]. The study highlighted potential limitations in certain areas which prompted some irrigation districts to conduct their own studies in order to provide a more comprehensive understanding of district water demands and impacts specific to local characteristics[2].

As a result of increased self-reliance, farmers may rely less on assistance (such as insurance), although it is unlikely that they will choose to exclude themselves from assistance programs. Rather, improved irrigation efficiency may encourage farmers to incorporate higher value crops[3].

Does the response improve societal/stakeholder awareness?

The study resulted in the public release of a five volume report which includes a summary and technical reports. The summary report serves a number of purposes. It contributes information toward larger scale planning activities in the SSRB and provides up-to-date planning data and analytical tools to irrigation districts. It also assists in providing improved public knowledge of the role and contributions of irrigation to the region[5]. While press releases were issued fol-

lowing publication of the study, emphasis was geared toward informing decision makers and elected officials[3]. Individual districts have provided information to irrigators through their publications and websites, and in part, as a result of the study, there has been a push toward educating irrigators on water management efficiency and related environmental issues[6].

The program does not encourage active public and stakeholder involvement in the response process. The study involved a joint effort by the Alberta Irrigation Projects Association (AIPA) and its represented districts, Alberta Agriculture, Food and Rural Development (AAFRD), Agriculture and Agri-Food Canada (AAFC) through the Prairie Farm Rehabilitation Administration (PFRA), and Alberta Environment (AENV). The study had a technical focus and public input was not incorporated in the process of data collection and analysis. Public policy discussion with respect to future planning has since been initiated but not as a specific component of the study, and in terms of local input, farmers were not involved in the data collection[3].

Does the response promote risk management?

Irrigation district boards are comprised of the peers of those who live in the district which creates incentive to have a water management that is perceived as fair and open[3]

Additional data required to answer question..

Criterion 3: Promotes Strategic Change

Does the response address targets of opportunity for strategic change?

The study was prompted by the recognition that there was inadequate scientific data available to ensure appropriate decision making concerning irrigation expansion planning in the region. Thus an opportunity was available to address data shortcomings and to make improvements.

The results of the study are incorporated into SSRB water management planning process which was initiated in the 1980's by AENV[5].

Does the response provide independent benefits?

There are multiple benefits associated with the adoption of this response. Improving irrigation efficiency can provide greater opportunities to increase crop yields, diversify crops, improve crop stability, and encourage diversity in farm production. These outcomes generate further economic benefits through backward linkages in terms of requirements for increased inputs and expenditures, and forward linkages related to storage, transportation, and processing. Improved irrigation infrastructure also contributes to the provision of municipal and industrial water supplies, and supports recreational and tourist activities associated with water sports and fishing[5].

Can the response be utilized elsewhere?

Insufficient data.

Criterion 4: Lessens Vulnerability

Does the response reduce social and economic risks associated with drought?

As the modeling component was developed, it provided the formation of an overall view of the system. This permitted the discovery of some demand management flexibility. It also helped pinpoint infrastructure problems as being responsible for an inability to meet demand in certain areas, rather than it being an issue of supply. The availability of up-to-date data and the ability to model more accurately resulted in greater overall fine tuning of the operating system. Furthermore, the capability to run the model in forecast mode permitted researchers to anticipate about a week in advance what water demands would be[3]. Overall, this resulted in a more efficient system, particularly during the 2001 drought year. Had the data not been readily available, it would have likely been a real struggle to attain it at the time[4]. While the study itself is not directly responsible for reducing vulnerability associated with drought, that reduction can be based on the processes and tools that have been developed ahead of time which allow system operators to more readily apply analysis to future drought management situations[1].

Does the response reduce environmental vulnerability to drought?

An outcome of increased efficiency of infrastructure and the rehabilitation and replacement of canals has been a reduction in uncontrolled seepage[5, 7]. This return flow previously created wetlands and prairie habitat and its reduction has implications for wildlife habitat[7]. As a result in part of improved understanding of the distribution system, there is an opportunity for districts to support controlled releases toward wildlife projects[5]. While some argue the habitat would not have existed as it is prior to irrigation, the issue is still being debated and in some cases, environmental and recreational groups have made arguments against improving system efficiency, despite previously alternative views on the subject[3].

Does the response reduce demand/supply shortfalls in water?

Due to the unique nature of each districts' hydrological and climatic characteristics, on-farm and district efficiencies, headwork and storage capacities and locations, and return flows, each irrigation district was assessed individually in terms of supply and demand.[5].

A range of activities associated with the study have resulted in a reduction in excessive waste and return flows which has improved overall supply. These include widespread monitoring, rehabilitation of irrigation district infrastructure, pipeline replacement of canals, the automation of structures, and enhanced management of irrigation district water[5].

Does the response incorporate flexibility?

Insufficient data.

Criterion 5: Social and Political Acceptability

Is the response socially acceptable?

Insufficient data.

Is the response equitable among key stakeholders?

Insufficient data.

Are there any necessary political conditions?

Political representatives are supportive of the program. Support for the study was present from various Ministries, largely due to the 1991 *South Saskatchewan Basin Water Allocation Regulation* and the commitment to review it in 2000 based on recognized data limitations. The need for up-to-date information in order to better inform water allocation guidelines resulted in pressure on the agricultural industry to adequately represent itself from a technical standpoint. The study provided an opportunity to do this and prepare for the *Regulation* guidelines review, as well as provide a positive impression of the industry to the public[3]. Furthermore, a cap was placed on irrigation expansion until the amount of expansion that could be done in the SSRB could be determined. This provided further incentive to gather the knowledge necessary to be able to move forward with irrigation development[1].

Criterion 6: Legal and Institutional Feasibility

Are there any statutory or regulatory measures influencing the response?

As a result of rapid irrigation expansion and increased environmental awareness and concern over water supply throughout the 1970's and 80's, a set of guidelines were developed under the SSRB Water Management Policy (1990) to address water management in the SSRB. The 1991 *South Saskatchewan Basin Water Allocation Regulation* was implemented specifically to guide decisions concerning water allocation and water management in the Basin. The guidelines were developed pursuant with Section 173 of the *Water Act*[5]. It was recognized at the time the *Regulation* was implemented that available data and information, particularly concerning in-stream water needs, was inadequate to make accurate decisions concerning water allocation. Thus a commitment was made to review it in 2000[5].

Do institutional arrangements affect capacity to respond?

There was sufficient jurisdictional authority to implement the response. The Steering Committee comprised representatives from four key agencies. This included three members from the AAFRD's Irrigation Branch, one member from AAFC's PFRA unit, nine AIPA directors representing the thirteen irrigation districts, and resource and liaison member from AENV[5]. Despite some difficulties that arose between agencies in terms of timing and coordination, jurisdictional barriers to implementing the study were absent[3]. Senior government agencies have also shown program support. In addition to contributions from both provincial and federal agencies in providing representatives for the Steering Committee, both technical and financial contributions were made. Work was performed by AAFRD and AENV staff, as well as by the irrigation districts at the local level and outside consultants. Between AAFRD, AENV and the districts, over $2.1 million of in-kind services were provided[5].

