IRRIGATION WATER MARKETS IN SOUTHERN ALBERTA

Lorraine Nicol
M.A. (Economics), Queen's University, Kingston, Ontario, 1983

A Thesis
Submitted to the School of Graduate Studies
of the University of Lethbridge
in Partial Fulfillment of the
Requirements for the Degree
MASTER OF ARTS

Department of Economics
University of Lethbridge
LETHBRIDGE, ALBERTA, CANADA

This thesis is dedicated to the memory

of my mother Elsie

and

my father-in-law Alex.

Abstract

Irrigation is central to the functioning of the southern Alberta economy. Irrigation also uses a significant amount of what is expected to be an increasingly scarce resource: water. The Alberta government is embarking on a long-term water management strategy in which irrigation water management will be pivotal. The government is considering a range of economic instruments to assist in this management. One instrument already implemented is the ability of private irrigators and irrigators within irrigation districts to trade irrigation water rights on a temporary and permanent basis. This has established the foundation for water markets.

The research presented in this thesis centers on establishing the characteristics of irrigation water markets in southern Alberta. The research also aims to determine whether the markets are behaving according to basic economic principles and whether they are supporting government's goals of increased water productivity, efficiency and conservation. The findings reveal that characteristics of water markets in southern Alberta are very similar to markets elsewhere and the markets are behaving in a manner one would expect. However, markets are also creating activity that at one and the same time support and contradict government's water management goals. In addition, the small degree of market activity in general suggests that if government is relying on markets to contribute to these goals to any significant extent, it will need to create conditions that promote greater water market activity.

Acknowledgements

I wish to express my sincere thanks to Dr. Kurt Klein for encouraging me to undertake this degree and focus on water research. Thank you for the countless hours involved in reviewing this thesis, providing me direction and valuable advice. You have also provided me with the privilege of being the first person to complete an M.A. in Agricultural Studies at the University of Lethbridge.

Thank you to Dr. Elwin Smith and Dr. Abdie Kazemipur for their work on the supervisory committee, to Dr. Bill Kerr for his work as the external examiner. To Dr. Danny Leroy, thank you for teaching me all I know about linear programming. Thank you to Ron Renwick, Jan Tamminga and Dave McGee for facilitating this research. To Dr. Shamsul Alam and Kathy Schrage, thank you for your administrative support and for becoming my friends along the way. Thank you Merle Christie for your incredible humor and wisdom.

To my wonderful husband, Chris, I thank you for your endless support and strength. To my precious children, Jeffrey, Alastair and Rachel, I hope you will be inspired by this work and my belief in lifelong learning.

To my beautiful mother, who I know would be proud of me; to my dear father-in-law, who passed away while this work was in progress, this thesis is dedicated to your memory.

Table of Contents

List of Tables

List of Figures

Chapter One

Introduction

1.1 Background

As is the case in many parts of the world, Alberta is confronted with water management challenges. Since irrigation accounts for 71 percent of surface water use in the province (Alberta Environment [AENV], 2002b), effective management of water for this purpose is imperative.

In southern Alberta, where the majority of irrigation activity occurs, irrigation permits the production of high-value crops, such as potatoes and sugar beets. Irrigation also enables farmers to grow forage crops with two to three cuts per year. This availability of water and of crops grown under irrigation has promoted several commodity users to locate in this area, among them vegetable processors, sugar beet refiners and high density feedlots. But by 1991, strains on water resources prompted government to set limits on water use. That year guidelines were established that set maximum amounts of water allocated for irrigation in the South Saskatchewan River basin. In 2001 a severe drought hit Alberta. A moratorium was imposed on additional allocation of surface water from the Belly, Waterton and St. Mary rivers. The Minister of Environment indicated additional moratoriums are inevitable in southern Alberta (Swihart, 2003).

