



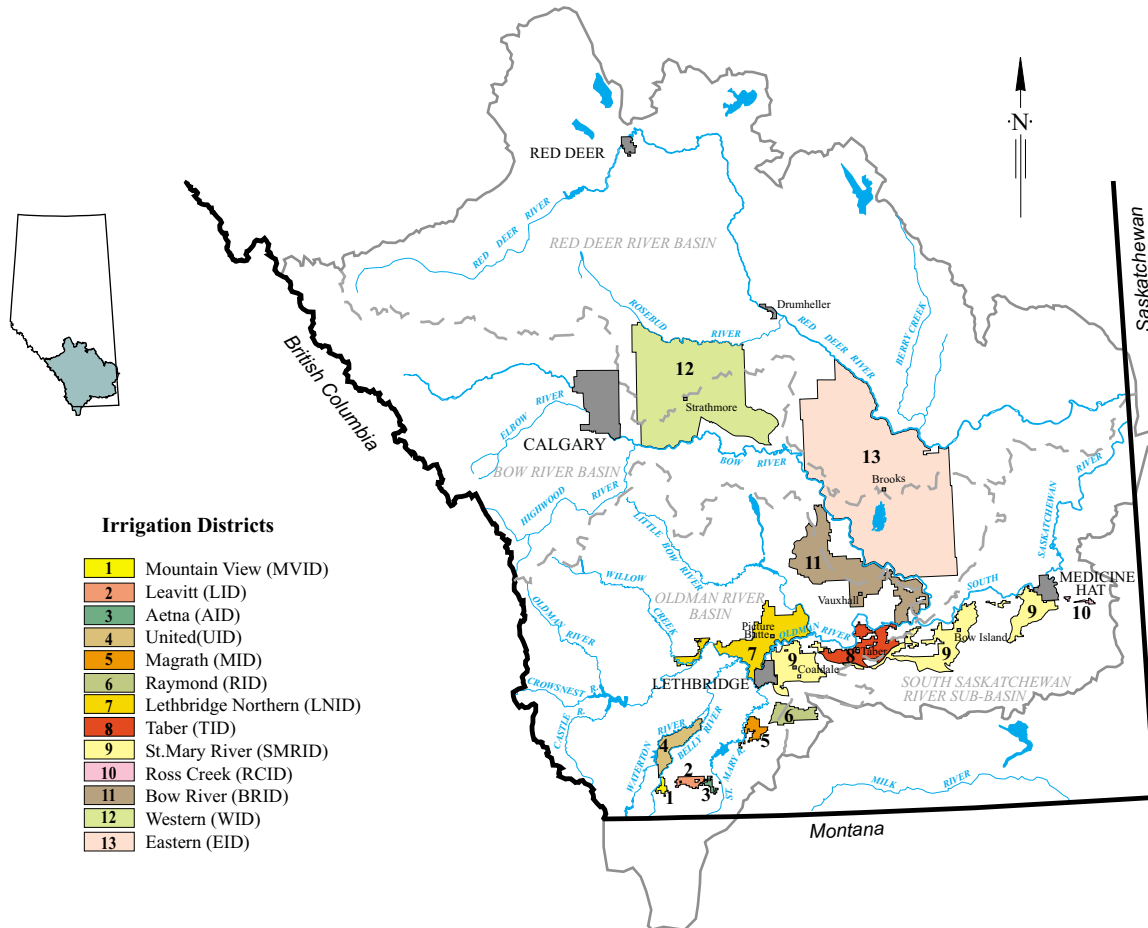
# Executive Summary

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## A. INTRODUCTION

Irrigation in Alberta has an interesting and colourful history that spans more than a century. The industry has experienced periods of great optimism, bitter disappointment, struggling for survival, maturation, and triumph. The irrigation districts are now well established and operate as progressive enterprises. A variety of water uses have been integrated into their developments and operations, including wildlife conservation, recreation, hydro power and water supplies to communities, industries, livestock and domestic users. Crop diversity and value-added commercial enterprises are encouraged and are increasing within the districts. Irrigation has become an integral component of the social and economic fabric of southern Alberta.