Does the response facilitate communication, information sharing, and coordination among agencies, organizations and stakeholders?

The study involved a cooperative multi-agency effort. The Agencies included the AAFRD Irrigation Branch, the PFRA on behalf of AAFC, the AIPA on behalf of the Province's thirteen irrigation districts, and AENV[5]. Good dialogue and collaboration between parties at the onset of the study were some-

what diminished toward the end. This was potentially attributed to a rush to complete the project and differing priorities among stakeholders, resulting in a shift in the degree of ownership felt by partners. Initially, the irrigation districts had the highest level of ownership and were heavily relied upon for cooperation. As pressure mounted to complete the research, greater direction came from AAFRD and the AIPA and this may have resulted in some distancing on the part of the districts toward the end[1, 3]. There were also some difficulties concerning the coordination of some of the modeling with AENV although this may be attributed to staff shortages and timing issues[3].

The leadership and overall direction for the study was provided by the multi-agency IWMS Steering Committee. Established in 1996, the Steering Committee created the Summary Report which characterizes the state of southern Alberta's irrigation industry, and contributes important data toward AENV's SSRB water management plan. The Committee was comprised of nine AIPA directors, three AAFRD representatives from the Irrigation Branch, one representative from the PFRA, and AENV representative/liaison[5]. Working groups were developed to coordinate research and analysis for each of three focal areas: on-farm water use; distribution system efficiency; and computer modelling[5].

Does the response impact other adaptation measures?

Since the study was so focused on management of irrigation infrastructure, it is not likely to have impacted other sectors. However, while non-agricultural irrigation was taken in to account in the study[3], it did not specifically take into account impacts of water supplies to non-irrigating sectors.

The basis of the study concerns an understanding of current and future water requirements in order to better facilitate irrigation expansion in southern Alberta. The study identified three key areas of water inefficiencies: on-farm application, canal seepage, and evaporation. A major component of identifying methods of improving water use efficiency within the system involves utilizing water savings to further expand irrigation, and potential expansion scenarios were determined[5]. For some districts there has been disagreement over expansion as some are wary of taking on further risk. Since the study was undertaken, some districts have expanded while others have not[4]. In addition, other sectors are likely to view water savings through improved efficiencies as being more appropriately utilized to address water shortages elsewhere to address environmental, domestic or industrial water supply concerns.

According to the AIPA, the level of detail regarding the irrigation system and networks is considered to far surpass that available for the basin[3]. If this is the case, then the study may enhance adaptation through increased knowledge of the system.

Criterion 7: Financial and Technical Feasibility

Is the response economically acceptable?

Insufficient data.

Are financial resources sufficient for implementing the response?

Funding sources for the program are reliable. AAFRD, PFRA and the irrigation districts, through the AIPA, contributed financial resources annually toward the study. Funds were raised by districts by applying a per acre levy on water users[1, 5]. The majority of funds were utilized through consulting services[5]. Funding was also raised by individual irrigation districts toward return flow channels and monitoring stations within their respective water distribution systems[5, 6]. Much of this was achieved through a provincial/district cost share agreement under the Irrigation Rehabilitation Program[5]. Estimates of the costs associated with the study were determined in advance and AAFRD and the irrigation districts were able to provide commitments over a 4-5 year period to the various projects associated with the study[3] Ongoing data collection costs are being absorbed by the districts and ongoing modeling is being performed by AAFRD[1].

Is the appropriate information and technology accessible?

Detailed technical reports were developed by AAFRD staff and consultants[5]. A variety of analytical tools were used to accomplish the study, resulting in extensive databases that are updated on an ongoing basis. The study involved a detailed analysis of the irrigation system in terms of on-farm water use, distribution system efficiency, and computer modelling. Together, these incorporated the use and/or development of up-to-date databases, modeling systems, field testing, monitoring stations, and risk assessments. Four technical volumes were produced detailing these components of the study[5]. One challenge that is still faced regarding technical data concerns the timing of data collection among agencies (e.g. weekly vs. daily). This creates a barrier in terms of aligning the data from different sources[3].

Is appropriate staff available to implement the response?

Work for the study was undertaken by irrigation district staff, AAFRD, AENV and consultants. Generally speaking there was sufficient and appropriate staff available. With the range of agencies involved, shortages that might occur in appropriate staff could basically be satisfied through the other partners[3]. One particular shortage that exists is a shortage of sufficient staff with the ability to both understand the technical aspects of the data and modeling components, and to translate that information to those without a technical background[3].

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Ontario Low Water Response (OLWR)

Criterion 1: Promotes Preparedness

Does the response incorporate a clear understanding of agricultural drought?

The intent of the Ontario Low Water Response (OLWR) is to prepare and support provincial agencies and local communities in the management and coordination of responding to drought events locally. The guidelines emphasize and primarily target 'low water' levels and long-term management of low water conditions[14]. A clearly stated definition of drought is provided by the guidelines[14]. However, while the definition is general enough to include agricultural drought, it does not define it specifically. Rather it refers to drought generally as it relates to weather and low water conditions across a watershed. The guidelines also include specific drought indicators and thresholds, as well as tools for measuring and quantifying a drought. Precipitation and streamflow measurements are the primary source of indicators which are used to characterize three levels of drought[14]. Ontario Ministry of Natural Resources (OMNR) staff in the Surface Water Monitoring Centre (SWMC) collect weather and streamflow data weekly, compare it to long-term records, and monitor conditions in relation to specified low water and drought indicators[11].

Is the response proactive and anticipatory?

The guidelines are available continuously and are adopted by local communities on a voluntary basis following the identification of a risk of water supply deficits and thus are reactive. Water Response Teams (WRTs) are only formed after a Level 1 drought condition is announced[4]. The absence of a proactive drought contingency planning approach can mean that priorities are only developed following the implementation of the guidelines, resulting in mitigation problems. A shift toward a more proactive strategy over the long-term has been identified as an important step in the plan[15].

The plan incorporates a warning system with three levels of water conditions, based on assessment tools, which represent progressively more severe impacts. Each level has a corresponding set of guidelines. Upon indication of potential water supply deficits, the first level, Level I, is adopted which represents a 'warning' phase. As conditions indicate a more serious threat, the response is upgraded to Level II where water conservation measures are emphasized. Level III indicates an inability of demand to be met by existing water supplies and results in mandatory water use restrictions[14].