Alberta recently has finalized a long-term water management strategy that is described in a provincial government document: *Water for Life: Alberta's Strategy for Sustainability*. It identifies water conservation as a "key direction" (Alberta

Environment, 2003c, p.20). The emphasis of water conservation efforts is on using water effectively and efficiently, improving water use productivity and finding effective ways to manage demand and supply issues (AENV, 2003c)

Towards this end, new legislative tools that provide irrigators with market-based instruments should enhance producer's ability to improve productivity and more effectively manage water. The Water Act of 1999 allows for the transfer of water rights among all water license holders. The Irrigation Districts Act of 2000 allows for the transfer of water rights among irrigation users within irrigation districts. In both cases, the transfer can be permanent or temporary. One of the specific actions contained in the *Water for Life Strategy* relates to this market-based activity. It is to "monitor, evaluate and report on the water allocation transfer system" (AENV, 2003c, p. 12).

The markets for permanent and temporary trades in water rights have given rise to what is commonly referred to in the literature as formal and informal markets. One key feature distinguishes the two: "in the formal market, the longer-term entitlement to the water is transferred from the seller to the buyer, while in the informal market, only the right to use a given volume of water, for a given period of time, is traded" (Bjornlund, 2003a, p.2). The focus of this study is on an examination of the role and experience of these two types of water markets in southern Alberta.

1.2 Problem

Government either administers water prices or the value of water can be discovered through unhampered market processes. Irrigation water in Alberta has been subject to government regulations in Alberta for more than 100 years. This has produced

a web of administered pricing, subsidization, overuse in some areas and under-use in others, and widespread controls and rationing. One solution to this problem is to privatize the system of irrigation water and irrigation rights. The Coase theorem states that once property rights to resource use are established, free exchange of those rights will achieve efficiency, irrespective of which party is granted the right (Hyman & Strick, 2001). The existence of a water market should lead to behavior that is motivated by opportunity cost. If resources are privatized, they will be allocated to the most important uses by means of an unhampered market system. Bidders able to satisfy consumer demands most completely would be able to out-compete less able bidders for these resources. For participants, there is room for a deal if the buyer's willingness to pay exceeds the seller's willingness to accept plus any transaction costs (Howe, Boggs & Butler, 1990).

Markets permit water to move to higher value uses, thus increasing the resource's productivity and enhancing economic growth. Conservation efforts also can be enhanced since users, able to sell any excess water, are provided an incentive to conserve. For unprofitable producers, selling their water rights provides needed cash and may help to facilitate an exit from the industry.

But existing institutions have been developed during a water surplus era (McCann & Easter, 2004) and will have to undergo change under a market-based system. Thobani (1998), who has studied water markets in Chile and Mexico, stressed the high costs associated with setting up a new legal, regulatory and institutional framework. Market participants themselves also will face transaction costs involved in the market process. It can take several years for tradable water rights system to be implemented; in the

meantime, key policy makers need to be "strongly committed and patient" (Thobani, 1998, p.44).

Economic theory and experience gained through water markets elsewhere in the world indicate that water markets are possible in Alberta. However, markets take time to reach their full potential and are complex and unique, evolving within the particular legal, social and political environment of the state. Bauer (1998) captures the essence of this point stating:

> Markets are complicated social institutions, not spontaneous, or automatic mechanisms driven by natural forces. To exist and to operate over time, markets depend not only on economic factors of supply and demand, but also on many extra-economic factors and prior definitions: such as political decision, legal rules, cultural attitudes, and geographic and environmental conditions. These factors and definitions are affected by relations of social and political power and by the distribution of wealth. Markets can be no more neutral than their surrounding social contexts and underlying institutional arrangements (p.120).

The research problem in this study is to determine the characteristics and experiences of the newly-established informal and formal water markets in southern Alberta. These markets are in their infancy and are evolving within the province's unique legal, institutional, political, economic and geographic framework. It will be instructive to compare the findings for southern Alberta to the characteristics of water markets elsewhere in the world, especially in Australia, Chile and California, where varying degrees of success with water markets have been experienced.