The irrigated area in southern Alberta has been steadily increasing. While expansion is important to the health of the industry and the economy of the province as a whole, it is recognized that irrigation places a high demand on the limited water resources of the region. In 1991, the Alberta government established irrigation expansion guidelines that limit the amount of water that can be allocated to the irrigation districts and to private irrigation projects in the South Saskatchewan River Basin (SSRB). The guidelines are incorporated in the *1991 South Saskatchewan Basin Water Allocation Regulation* under the Water Act. In establishing the *Regulation*, the government recognized that existing scientific information on water use was inadequate to make definitive decisions on irrigation expansion and called for the *Regulation* to be reviewed and refined in the next decade.





## B. OBJECTIVES

Irrigation districts and producers recognize the need to be pro-active on water conservation and environmental matters. To address the additional demands irrigation expansion places on water resources and the environment, a study of irrigation district water requirements and opportunities was initiated in 1996 using the best available science, technology, long range planning, and local knowledge. The study was a cooperative effort of the Alberta Irrigation Projects Association (AIPA), representing the 13 irrigation districts in Alberta, the Irrigation Branch of Alberta Agriculture, Food and Rural Development (AAFRD), and the Prairie Farm Rehabilitation Administration (PFRA) of Agriculture and Agri-Food Canada (AAFC). Alberta Environment (AENV) acted as a resource and liaison.

As part of the study's mission to provide a comprehensive, scientifically sound analysis of current and future water management within the irrigation districts, six specific objectives were set.

- Identify and quantify current irrigation water requirements and the state of current irrigation water management.
- Quantify changes in water use and water management efficiencies during the 1990s.
- Quantify possible future irrigation water use.
- Develop leading-edge computer tools to assess current and future irrigation water use and management opportunities.
- Assess the risks, impacts and possibilities of irrigation area expansion.
- Assess the potential contribution of irrigation expansion to the provincial economy.

## C. KEY ACTIVITIES AND FINDINGS

The Irrigation Water Management Study involved more than four years of field research, data collection and analysis, and focused on five component areas:

- On-farm water use;
- Distribution system characteristics;
- Irrigation district computer model development;
- Impacts of irrigation water shortages; and
- Analyses of current and future irrigation scenarios.

Work was carried out by staff from the irrigation districts, AAFRD, AENV, and by consultants. Funding for instrumentation and consultants' work was cost-shared by AAFRD, PFRA, and by the irrigation districts through their umbrella organization, the AIPA. The following key activities were undertaken by the project teams.

- **Agro-climate** - A comprehensive, historical agro-climatic database, that included the SSRB, was used to determine associated potential evapotranspiration data in the basin. This database, expanded from one originally developed by AAFC and Environment Canada, is referenced to a 50 km to 50 km grid. The expanded database was the source of all climate data required in the computer modelling of crop specific water demands, soil moisture balances and evaporation losses. The database was also used to assess the impacts of water shortages on crop yields and to assist in the assignment of on-farm irrigation system flow capacities based on regional climatic conditions.



- Cropping Patterns** - A review of historical cropping patterns within the irrigated areas and a report on the prospects for the future of the agricultural industry were completed. Based on this work, it is projected the crop mix for irrigated agriculture will evolve toward an increased area of forage to support the livestock industry, an increased area of specialty crops to support value-added processing, and a reduced area of cereal grains. This will result in slightly higher water requirements than the current crop mix.

- Irrigation Water Management** - The 1991 *Regulation* was based on meeting 100% of crop water requirements. A comprehensive, five-year (1996 to 2000) monitoring program determined that the amount of water irrigation farmers were applying meets, on average, about 84% of the crop water requirement to obtain optimum yields. However, water application has increased during the past 10 years, and will likely continue to increase to about 90%.

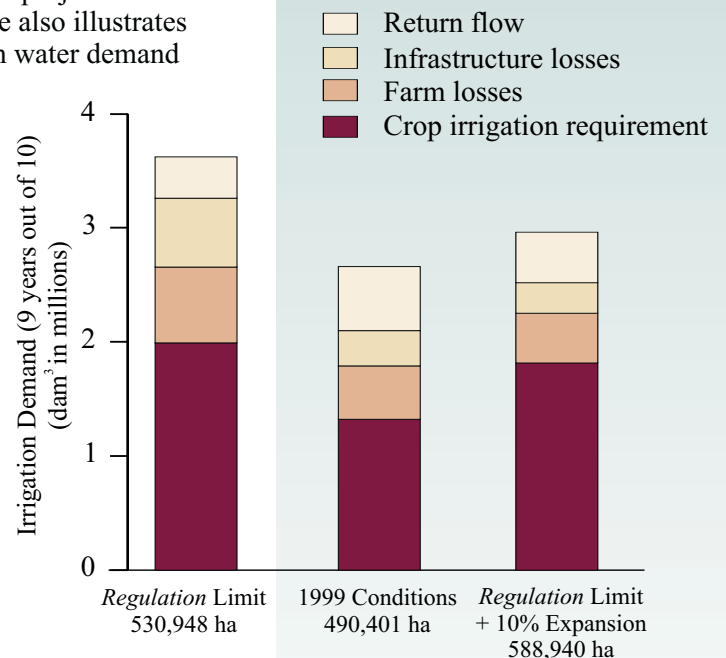
Assuming continued improvements in on-farm and irrigation district infrastructure and water management, overall irrigation water management efficiencies could improve in the Oldman Basin districts from the 1999 level of 53% to 64% in the future. Similarly, efficiencies are projected to increase from 40% to 55% for the Bow Basin districts.