While the OLWR provides steps to address the conditions leading up to a drought through Levels I and II, the guidelines lack specific emergency response measures in the event of a Level III announcement, which is indicative of potential drought conditions. Rather, the framework suggests referral to municipal emergency response plans[4]. The plan specifically states that it, "does not address 'emergency' response measures as defined by the Emergency Plans Act" (p2)[14]. While Level III conditions have been reached in some parts of Ontario, it has not been declared. Possible reasons for this may be the too broadly defined classes of water restrictions (i.e. essential, important, and nonessential) set out within the program[15], and insufficient clarity or understanding of what are the appropriate Level III procedures[2].

Resources toward OLWR are not necessarily secured in advance of low water conditions and are somewhat variable. The availability of resources to each ministry to use toward OLWR is dependent on the moisture conditions that exist in each year, as well as whether the conditions are predominantly local or regional. Due to the relatively new nature of the plan and its minimal application thus far, it is still difficult to determine what the appropriate amount of resources would be[9].

Does the response contribute to long-term planning?

To encourage ongoing evaluations, each year there is a debriefing session in which WRTs are invited to meet with OMNR and discuss implementation challenges, and share lessons and experiences[1, 17] . The response was introduced in 2000, reviewed in 2001/02, and revised in 2002. It was reviewed and revised again in 2003. There has not been a review since as conditions have been relatively wet and have not warranted it[1]. While the plan does not incorporate a built in review system, assessment of its implementation is undertaken by staff. Changes can be implemented according to needs arising at the local level resulting in continuous development of response activities based on individual assessment[9]. An interministerial team also focuses on the results of WRT workshop feedback and attempts to address issues that are raised[17]. As a result, specific protocols may be developed, changed, or improved upon, such as establishing standardized indicators to declare response levels[1, 17].

Criterion 2: Promotes Self-Reliance

Is self-reliance promoted by the response?

Under low water conditions it is up to the local Conservation Authority (CA) to establish a WRT[11], a multi-stakeholder committee including local water users and managers, municipalities, and provincial representatives. Watershed boundaries generally guide the geographical jurisdiction of each WRT. The team makes recommendations and facilitates coordination of agencies, non-governmental organizations and users. It may implement drought management tools including coordination of irrigation, communicating with the public, and accessing municipal by-laws[11]. However, the province has the final decision-making power regarding the WRTs recommendations[9, 11], and as such local level authority is minimal. WRTs do not possess the authority to implement reductions of water use and must rely on senior government agencies to monitor, enforce and issue fines[4]. Despite the framework provided by the guidelines, lack of authority at the local scale, particularly under Level III conditions, may result in uncertainty regarding protocols or course of action, requiring senior level intervention[3].

Dependence on disaster assistance may be reduced through the response. By implementing conservation actions at Levels I and II, demand on water resources can potentially be reduced which may be sufficient to prevent the establishment of a Level III (drought) condition[17]. Dependence may also be reduced through building increased awareness by local water users and more efficient water management[9].

Does the response improve societal/stakeholder awareness?

Hazard information, such as weekly low water conditions maps and reports, is available to the public at the OMNR low water website[12]. These include information on monthly weather conditions, confirmation of areas within the province where a Low Water Response was initiated, illustrative indicator maps and graphs, summaries of flow conditions, and vulnerability maps indicating areas of the province that may be susceptible to dry conditions[12]. While public outreach is not a strong component of the program[2, 4], additional information on water issues may be provided by CAs and municipalities through posting press releases in local offices and websites, which in turn can be utilized by the media[11, 17]. The focus of the OLWR is major water users and water managers and these are represented on the WRTs. WRT representatives are responsible for informing their respective constituents and the general public[9]. The broad community is represented within the WRTs through municipal councillors[17]. While it is not a mandatory component of the program, the teams may choose to hold community-wide meetings[9, 17].

Does the response promote risk management?

Information generated through the monitoring component of the OLWR program can assist in improved targeting of other incentive programs related to water use and management. However, the OLWR does not incorporate financial incentives and there is not a significant educational component[9]. The program may instead create disincentive as a result of friction among users concerning water allocation. Under the program, users who hold a Permit to Take Water (PTTW) are expected to reduce their water consumption, and penalties can be enforced during a Level III condition for non-compliance including: permit cancellation, fines, and litigation[10, 13]. Since not all users who require a permit actually have one, these users cannot be targeted for water reductions, resulting in inequities among users[2].

Much of the incentive that exists at the agency level concerns avoidance of unnecessary conflict and mitigation. Incorporating the OLWR guidelines can assist in improving water supplies during periods of low water which directly impacts decision making concerning water allocation and equity issues. Ministries and agencies also have a vested interest in the success of the program in terms of relevance to respective agendas and legislative responsibility, so it is in their favour to participate[2, 9].

Criterion 3: Promotes Strategic Change

Does the response address targets of opportunity for strategic change?

In many Ontario watersheds, there already exist multi-stakeholder committees concerning water management which can be utilized by CAs to develop WRTs[11, 14]. Under low water conditions, the OLWR complements the Province's PTTW program by providing a water sharing framework[18]. WRTs may also work closely with local Irrigation Advisory Committees (IACs). These committees, in response to low water conditions, facilitate reduced water consumption and greater sharing of allocated water resources, thus increasing the efficacy of the OLWR program[18].

Does the response provide independent benefits?

Economic benefits from the program may develop from adopting locally relevant strategies due to the

program's flexibility[9, 17]. While public awareness is not a primary component of the program, the potential exists for OLWR to be a good tool to educate the public about water resources and local management[2]. Voluntary reductions at Levels I and II have the potential to prevent or reduce the intensity of a drought thus reducing or mitigating drought impacts. The program also provides an opportunity for provincial representatives of the different ministries in the WRTs to promote their own programs (e.g. Best Management Practices) in meetings[1]. Non-agricultural stakeholders that benefit from the program may include self-supplied sectors and industries, and the environment (also a water user) represented by the CAs. The program also provides a forum to limit conflict in water allocation[17], and contributes to a systemic and sustainable process of water monitoring[2, 9].

Can the response be utilized elsewhere?

OLWR generally consists of categorizing watersheds, monitoring the system, and recording results in order to assist in declaring the different levels within the program[2]. It essentially provides a general framework for coordination and collaboration. This allows for locally relevant strategies because it is not prescriptive[17]. Yet certain attributes are important to the success of OLWR: the program is designed to operate under state ownership of water resources, permitting government intervention; it was designed for the relatively small size of Ontario's watershed area; and it was not intended for a high population density[9]. Water management under the OLWR also operates on a watershed basis. As a provincial tool for addressing low water and drought issues the watershed- based approach, which incorporates CA mechanisms, assists in successful collaboration across jurisdictional boundaries[8] and in order to replicate the program elsewhere, it is important to incorporate a strong role of CAs as well as appropriate water allocation legislation[1].

Criterion 4: Lessens Vulnerability

Does the response reduce social and economic risks associated with drought?