Examining the market for temporary and permanent trades in water will generate information on the unique features of each. In the market for temporary trades, information attained through this study will help to determine the awareness among farmers of the ability to transfer water; the extent the transfer system was used; the

existence of any administrative and/or policy and legal impediments and constraints to water transfers; whether or not water was being transferred to higher value crops; and the price farmers paid for the additional water.

Studying the market for permanent trades in water will help determine the extent the transfer system has been used; the steps involved in the approval process; the associated transaction costs, and whether they impede market activity; whether or not water is being transferred to higher value use; and the price paid by buyers.

Findings from this study should be useful to policy makers as they strive to develop institutions, policies, and laws that result in more efficient use of the increasingly scarce water resource in Alberta.

1.3 Objectives

The overall objective of this research is to increase the body of knowledge of the characteristics and experiences of the temporary and permanent trades of irrigation water rights in southern Alberta. The findings should help determine the effectiveness of the new legislative and administrative provisions in pricing and reallocating water and guide future developments in water management. Specific objectives include:

i) to determine the extent to which informal and formal water markets have been used in southern Alberta,

ii) to determine the extent to which the behaviour of water markets in southern Alberta conform to economic principles and the extent to which the characteristics of these water markets conform to characteristics of water markets elsewhere in the world,

iii) to evaluate the conditions that have hampered or enhanced the use of water markets and identify improvements to the system,

iv) to determine the extent to which government's goals, as outlined in the *Water for Life Strategy,* are being realized through water markets activity in southern Alberta.

1.4 Thesis Organization

This thesis is organized in the following manner. To provide the broad context to irrigation water management in Alberta, Chapter two details Alberta's water resources, irrigation activity both past and present, the current legislation and policy framework, and the distinguishing features of irrigation districts and private irrigators. A review of economic instruments used in irrigation water management and experience in water markets in three jurisdictions – Australia, Chile and California - are presented in Chapter three. Chapter four explains the study's procedures including, for each of the informal and formal markets, the context of the studies, survey procedures, analytical procedures and the hypotheses to be tested. Research findings and their interpretation are presented in Chapter five. Policy implications are drawn together in the concluding section of the thesis, Chapter 6, in addition to suggestions for further research.

Chapter Two

Southern Alberta Irrigation

2.1 Introduction

The chapter provides the broad context to the issue of irrigation water management. It begins by detailing southern Alberta's water status, including an overview of supply and demand, in Section two. Section three focuses specifically on southern Alberta's irrigation activity today, followed by the history of its development in Section four. The fifth section details the legislative and policy instruments used in irrigation water management: the Water Act of 1999, the Irrigation Districts Act of 2000, and the *Water for Life Strategy* of 2003. This is followed by the features of irrigators within irrigation districts versus private irrigators, contained in Section six. The chapter draws together conclusions in Section seven.

2.2 Alberta Water Resources

Alberta has 2.2 percent of Canada's fresh water supply. In Alberta, 80 percent of water supplies lie in the northern part of the province while 80 percent of demand comes from the southern half (AENV, 2002b). Only about two percent of water consumed in the province comes from groundwater, 98 percent comes from surface water. There are two main surface water users in Alberta – irrigation, which accounts for 71 percent, and commercial/industrial which accounts for 15 percent. Municipalities account for just five percent of surface water consumption. The three main groundwater users are

commercial/industrial - 53 percent; agriculture – 25 percent; and municipalities – 18 percent (AENV, 2002b).

In Alberta, several major river systems or basins exist. Except for the Beaver River Basin, all other basins – the Peace/Slave, Athabasca, Hay, North Saskatchewan, South Saskatchewan, and Milk - originate from glacier melt. These are depicted in figure 2.2.1.