- Irrigation Water Demand** - A water demand analysis for the 13 irrigation districts was conducted using a methodology and format similar to that used in 1991, using updated and more scientifically sound data. The total demand for the 1991 *Regulation* limit of 531,434 hectares is estimated to be 2,920,714 cubic decametres, compared with the *Regulation* licence volume of 3,622,792 cubic decametres identified in 1991. This represents a reduction of about 19%.

As can be seen in the figure below, the water licence allocations defined in the 1991 *Regulation* are greater than the demands derived through modelling of both the 1999 level of development and the projections for a 10% expansion beyond the *Regulation* limits. The figure also illustrates the extent of relative changes in the individual irrigation water demand components resulting from ongoing water use efficiency improvements, as modelled in comparison to the 1991 *Regulation* allocations. The overall water demand is noticeably lower in 1999 and with 10% expansion beyond the *Regulation* limit, even as projected irrigation management moves closer to meeting near-optimum crop water requirements in the expansion scenario.

- Water Losses** - The three principal causes of consumptive water loss in an irrigation project are described below.

**On-farm Application:** The percentage of water diverted to on-farm systems that actually ends up being available for crop use is referred to as the on-farm application efficiency. This overall value had increased from approximately 60% in 1990 to about 71% by 1999. Additional efficiency gains are projected for the future as application technologies continue to advance and are adopted. Overall application efficiencies could approach 78%.



**Comparison of modelled irrigation demand volumes and the *Regulation* allocation (excluding Ross Creek Irrigation District).**



**Canal Seepage:** The study of actual seepage losses from canals in southern Alberta indicated the volume of seepage from canals is about 2.5% of the licence volume, much lower than the 13% estimated in 1991 when the irrigation *Regulation* was established.

**Evaporation:** Canal and reservoir evaporation losses from the current district infrastructure are about the same as estimated in 1991. Though some decrease in evaporation losses will occur through further installation of pipelines, canal evaporation will not change significantly. Reservoir evaporation losses will increase if new off-stream reservoirs are developed within the districts.

- **Return Flow** - Many of the irrigation districts installed automated monitoring equipment to accurately measure the flow of water that returns to the river from the districts. Monitoring showed return flow varied substantially from district to district, from a low of 7% to a high of 56% of the gross diversion. In five of the six largest districts, average return flow was substantially higher than assumed in the 1991 *Regulation*. The exception is the St. Mary River Irrigation District, which returns less water than was assumed in 1991.
- **Potential Expansion** - Ten scenarios, representing current and possible future conditions within the irrigation districts, were computer simulated (modelled) to determine the impact of various management measures on gross irrigation demand. The analysis indicates that various one-at-a-time management shifts affect the gross diversion demand as shown in the table below. Values represent changes resulting exclusively from the expansion variable. Variables shown can be applied in combination with any of the other management variables. The percentage change in gross demand is referenced to the Base Case. For example, increasing the percentage of specialty crops in the overall crop mix could result in an increase in water use of more than 3%. Moving to more efficient sprinkler systems could result in a decrease in gross diversion demand of almost 6%. The extent of the impacts will vary from district to district.