Water conservation measures adopted at the onset of low water conditions have the potential to alleviate the impacts to individual agricultural operations. Economic risks to different regions, sectors, and user groups in terms of water use restrictions are generally considered by WRTs in order to achieve minimal impacts associated with low water[9, 17]. However, water use restrictions are usually implemented on a uniform basis by WRTs, with equal levels of water reduction across sectors and users[2, 17].

Does the response reduce environmental vulnerability to drought?

Insufficient data.

Does the response reduce demand/supply shortfalls in water?

OLWR reduces demand through voluntary and imposed water-use restrictions[14]. The program may have an indirect effect on demand by making it easier for municipalities to adopt water-use restrictions and bylaws due to increased awareness fostered by the WRTs[17] and thus adoption of voluntary reductions and conservation measures.

Does the response incorporate flexibility?

The response is not tied to any specific technology and the practices that are used within the program are not fixed. Ultimately, strategies are designed at the local level and for local circumstances which allows for a great degree of regional flexibility[17]. Roles may be adjusted as well in order to facilitate variations in institutional structure. For example, CAs are responsible for assembling WRTs. Where a CA is absent, the OMNR will step in and determine appropriate watershed units through combining or dividing existing recognized watershed boundaries[14]. Flexibility also exists through the utilization of WRTs. Since structure varies across ministries, appropriate communication networks between WRT ministry representatives and the Ontario Water Directors' Committee (OWDC) Low Water Committee can be determined on an individual basis[14].

During a Level III drought condition, the OLWR requires a 20% reduction in water taking under the PTTW program. The potentially high number of permits in a watershed, lack of comprehensive permitting with absentee water users, and the long time period for which permits are issued limits the adaptability, ease and speed with which the program can adjust to changing water demands[7].

Criterion 5: Social and Political Acceptability

Is the response socially acceptable?

At the provincial scale, the various ministries involved are well established and their role is acknowledged by the public. At the local level, CAs are viewed as 'water managers' through the various programs they are involved in, such as watershed planning and flood management[2], and they can provide locally relevant

knowledge to water planning and management initiatives[1]. Since CAs have a variety of funding sources, they may also be perceived as semi-autonomous from government[9]. CA association with environmental priorities may be viewed with concern by some stakeholders (e.g. farmers)[17], but in terms of OLWR, the development of WRTs by CAs with representatives from varying institutional and non-governmental levels aids in fostering a participatory approach[9].

The OLWR is not a widely publicized program and it does not incorporate much public discourse. However, the overall goal of managing limited water resources addresses a variety of public concerns including mitigation of environmental impacts, access to water resources for both public and private use, and economic water interests for industry, tourism and recreation. By potentially offsetting risks in these areas, the program reflects public concerns[1].

Is the response equitable among key stakeholders?

Under low water or drought conditions, the agricultural community faces the greatest threat as entire crops can be lost, whereas other industries may only lose a portion of revenue over the duration of the event. Food production is not clearly identified as a priority despite greater consequences to this industry and water use restrictions under low water conditions are administered without consideration of unique industry-based impacts[2]. Furthermore, broad spectrum water restrictions are applied to the agricultural community as a whole and the guidelines fail to recognize different water requirements across various agricultural commodities (e.g. crop types)[15].

Not all water users who should possess a permit under the PTTW program are identified by the Ontario Ministry of the Environment (OMOE), and thus the amount and location of actual water taking is unclear. These unknown users are overlooked by the permitting system resulting in unfair discrimination against valid permit holders when water use restrictions are applied[15]. In addition, stakeholders who have already undertaken conservation measures of their own initiative, such as utilizing more water-efficient technology, are subjected to the same water reductions under low water conditions as those who have not[2, 15].

The guidelines recommend that in order to determine a plan of action, WRTs should meet regularly during low water conditions. The guidelines also suggest the importance of WRT membership accurately representing a watershed's sector composition[14].The meetings provide an opportunity for stakeholder representatives to improve understanding and communication, and to develop recommendations concerning the use of regulatory and other tools. Representatives from the various stakeholder groups, who are responsible for communicating back to their respective sectors, attend meetings voluntarily. As a result, members who do not participate in the meetings fail to speak on the behalf of their stakeholder groups. This can result in inadequate representation and consensus on decision-making from stakeholder groups within the affected watershed, and ineffective information dissemination[15].

Are there any necessary political conditions?

Political support exists at the provincial level which is expressed through the participation of the various ministries, although discussion of the program among many MPs has dwindled in the absence of recent serious water shortages[2]. At the municipal scale, when water restriction by-laws are new to an area there is an associated learning curve for the public which can affect the popularity of elected municipal councillors[17]. The program may also be viewed with some cynicism at the local level because there is not much funding associated with it, and for some municipalities, water quantity may not be a high priority so it is generally off the radar[9]. However, WRTs provide a useful source of direction and guidance and assist municipalities in confronting potential conflicts and water shortage issues more proactively[17].

Criterion 6: Legal and Institutional Feasibility

Are there any statutory or regulatory measures influencing the response?

The program was designed to function within the current legislation. A wide variety of legislation exists associated with water quality, water quantity, and water-related land management. Some of the primary pieces of legislation associated with OLWR are the *Ontario Water Resources Act*, the *Municipal Act*, and the *Conservation Authorities Act*. Federal legislation such as the *Fisheries Act* and *Navigable Waters Protection Act* must also be considered in any water management that is undertaken[14].

Do institutional arrangements affect capacity to respond?

There are a variety of federal and provincial agencies assuming different roles and responsibilities concerning water management in Ontario and these agencies act upon legal authority embedded in a range of legislative tools to implement and enforce their actions. However, municipalities can only restrict non-essential water use and are unable to do more than

request voluntary conservation outside of respective municipal systems. CAs lack the legal capacity to implement and enforce water use restrictions[6], and WRTs do not have any unique legislative authority. Rather, they assist by providing recommendations on the use of regulatory and conservation measures[14].

The policy document dictates who should be involved, who should lead, who should be part of the WRTs, and what agencies are intended to accomplish[9]. At the local, watershed, provincial and federal scales, specific roles and responsibilities are outlined[14] and these are largely dependent upon agencies' organizational mandates, legislative tools, communications capabilities, and experience and understanding[4]. Specific roles for WRT representatives are also identified[14]. However, heavy reliance on voluntary implementation of some activities on the part of municipalities, CAs, and watershed residents potentially constrains effective water shortage management. Despite the appropriateness of local decision-making, some communities lack the capacity to monitor effectively and establish priorities in water use[6].

Senior government has shown financial support for the program. The province has provided funding and staff toward establishment of groundwater monitoring in cooperation with CAs, providing information to stakeholders, assigning staff to act as liaisons, foster communication and collaboration, and expand support toward development of infrastructure and municipal groundwater studies in order to assist in anticipating and minimizing impacts of low water conditions[1, 6].

Does the response facilitate communication, information sharing, and coordination among agencies, organizations and stakeholders?