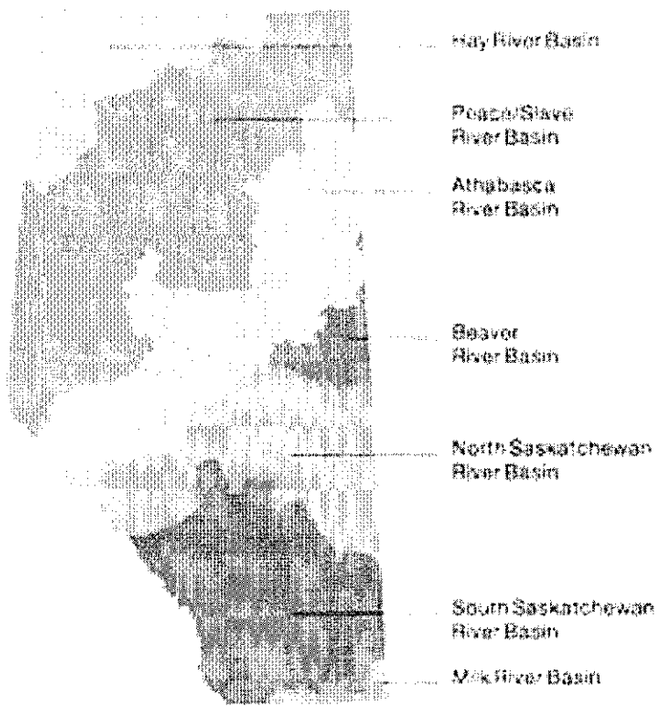


Figure 2.2.1 Major River Basins, Alberta

Source: http://www.waterforlife.gov.ab.ca

For purposes of irrigation, the South Saskatchewan River Basin is the most important. All of the province's 13 irrigation districts are found in this basin[1]. The basin includes the sub-basins of the Bow, Red Deer, Oldman and South Saskatchewan River systems. Major urban centres in the South Saskatchewan River basin include Calgary, Lethbridge, Red Deer and Medicine Hat. Figure 2.2.2 depicts the thirteen irrigation districts in this geographic setting.

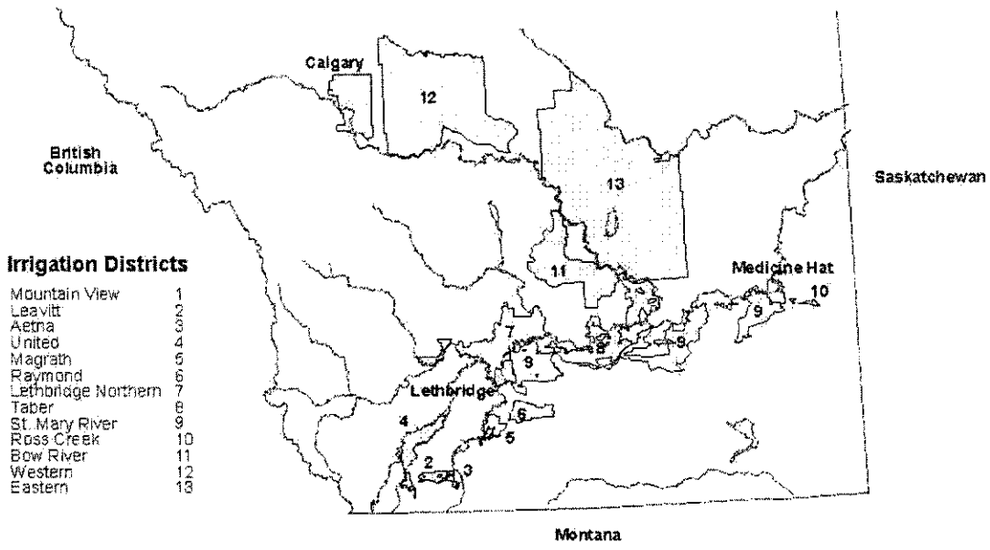


Figure 2.2.2 Thirteen Irrigation Districts in Southern Alberta

Source: http://www.agric.gov.ab.ca/irrigate/irrbase.html

Few natural lakes exist in the southern part of the province. Many man-made lakes, in the form of reservoirs, do, however, exist, as part of the water management system. They are integral to irrigation water management.