Seven of the scenarios were modelled to determine the possible financial impacts of irrigation deficits on farm enterprises. The model revealed that

#### Impacts of management decisions on gross irrigation demand.

Management Variable	Irrigation Area (ha)	Expansion from Base Case (%)	Change in Gross Demand (%)
<b>Base Case - 1999 conditions</b>	<b>490,385</b>		
<b>Expansion to 1991 <i>Regulation</i> limit</b>	<b>535,400</b>	<b>9.2</b>	<b>5.4</b>
<b>Expansion to 1991 <i>Regulation</i> plus 10%</b>	<b>588,939</b>	<b>20.1</b>	<b>13.4</b>
<b>Expansion to 1991 <i>Regulation</i> plus 20 %</b>	<b>642,479</b>	<b>31.0</b>	<b>20.0</b>
<b>Crop Mix Shift</b> (increasing % of forage and specialty crops)			<b>3.1</b>
<b>System Mix Shift</b> (increasing % of higher efficiency sprinkler systems)			<b>-5.7</b>
<b>On-farm System Management Efficiency Improvements</b>			<b>-3.0</b>
<b>Increase toward On-farm Crop Water Optimization</b>			<b>9.5</b>
<b>Improvements in District Return Flow Management</b>			<b>-3.3</b>

even if water supply deficits occur in increasing magnitude, frequency and duration as a result of irrigation expansion, the economic sustainability for farm enterprises may still be maintained through improvements in water use efficiency and increases in on-farm water applications. This is particularly significant for those farm enterprises that can transfer water from low value crops to higher value crops during water deficit years.

Farm economic sustainability is sensitive to the type and diversity of crop mix within an enterprise. For instance, model results indicate that, for some regions, farm enterprises wholly dependent on grains and oilseed production may not be sustainable in the future, particularly if water supply deficits increase and water applications remain at current levels. However, diversification to higher value specialty crops and forages can provide higher net revenues, even with more frequent and higher water supply deficits that arise from irrigation expansion.

## **D. BENEFITS OF IRRIGATION DEVELOPMENT**

### **1. Current Benefits**

Irrigation has had a profound impact on southern Alberta and the entire province. Currently, irrigation development occupies 4% of the cultivated land in southern Alberta's irrigation districts. Considering the increases in primary production due to irrigation and the spin-offs in agri-food processing, this level of irrigation contributes about \$832 million or 18.4% to the agri-food gross domestic product for Alberta. In addition, the irrigation infrastructure provides significant non-irrigation benefits related to municipal and industrial water supplies, recreation, tourism, and wildlife.

Irrigation development reduces farm risks, fosters on-farm diversity, increases profit margins, and reduces the need for government and private safety nets. Irrigation improves the long-term sustainability of smaller farm units. The larger requirement for irrigation supplies and services supports rural agri-business enterprises. Higher labour requirements for primary production on irrigated land, for the agricultural service sector, and for irrigation induced post-primary processing, increase rural population and contribute to more vibrant communities and infrastructure development.

### **2. Future Opportunities**

Irrigation intensification and expansion will contribute to the province's agri-food strategy and to general social and economic objectives in Alberta. For example, the agricultural development strategy in Alberta calls for increased livestock production and strong growth in the agri-processing sector. To be successful in meeting growth targets, a significant amount of growth must take place in the irrigation-dependent southern part of the province. This region has high potential for increased forage production and currently has a high value-added processing to primary production ratio. Many of the crops that are in demand as processed products must be grown under irrigation in southern Alberta, where the longer growing season, high heat units, and relatively secure water supply provide suitable and stable conditions.

Results of the Irrigation Water Management Study provide a status report on the irrigation industry in Alberta and on prospects for the future. With the databases and analytical tools that have been developed by government agencies and the irrigation districts working together, the districts and government are well-positioned to address the challenges facing the industry in the 21st century.





## E. CONCLUSIONS

Based on the technical information that has been developed, and the simulation modelling conducted in the Irrigation Water Management Study, the following key conclusions are drawn.

**Simulation modelling indicates that overall irrigation efficiencies could improve from the current 54% to 64% for the Oldman River Basin districts, and from the current 40% to 55% for the Bow River Basin districts, with continued improvement in on-farm systems, district infrastructure, and water management.**

On-farm efficiencies have improved from about 60% in 1990 to about 71% in 1999 due to the shift to more efficient irrigation systems and methods, and improved on-farm management. District losses and return flows have decreased due to rehabilitation of district infrastructure, replacement of canal laterals with pipelines, automation of structures, extensive monitoring, and improved district water management.