The development of relationships and partnerships between local and provincial governments is part of the intent of the guidelines[14] and agency collaboration is considered in the process. Multi-agency collaboration is fostered through WRTs as provincial and local agency representatives act to ensure activities are coordinated among the team members and back to the respective agencies[4]. CAs, responsible for developing WRTs, serve as a point of contact to local public interest groups and stakeholders.

Communication is also fostered through the OWDC Low Water Committee, whose principle members include Field and Policy Directors of the OMNR, Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), Ontario Ministry of Environment (OMOE), and Ontario Ministry of Municipal Affairs and Housing (MMAH). Under Level II or III conditions this sub-committee is created to interact with affected watersheds and provide provincial response coordination under the direction of a Low Water Committee Coordinator. Communication networks provide WRTs with direct access to the Low Water Committee[14].

The overall direction, emergency support, and policy, science and information coordination is provided at the provincial level[4]. The lead agency in administering OLWR is the OMNR. Development of the drought response plan was spearheaded by OMNR, in partnership with other Ontario ministries, Conservation Ontario, and the Association of Municipalities. Locally, WRTs provide recommendations and direction, and CAs take the lead in the establishment of these teams. In areas where CAs do not exist, OMNR will take over[11].

Does the response impact other adaptation measures?

The OLWR has a positive impact on other activities through its monitoring outcomes. Consistent and systematic monitoring of water systems' conditions generates information that is relevant at the local level for other activities[2]. The information produced within OLWR can also be utilized to better target funding, infrastructure development, and support. Alternately, because the process informs the watershed classification of the PTTW program, permits may become more restricted in high use watersheds, limiting economic development[17].

The program has the potential to work well within the source water protection process as its committee and the WRT have the potential to co-exist. Source protection representatives from OMNR, located in different regions of the province also act as OMNR representatives on WRTs and have recently participated in training sessions with OLWR providing a link between the two areas[1]. Municipalities address a variety of issues and there exist multiple local-level agendas. Water quantity is only one of many issues and activity or conflicts in other areas of concern may influence the ability of local committees to deal with water conflict[2]. Alternately, the social capital that is built with OLWR through the collaborative process among stakeholders may be used toward other programs[9].

Criterion 7: Financial and Technical Feasibility

Is the response economically acceptable?

Financial costs associated with the OLWR include: staff time involvement on WRTs to represent stake-

holders (and sometimes fuel costs for attending meetings); ministry staff training costs; and a range of administrative costs such as WRT meeting organization[1]. A key characteristic of the program is that it builds on existing hard and social infrastructure (e.g. monitoring, staff, and CA offices). Monitoring is an ongoing cost incurred by the province that is not exclusive to the OLWR program. Thus, the budget for monitoring does not arise directly from the program. However, if additional costs are accrued from monitoring undertaken specifically for OLWR, those expenditures will fall within the program budget. This was not always the case but was added due to concerns raised by the CAs[1].

Efficient allocation of resources is important to the program's success and is achieved through targeted funding. Financial assistance is provided to CAs when they submit receipts to claim expenses which results in money being used where action has actually been taken. Previously, resources were unavailable to CAs in advance of a Level I announcement but this has been adjusted to permit resources for pre-meetings[17]. Efficiency is also achieved by the OLWR building on existing programs, avoiding duplication and redundancy. Staff and agencies that are already established take on much of the response activities, and infrastructure (e.g. monitoring equipment) is utilized for other purposes than the response resulting in multiple benefits[1].

Are financial resources sufficient for implementing the response?

OLWR is funded by OMNR and the program is delivered through existing mechanisms such as previously established monitoring networks and CA offices so it is in some respects an add-on program with a budget for management costs. As a regular budget cost, financial assistance is distributed on an annual basis to CAs to offset the program's management costs. This is only a recent change made to the program to improve its implementation[1]. When OLWR is implemented the cost of operating the program increases four to five times. The announcement of a Level I or II results in increased WRT meetings. There are also added costs during low water periods associated with press releases informing the community about recommendations and actions being taken[1].

Provincial funding is essential to the program as local access to resources vary widely. CAs with regional municipalities (e.g. Regional Municipality of Peel in the Credit River Watershed) that fall within their watershed boundaries may have greater capacity to assemble resources for drought contingency planning than those that rely on county level governments. The size of a regional government's operating budget is likely to be substantially greater than that of a county government. CA revenues will also vary widely, impacting the availability of resources at the local level for implementing the program[3, 6].

Is the appropriate information and technology accessible?

Due to budgetary costs and staffing, access to appropriate information and technology is generally greater in areas with strong financial resources within local government agencies and the CA[6]. However, local agencies in Ontario may access information from a number of resources, including watershed and hydrogeological studies, well water records and the PTTW database from OMOE, and monitoring records from various sources[5]. While improvements could be achieved in some of the data collection methodology[16], good quality information is readily accessible to water managers through Internet sites such as the low water data provided by OMNR. The site provides monthly weather conditions, confirmed areas where a Low Water Response was initiated, illustrative indicator maps and graphs, summaries of flow conditions, and vulnerability maps indicating areas of the province that may be susceptible to dry conditions[12]. Efforts are also underway to enhance monitoring data that is collected by OMNR[1].

Is appropriate staff available to implement the response?

Several watersheds have access to trained staff at the CA, municipal, and provincial levels[3, 6] as well as access to consultants in water resources management and technical experts, and in some cases these consultants are placed on retainer by the CA, occasionally on a permanent basis[5]. Locally, staff availability is associated with the level of importance of water quantity since CAs have a variety of water related issues to contend with. In some watersheds, water quality is a higher concern and in these situations, staff may be outsourced to other programs. Provincial agency representatives are not always available to attend the WRT meetings and this can also be a source of frustration[17].

Each year the province runs training sessions for CA staff and some other stakeholders that are very active on WRTs. OMNR does a great deal of capacity building for CA staff. If there is a perceived need that is sufficiently demonstrated regarding a particular training requirement, the OMNR can address this and

provide training to CA staff. These needs are often identified at debriefing sessions that are conducted on an annual basis to assess the implementability of the program[17]. At the provincial level, the ministries have training programs for their own staff according to their different types of expertise. Each ministry also provides training and support for their local WRT representative[9].

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Environmental Farm Plan (EFP)

Criterion 1: Promotes Preparedness

Does the response incorporate a clear understanding of agricultural drought?

The EFP was not intended specifically to address drought or water shortages. The program objectives are generally to assist agricultural operations identify environmental impacts associated with farming activities, and to support agricultural stewardship. However, several activities that are encouraged through the EFP relate to farm water resource management. In addition to promoting environmentally oriented stewardship activities, BMPs that are encouraged through the EFP also include measures such as reducing risk to water quality, riparian area management, conserving soil resources, and expansion of water supply. Thus, while EFP is focused around environmentally sustainable farming practices, an additional unintended benefit is the adoption of agricultural methods that may assist in addressing drought or low water conditions on the farm.