[1] The thirteen irrigation districts are: Mountain View, Leavitt, Aetna, United, Magrath, Raymond, Lethbridge Northern, Taber, St. Mary River, Ross Creek, Bow River, Western and Eastern.

Water is managed within Alberta by several systems: provincial government policy and law makers, administrators within irrigation districts, and farmers themselves. At the provincial policy and law making level, licensed water use for irrigation purposes is managed along with domestic, industrial, recreational and environmental requirements.

Irrigation water license holders, who are private irrigators and irrigation districts, as well as other licensees such as municipalities and industries, are provided limited rights to water on a "first-in-time, first-in right" basis. This means that water is allocated year-by-year based on supply and the seniority of the license holder. Licenses are held by private holders individually and by irrigation districts which are the umbrella organizations that hold water licenses and manage the water on behalf of individual farmers within the district. These districts transfer water to farmers based on acreage on the assessment roll[2].

The provincial government must ensure, because of appropriation agreements with the United States and Saskatchewan, adequate water flows across borders to the south and the east. The International Boundary Water Treaty between Canada and the United States governs water diverted from the St. Mary and Milk rivers to the United States. In general, it allocates three-fourths of the flow of these rivers to Canada and one-fourth to the U.S. The Prairie Province Master Agreement on apportionment governs the share of water that must flow from the South Saskatchewan River to Saskatchewan. The Oldman River and the Bow River become the South Saskatchewan River. For purposes of the agreement, the Red Deer River is also considered part of the South Saskatchewan River system. Under this agreement, Alberta is entitled to divert from each river a

[2] Acres approved for irrigation by the irrigation district and for which an annual water rate is paid to the district.

quantity of water equal to one half of the natural flow originating in or flowing through the province (AENV, 2002b).

2.3 Alberta Irrigation Activity

Southern Alberta is defined as a semi-arid region because evaporation potential from the ground surface exceeds precipitation that typically occurs over a given period (Nerbas, 1993). Much of southern Alberta's land would not be viable for production of annual crops and forages without irrigation (Hoppe, 2000). Due to irrigation, crop yields in this region can be three times that of nearby dry land areas (Hoppe, 2000). The range of crops that can successfully be grown also expands considerably with irrigation. There are 129 varieties of crops suitable for irrigation in southern Alberta and 64 percent of the crops grown with irrigation cannot be grown elsewhere in the province because of climactic constraints other than moisture deficits (Ring, 1988).

Land has been successfully irrigated in Alberta for more than a century, beginning in the 1880s. The total area irrigated has gradually increased over the years and now totals about 1.5 million acres. Irrigated land produces about 16 percent of the province's gross agricultural output from only 4 percent of the total agricultural land (Alberta Agriculture Food and Rural Development [AAFRD], 2000a).

Generally, the benefits of irrigation include: increased yields, the ability to grow new crops, greater economic stability and diversity through agricultural production; "backward linkages" through increased input requirements such as fertilizers, pesticides, irrigation equipment and special crop harvesting equipment; and "forward linkages" through storage, transportation, and meat and vegetable processing (Alberta Irrigation

Projects Association [AIPA], 2002). Economic evaluations of the extent of those benefits vary but they all conclude the benefits are significant[3].

2.4 History of Irrigation Development

Railways and private industry were active in the development of irrigation in its early phase. The initial phase of irrigation development occurred in the 1880's when commercial irrigation was developed by the railway companies in an attempt to lure settlers to the area. These settlers brought with them the doctrine of riparian rights as a means of settling disputes in the allocation of water (Percy, 1977). Under this doctrine water rights are restricted to those whose property abuts bodies of water.