**A 10% to 20% expansion in the irrigated area beyond the 1991 Regulation is sustainable in the Bow Basin, with improvements in water use efficiency, reduced return flows, and higher crop water applications.**

All financial performance indicators showed improvements compared to current conditions in the Bow Basin, in spite of higher irrigation deficits. This conclusion does not apply equally to all districts nor to all irrigation blocks within the districts. More detailed analyses are required to examine impacts of expansion on individual districts and blocks.

**Up to a 10% expansion in the irrigated area beyond the 1991 Regulation could be considered in the Oldman Basin, with efficiency improvements, reduced return flows, and higher crop water applications.**

A cautious approach to irrigation expansion in the Oldman Basin is recommended. Though water supply deficits would be significantly higher in this basin than in the Bow River Basin, most financial performance indicators show improvements from the current situation. However, some irrigation blocks and districts should probably not expand beyond the 1991 Regulation. Irrigation districts will require more detailed analyses before making the decision to expand.

**Financial modelling indicates that irrigated farm financial performance can be improved from current conditions, even with irrigation expansion and more frequent and higher water supply deficits.**

Comparing model output for expansion scenarios against 1999 conditions indicated that average net farm incomes increased, and the risk of insolvency decreased, for most representative farms. The probability of negative net farm income in any one year decreased for all farms in the Bow Basin districts, but increased for some farms in the Oldman Basin, indicating higher variability in annual income in the Oldman Basin.

Prerequisites to improved farm financial performance are on-farm and district water use efficiency improvements, reduced return flows, higher crop water applications, and crop mixes that include at least one high value crop. Improved efficiencies and reduced return flows will minimize the magnitude and frequency of water supply deficits. Higher crop water applications will increase yields and revenues in non-deficit years, so that producers are in a better position to withstand lower revenues in deficit years. Farms that irrigate only cereals and oilseeds are considerably less profitable than farms that include higher value specialty crops or forages. Including a higher value crop in the mix provides the opportunity to maximize revenues by shifting water applications from low value crops to higher value crops.

**Irrigation water supply deficits less than 100 mm per year are not considered to have serious financial consequences for most producers.**

At the crop level, the net effect of a specified water supply deficit is only a portion of that deficit. The actual net effect at the crop level is somewhat reduced because a portion of the projected deficit consists of losses incurred through water application inefficiencies that were already accounted for in the irrigation demand. These on-farm losses do not actually occur if water is not available for diversion to meet the projected irrigation demand. For example, a projected 100 mm deficit in the gross diversion supply may only translate into a 70 mm to 75 mm deficit at the crop level. Also, irrigators can redistribute available water to those crops that generate higher net revenues. As a result, the impact of smaller projected gross diversion deficits (less than 100 mm) is unlikely to have much financial significance.

**Irrigation intensification and expansion will make a positive contribution to Alberta's agri-food industry and the province's social and economic objectives.**

The agricultural development strategy in Alberta calls for increased livestock production and strong growth in the agri-processing sector. To be successful in meeting growth opportunities, significant growth must take place in the irrigation-dependent southern part of the province. This region has high potential for increased forage production and currently has a high value-added processing to primary production ratio. Irrigation contributes to the province's agricultural resource base by increasing the productivity of the land by 250% to 300% compared with dryland areas. Many of the crops that are in demand as processed products must be grown under irrigation in southern Alberta, where the longer growing season, high heat units, and relatively secure moisture conditions provide stable, high quality production.

Irrigation improves the sustainability of the family farm, supports agri-business enterprises, and contributes to infrastructure development and more vibrant communities. Irrigation infrastructure provides significant non-irrigation benefits related to municipal and industrial water supplies, recreation and tourism, and wildlife conservation.







**Innovation, research, and improved technology will continue to be critical components of agricultural growth, and will add to long-term success in primary production and value-added processing.**

Innovation and research have brought new ideas, new resources, and greater potential for economic synergies to the agricultural industry, including the establishment or expansion of several multi-national agri-processors in the irrigated south. Potential for similar growth in the future is excellent.

**Ongoing research and integrated planning are required by the irrigation districts and government agencies to further improve irrigation water use efficiency, increase value-added production, and ensure that Alberta's water resources are used wisely.**

The Irrigation Water Management Study has provided the most comprehensive and integrated assessment of past, present and future irrigation water management in Alberta's history. The study will help irrigation districts and government make informed decisions about sustainable development and water allocations in the South Saskatchewan River Basin. Continued evaluation of future irrigation and water management opportunities is needed to support Alberta's economic, social and environmental objectives.