Is the response proactive and anticipatory?

EFP assists farmers to identify benefits and risks to the environment associated with their own farm operation through a detailed systematic process. On-farm environmental concerns can then be addressed through setting priorities for predetermined courses of action[2]. The process consists of a sequence of steps. Following attendance at an EFP workshop, farmers develop Risk Assessments for their operation that allows them to rate environmental concerns. Based on the outcome, farmers then develop an Action Plan that is submitted for peer review, and is then implemented[3]. Some actions within the BMPs take into account the impacts of shortage in water supply. For example, in some cases irrigation assistance is available for shelterbelt installation projects which recognizes the risk to those trees associated with availability of water[6]. Other practices such as reduced tillage can also improve soil and water quality[17].

Does the response contribute to long-term planning?

There is a national BMP committee in place to encourage an on-going evaluation of the program. All the provinces and producers can submit suggestions as to what practices should be added and/or changed, and this is then reviewed annually. Many applications are submitted such as changes to BMP incentive programs, addition of new BMPs, and suggestions for eligible items under specific BMPs etc. It is estimated that in the last round, probably about a quarter of the requested applications were addressed[6]. Long-term planning also occurs at the farm scale. Although farmers may choose to address some problems with short term solutions, the learning process facilitated by the self-assessment approach feeds into longer term planning and solutions. For example, Alberta's second workbook version was adjusted to provide an opportunity for farmers to state their 'vision' for their farm to assist them in developing a long-term perspective, making it easier for them to prioritize what actions should be undertaken first[18].

Ongoing planning of the program takes into consideration changes in legislation and technology. Multiple workbook editions have been developed in many of the provinces based on an identification of needs for improvement, largely in terms of the content or format of the workbooks. In Alberta, all of the changes to the workbook for the second edition were based on feedback by participants who were provided with evaluation forms. This provided farmers and the delivery team with an opportunity to provide ideas and comments throughout the EFP process. An adult education expert was also utilized to evaluate the strengths and weaknesses of the workbook and this was taken into consideration in its development[18].

Criterion 2: Promotes Self-Reliance

Is self-reliance promoted by the response?

The EFP is essentially based upon a self-assessment system, which results in decisions and planning activities occurring at the farm scale[16]. Farm scale decisions are made based on external expertise and input from peers, but ultimately it is up to individual farm operations which approaches they will utilize. Farmers may decide to undertake the costs of implementing on-farm Action Plans on their own or they may apply for government financial or technical assistance through cost-sharing programs, such as the National Farm Stewardship Program and Greencover Canada[2]. In many cases, there are multiple concerns identified on the farm through the EFP process. Since financial assistance toward implementing Action Plans are cost shared at either thirty or fifty percent, farmers themselves will often prioritize what they choose to spend money on as they cannot afford to address all issues[17].

Does the response improve societal/stakeholder awareness?

Societal awareness through hazard information concerning water related issues is incorporated to varying degrees in each of the province's EFPs. For example, in British Columbia there is more irrigation agriculture than in Ontario, so British Columbia's plan has a much stronger emphasis on water efficiency in its publications than Ontario's. Generally, information is available and accessible publicly through Internet web pages, publications, info-sheets, and guides. Much of this may be accessed by the public but EFP is focused on educating farmers, not the general public, and as such there is very little if any publicizing outside of the agricultural community[16].

Each province offering the program publishes its own version of the EFP Workbook which is available to participants. The workshops also provide a significant venue for promoting BMPs and educating farmers. In some cases, members of the public may attend the workshops, providing they participate[18]. Farmers are provided with information resources and may access technical expertise through the various provincial delivery agencies throughout the process.

The EFP process incorporates active engagement of the farmers through a series of steps. Farmers initially participate in workshops and are then encouraged to develop an individual review of their farm based on information attained in the workshop. This is reviewed by peers or by a third party technical expert, depending on the province, and is generally followed by any recommended adjustments and then implementation of the plan.

Does the response promote risk management?

Generally, incentives to farmers to participate in the program involve education and financial and technical assistance. Education is a strong component of the EFP and a great deal of effort is put into developing the workbooks that are used by farmers to assess the risks on their farms and develop Action Plans. A variety of cost share programs provide farmers with assistance in implementing Action Plans. Access to project funding under cost share programs is often dependent on a farmer having completed an EFP. For example, in Ontario a farmer must have an EFP to be eligible for funding of Tier One projects under Canada-Ontario Water Supply Expansion Program (COWSEP)[7]. Farmers may also recognize financial incentive through potentially reduced operational costs associated with changes in farm practices (e.g. adoption of GPS technology to avoid excessive pesticide applications)[6]. An additional incentive for many farmers is the ability to present themselves to the public as being environmentally conscious by posting an EFP sign at the farm-gate. In British Columbia if a farmer fails to comply with all the key action items that have been identified as requiring compliance with existing legislation, they will not receive a sign[6].

Criterion 3: Promotes Strategic Change

Does the response address targets of opportunity for strategic change?

Insufficient data.

Does the response provide independent benefits?

In addition to improving farmer awareness of environmental impacts of their operation, the implementation of BMPs have considerable benefit in terms of reducing human impact on the environment. BMPs target a variety of farm practices to address a range of issues concerning the water contamination and protection of environmentally sensitive areas. Some of the specific BMP categories include: Riparian Area Management; Enhancing Wildlife Habitat and Biodiversity; Species at Risk; Preventing Wildlife Damage; and Biodiversity Enhancement Planning[3]. Economic benefits can also be achieved through the program by assisting farmers in developing practices that reduce operation costs. For example, by improving cropping systems and pest management, farmers can reduce waste and improve efficiency of the operation, reducing seed and fertilizer/pesticide costs. The adoption of BMPs can also assist with other programs. For example, there are Watershed Evaluations of BMP Sites (WEBS) across Canada that undertake in-depth analysis of water quality or soil changes. Knowledge of the number and location of BMPs that are applied under the EFP can assist in determining impacts in these areas[6].

Can the response be utilized elsewhere?

The program is not targeted at any particular attributes of a drought. Differences in delivery capabilities may be based on regional characteristics of the area such as size, population, staff availability etc. However, the EFP is applicable in any area where farming is present. The program is flexible in that it can function differently depending on where it is and can be adjusted to local needs. The first province to implement EFP in Canada was Ontario which built it upon the Farm*A*System program in Wisconsin, United States[12]. Other provinces subsequently adapted the Ontario EFP to their own versions, highlighting the key components specific to local farming and environmental conditions[6]. Different delivery agency

approaches across the provinces provides evidence of the flexibility of the program. For example, in Alberta farmers pushed strongly for an arms-length from government approach which resulted in the development of an independent non-profit company delivering the program[18]. Because of the diverse agricultural sector in British Columbia, the program is delivered there in agreement with the eighteen different commodity groups, which target their respective farmers[8]. Both of these mechanisms have assisted in building trust with producers[8, 18].