By 1894 interest in irrigation was intensifying. At that point the federal government intervened by passing the Northwest Irrigation Act, which placed control of water rights in the hands of the Crown and also restricted riparian rights. This Act has been described as the "cornerstone" of Alberta's water resource allocation system, for, as Percy (1977) states, the provisions of this Act regulated appropriations of water for all purposes and remains the "basis of water use legislation in all three prairie provinces today" (p. 145).

The Act suppressed individual riparian rights (except for domestic use) and vested in the Crown the right to control the diversion and use of water through a licensing

[3] For example, the *Irrigation in the 21st Century* study (AIPA, 2002) estimated that the increases in primary production due to irrigation and its backward and forward linkages adds about $927 million to agri-food GDP in Alberta. A 1993 study commissioned by the AIPA (UMA Engineering Ltd. 1993) concluded that 13 percent of regional GDP and 19 percent of regional production is directly and indirectly associated with irrigated agricultural production. In addition, thirty percent of regional employment opportunities are associated with irrigation. A 1984 study also commissioned by the AIPA (Underwood McLellen Ltd., 1984) concluded that irrigation activity was responsible for the employment of 35 thousand people in

system (AIPA, 2002). The Act specified that water could be acquired only by the licensing system as set out in the Act. The rights to water usage were given three priorities – domestic, industrial and "other". Within these categories precedence was determined by the date upon which the application for the license was filed (Percy, 1977). Thus began water allocation based on prior appropriation or the first-in-time, first-in-right principle.

Corporate enterprise continued to be involved in the development of irrigation systems and by 1919 close to 76,890 hectares were being irrigated within areas of the current Western, Eastern, St. Mary River, Magrath and Raymond Irrigation Districts; other areas were in the development phase (AIPA, 2002). However, returns to corporate investments were discouraging. By 1915 the province passed the Alberta Irrigation Districts Act which provided for the establishment of irrigation districts in which farm land could be mortgaged (provincial guaranteed), to provide funds for irrigation development (Prairie Farm Rehabilitation Administration [PFRA], 1982). The Water Resources Act of 1931 transferred jurisdiction over natural resources, including water, from the federal government to the provinces (PFRA, 1982).

The economics of irrigation farming remained problematic in the early years. When the province established several commissions to address this issue, one recommendation called for "greater government financial responsibility, recognizing that the benefits of irrigation go beyond the farm gate" (AIPA, 2002, p. 15). Hence the provincial and federal governments accepted direct responsibility for the establishment of new developments and the expansion and maintenance of older schemes (PFRA, 1982).

Alberta, directly or indirectly. These activities accounted for $941 million of provincial gross domestic product annually.

By 1950, the era of corporate irrigation enterprises was over and 11 of the current 13 irrigation districts were established and operating (AIPA, 2002). The additional two irrigation districts, the Bow River and St. Mary River, were established in 1968. As well, in 1968, all former acts governing irrigation districts were repealed by the Alberta government and replaced by a new Irrigation Act. This Act granted licenses to irrigation districts and provided uniform rules and administrative authorities for them. Each district was, and continues to be, run by a Board of Directors. The Board is entitled to regulate the supply and distribution of water to water users within the district (Percy, 1977).

The 1950s to 1970s were decades of significant government involvement in irrigation development and management, including large expenditures for the rehabilitation and expansion of irrigation infrastructure (AIPA, 2002). In the early years, the creation of the PFRA in 1935 set in motion federal government involvement in irrigation. By the 1950s the PFRA had become a major player. And by 1970, both the provincial and federal governments had been involved in rehabilitation and expansion of irrigation in virtually all 13 irrigation districts (AIPA, 2002). The federal government considered most of its work done:

> By 1970, the federal government had accomplished its primary objectives of stabilizing and expanding irrigated agriculture in southern Alberta and resettling drought-stricken farmers and war veterans. It was prepared to relinquish its direct role (AIPA, 2002, p.17).