While the general principles are common nationally, the EFP process varies among the provinces in terms of how the program is delivered. Ontario, New Brunswick, Prince Edward Island and Alberta typically utilize a process that involves farmers participating in jointly attended workshops where technical assistance is provided. Farmers learn the concepts at these meetings and then apply them to their own farm operation. After completing an Action Plan, it is anonymously peer reviewed. The review is usually done by other farmers or by extension staff, but other resources for review are also available depending on the province. For example, in New Brunswick, a staff member at the Eastern Canada Soil and Water Conservation Centre (ECSWCC) may conduct the review[5], while in Alberta, other farmers are frequently responsible for reviewing the Action Plans[18]. Once a plan is reviewed, the farmer can proceed with projects or apply for financial assistance. This differs from the approach in Quebec where a group of farmers (30-40) create Water Clubs that hire an agrologist or extension specialist to advise directly with club members on a variety of EFP projects[7]. In British Columbia , individual farmers are moving toward a process of having a planning advisor visit their farm and assist in the development of the Action Plan. The farmer completes the plan and the advisor approves it[8].

Criterion 4: Lessens Vulnerability

Does the response reduce social and economic risks associated with drought?

The EFP can minimize the impacts of drought to farm operations through adjustments in operating practices. Many of the specific BMPs such as Enhancing Wildlife Habitat and Biodiversity, Erosion Control Structures, Irrigation Management, Ponds for Storing Water for Agricultural Purposes, and Water Supply to Farm for Agricultural Use[3], are categories under which farmers can improve their access to water sources. By developing these sources in advance of a drought or low water condition, farm operators improve their ability to maximize water management through improved access and storage. While these measures may only provide sufficient water for a limited period, it could extend supplies long enough to reduce the severity of impacts.

Does the response reduce environmental vulnerability to drought?

The program is intended to improve environmental awareness, assist farmers in assessing the impact of farm practices on the environment, and subsequently, through the BMPs, to reduce environmental impacts of agricultural activities. The outcome of adopting practices such as wetland restoration, establishing wildlife shelterbelts, and biodiversity planning is the provision of environmental benefits. The uptake of these practices has yet to be fully realized. Early adopters in Alberta, for example, have targeted BMPs associated with precision farming, fuel storage and manure management. However as farm operators become increasingly aware of the benefits of adopting practices with key environmental benefits, they are more likely to include them[9].

Does the response reduce demand/supply shortfalls in water?

There are a variety of practices associated with the program that can increase water supply. For example, in Ontario, funding is provided under COWSEP toward BMPs that increase water quantity at the farm scale. Practices include: expanding or adding new water wells, developing and expanding ponds for water storage, improving water delivery systems to the farm, and water treatment to address water quality of existing water supplies. Additional BMPs address water supply directly such as irrigation and riparian area management or indirectly through practices such as mitigation of evapo-transpiration through cover crops[7, 19].

Does the response incorporate flexibility?

The EFP is a national program that is delivered provincially. Issues vary across provinces and the program is flexible enough to permit some differences in its implementation and delivery. Differences in provincial legislation and organizational structure can influence how the model is implemented[18]. Each province may also emphasize particular practices which reflect the conditions and priorities of agriculture in these areas[16]. For example, in Alberta, pasture management is more pertinent than in Ontario, and while the Alberta Environmental Farm Plan Company (AEFP Co.) developed its program based on the Ontario model, it adjusted the workbook and work-

shops to provide greater emphasis in this area[18]. Similarly, at the farm scale, the program permits self-assessment and targeting of individual farm circumstances allowing for a wide range of responses depending on the issues that are identified[16].

Criterion 5: Social and Political Acceptability

Is the response socially acceptable?

The implementing agency at the federal level is AAFC, a nationally recognised government organization. Provincially, EFP programs are delivered through various non-profit farm organizations, associations or companies, in cooperation with the federal and respective provincial governments, and on behalf of representative farm organizations[2]. These are generally recognized by stakeholders as legitimate organizations that are compatible with agricultural objectives. In each case, because the program is voluntary, it is important that the local agency delivering the program is accepted by the farm community. For example, in Alberta, it was crucial to farmers that the agency operating the program be arms-length from government, in which case, a non-profit company was created specifically to deliver EFP. This improved farmer support for the program in Alberta[6, 18]. In Ontario, the use of a one-window-service, utilizing the Ontario Soil and Crop Improvement Association (OSCIA) as the 'one-window' through which farmers in the province access environmental programs, has been effective in maintaining dialogue with the farm community[7]. A proven track record in delivery of programs and communicating effectively with farm communities has strongly contributed to OSCIA's credibility in this respect[13]. In some cases, provincial agricultural representatives, such as the British Columbia Agriculture Council (BCAC), provide direction to the program in conjunction with the various farm commodity groups who deal directly with their respective agricultural communities[8]. In other cases, provincial agricultural representatives, such as the Prince Edward Island Federation of Agriculture (PEIFA), implement the program directly through an authorised board and staff[11].

A strong grass roots farm community effort was originally behind the adoption of the EFP, where farm leaders were interested in addressing public perception of farm management of environmental concerns[13]. Following the pilot project undertaken in 1993 across seven Ontario counties, ninety-five percent of participants in the program indicated that they would recommend the EFP to a neighbour. Since the initiation of the pilot program, there have been more than 27,000 participants in Ontario[10]. The program has remained strong over time, with over 7,300 farmers participating in the third Ontario EFP edition, which was introduced in May 2005, and nearly half being repeat participants[1]. Initially there were concerns regarding access to information of private farms participating in the program and to some extent this has affected program uptake among farmers[22], but in many cases these fears have been alleviated by the volunteer nature and confidentiality of the program[14]. This concern over confidentiality was the case in Alberta, and led to the adoption of a non-governmental company to implement the EFP. A Memorandum of Understanding was also obtained from the Department of Environment that would maintain the confidentiality of individual Alberta farmers' EFPs, resulting in support from the agricultural community[6, 18].

The EFP is relatively new in Alberta and approximately 8,000 farmers have already been through the process, and are at various stages of completion[4]. In the first year that the EFP was introduced in New Brunswick there was a great deal of support and initial uptake of the program, but many farmers did not finish the process, likely because of the unanticipated amount of work involved. This has since changed as understanding of the program has improved and there is both greater uptake and a higher completion rate[15]. Another key component that has influenced the popularity of the program in all provinces has been the provision of incentive funding which has provided farmers with assistance to actually implement the plans they develop[6].

Is the response equitable among key stakeholders?

Access to technical expertise and information is available to all farmers interested in participating in the program. Each farmer has equal opportunity to be involved in obtaining an EFP for their own operation[6]. Workshops are generally free to participants and are offered in a variety of regions across individual provinces. Workshops are also offered at various times of year. In some instances, farmers must address specific issues that have been identified on their farm in order to receive a sign that indicates participation in the program, such as in British Columbia, but they are still eligible for a completed EFP regardless[6]. In terms of financial assistance, farmers are free to choose the cost-share programs that are most beneficial, applicable, and relevant to each operation[18].

Where there may be some inequity is with farmers who spent money on projects and improvements to their operation prior to the availability of cost-sharing opportunities, and in these cases they are not compensated. Also, farmers with higher risk operations

benefit more from cost-sharing than do those requiring fewer changes to their farm[14]. In the context of stakeholder representation, farmers from any agricultural commodity group may participate in a BMP. Efforts to accommodate producers are evident in provinces such as British Columbia where there is a wide range of commodity groups spread out across the province. The BCAC has contribution agreements with seventeen other farm organizations which are largely commodity based, but also in some cases geographically based as well. This provides an opportunity to connect with both local and remote producers[8]. In some provinces, members of the public may also attend the workshops as long as they also participate[18].

Are there any necessary political conditions?

Insufficient data.

Criterion 6: Legal and Institutional Feasibility

Are there any statutory or regulatory measures influencing the response?

Each province has legislation that influences the various issues that are raised through the EFP. Acts and regulation pertaining to specific issues, such as minimum distance separations between manure storage and water courses, may be different in each province. Various acts may fall under the responsibility of different governmental departments. Provincial legislation may demonstrate emphasis on key issues that are of particular concern in some provinces such as Ontario's *Nutrient Management Act*. Cost sharing-programs associated with EFP may also incorporate legislation such as with the Canada-Alberta's Farm Stewardship Program (CAFSP) which reviews all BMP and project proposals under the *Canadian Environmental Assessment Act*. Further legislation at the federal level is in place that may impact the management of practices on the farm including the *Fisheries Act*, *Canada Water Act*, *Canadian Environmental Protection Act*, among others. Local by-laws also influence practices under the EFP such as details relating to water retention pond construction or chemical applications through irrigation systems.

Legal instruments have also been used to address farmer concerns related to program participation by providing assurance of non-disclosure. For example, in Nova Scotia, provisions in its *Environment Act* (1994-95) provide protection to farmers concerning negative information associated with their property that may be revealed in the process of submitting farm data as part of the EFP. Additional documents have also been developed to ensure confidentiality such as the Nova Scotia Department of the Environment's 'Policy on Access to Voluntary Environmental Audits'[22]. Similarly, concern amongst Albertan farmers over confidentiality in the program has been alleviated through agreements attained through a Memorandum of Understanding obtained from AENV [6, 18].

Do institutional arrangements affect capacity to respond?

There is sufficient jurisdictional authority and power to implement and enforce the EFP. There have been senior government commitments towards EFPs. As part of the Environmental Chapter of the Agriculture Policy Framework (APF), a number of national programs were developed and are currently funded. One of these is the EFP which is supplemented through various cost-shared funding programs[7]. For example, in Ontario, the budget under the Greencover Canada program is $15 million, and $5.6 million under COWSEP. This amounts to a total of roughly $80 million contribution dollars (not grant dollars, which is unprecedented), which is delivered through the AAFC's agreements with Ontario's delivery partners and provided as funding to farmers[7]. Another example of senior government agency support is in Alberta where the PFRA, acting on behalf of the federal government, provided essentially all of the delivery agent's (Alberta EFP Company) operating costs[6]. Consultations are underway to develop the next generation of the national APF programs and it is still unclear as to what sort of support will exist for EFP in the next round. There may ultimately be competition for funding of programs under the Environmental Chapter of the new APF[7].

Does the response facilitate communication, information sharing, and coordination among agencies, organizations and stakeholders?

As a national program with differing provincial organizational structures and multiple agency involvement, the EFP has a complicated organizational structure. The network of governmental and non-governmental agencies involved at various levels is generally bound through a series of committees interacting through industry, organization, and government program representatives. Information and communication is facilitated through various provincial working and management committees within the provinces, and the National Agri-Environmental Coordinating Committee (Environment Chapter of the APF) includes provincial government representatives as well as federal representatives for each province. A

Federal Leads Committee includes the AAFC leads in each province, and a national EFP Practitioners group also meets annually to discuss experiences with the EFP process. As complicated as the structure is, each committee and organization appears to have a clear role and communication linkages are quite strong[7].

In terms of leadership, the National Environmental Farm Planning Initiative is led by AAFC and implemented as one of the Environmental Chapter programs under the APF. Provincially, EFP programs are delivered through various non-profit farm organizations, associations or companies such as: OSCIA; AEFP Co.; BCAC; Agriculture Producers Association of New Brunswick (APANB); and PEIFA. These agencies deliver programs in cooperation with federal and respective provincial governments, and on behalf of representative farm organizations[2].

Does the response impact other adaptation measures?

Insufficient data.

Criterion 7: Financial and Technical Feasibility

Is the response economically acceptable?

In general, for a large percent of the BMPs associated with the program, the federal government pays roughly 30% of the cost. Producers pay about 70%. If the BMP is judged to increase public benefit, then the government share is 50%.The funding of the program is based on public versus private good[6]. Practices that are considered more of a capital expenditure, such as a transition from a wheel move to a pivot irrigation system, are not considered under the cost share[17].

Are financial resources sufficient for implementing the response?

Funding sources for EFPs are accessible through various cost-share programs. Funding sources are reliable for the predetermined length of time that they are committed to by the APF, which has generally occurred in five year increments. Funding for the cost-share programs associated with the EFP is set within a limited time frame. All the cost-share agreements end March 31, 2008 with the end of the current APF.

Is the appropriate information and technology accessible?

All of the BMPs chosen for the program have been reviewed and vetted to ensure that they will work from a scientific standpoint[6].

Additional data required to answer question..

Is appropriate staff available to implement the response?

Limitations in the availability of staff can minimize the possibility to adopt certain approaches with EFP such as hiring individual planning advisors to address farms on a one-on-one basis as is the case in British Columbia, Quebec, and Nova Scotia[6]. Staff shortages and limited availability of advisory support can also impact the ability to attract voluntary enrolment among farmers[20]. The availability of staff to implement the EFP varies from province to province. In British Columbia, New Brunswick and Prince Edward Island there appear to be sufficient staff that can draw on agency partners to assist with further technical advice[8, 15, 21]. In Ontario, additional hydrology expertise is needed and the program might benefit from additional specialists in agricultural irrigation as there is currently only one available[14]. Alberta faces a staff turn-over problem associated with entry-level program delivery agents. Wages for extension positions are relatively low based on contribution funding availability which attracts employees who are just entering the industry. The constant training of new staff and the revolving door of staff coming and going can be frustrating in communities where the delivery agent is attempting to foster relationships with farmers[18].

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