The provincial government's involvement increased as federal government involvement declined. Since 1969 the province has been involved in irrigation rehabilitation and expansion. A 1969 cost share program with the province involved districts paying 14 percent of irrigation rehabilitation and expansion costs and the

province paying 86 percent. That formula was changed from 14/86 to 20/80 in 1994 and to 25/75 in 1995. The 1995 formula was in effect in 2004 (AIPA, 2002). Provincial assistance for rehabilitation and maintenance continues at a rate of $17.2 million a year, on a cost-share basis (AIPA, 2000).

In 1975 the province agreed to assume responsibility for rehabilitation, operation and maintenance of the major irrigation headworks. In 1975 the government also introduced a 10-year program for rehabilitating the headworks and the main irrigation district canals. In 1980 this was extended for a further 15 years.

From 1970 to 1980 the irrigation assessment rolls increased 50 percent (AIPA, 2002). Revisions made to the Water Resources Act in 1975 further enhanced irrigation's place in the Alberta economy by giving irrigation water use priority over industrial, power or recreational use, third in water allocation behind domestic and municipal use (Percy, 1977).

2.5 Current Legislation and Policy

By the 1980s concerns were being voiced over the inflexibility of the Alberta water management system. Veeman (1985) advocated transferable water rights, saying the water license system was too rigid and inflexible to facilitate economic change and growth. Percy (1977) argued the prior appropriation system under the Water Resources Act could maximize the benefits obtained from water use only by "sheer coincidence" (p. 163). Such a system "fails to permit the transfer of a water right where a new, more highly valued use must be carried on at a different location on the stream" (Percy, 1977, p. 164).

The Act, he said, did not provide an adequate framework to deal with changing patterns of water use or with the competition for water among many different uses that were likely to occur in the future. He anticipated that agricultural water use might, in the future, be less valuable in economic terms than other uses such as for power generation or industrial or municipal use. Difficulties would arise because:

> ...the early water rights enjoy a highly privileged status, for they remain protected against newer uses in times of shortage. Furthermore, it is possible that existing rights may consume the available supply in a given stream or basin and thus preclude later and possibly more beneficial applications of water (Percy, 1977, p. 163).

By the early 1990s it was clear the 60 year old Water Resources Act could not provide the tools to cope with the water management challenges that were looming. In 1991 the Alberta government initiated a review of its water management policy and legislation and including the prospect of legislating tradable water rights. Freeman and Veeman (1993) stated that "without such reform, water is locked into lower valued use, efficiency in water use is not achieved, and the growth of the regional economy, in the face of increasing water scarcity, is impeded" (p. 262). Agriculture, they said, is the largest consumptive user of water but tends to be a marginal or low-value user and transfers of water from agriculture to higher value uses other than agriculture are "central to improved water conservation and management" (Freeman & Veeman, 1993, p. 262).

The government's review culminated in the passage of Water Act in 1999 and Irrigation Districts Act in 2000. Ultimately, temporary and permanent transfers of water licenses under the Water Act of 1999 included many of the elements advocated by Freeman and Veeman, (1993), including a formal approval process that assesses any effect on other right holders, an evaluation of any environmental impact that may occur,

ensuring the protection of in stream flow requirements, and incorporating river basin plans into the allocation process, among other features.

The Water Act also has a much broader mandate than the management of water allocation as dictated under the former Water Resources Act. The intent of the new Water Act (1999) is to support the conservation and management of water, to sustain the environment and support economic growth. And the management paradigm is to be integrated, shared and cooperative (Water Act, 1999). The Water Act (1999) also protects the seniority of existing water license holders that are in good standing, prohibits the export of Alberta's water to the United States, and prohibits inter-basin transfers of water between Alberta's major river basins. The Water Act is administered by Alberta Environment.

Under the Water Act, potentially large amounts of water could be permanently transferred between very different users (an irrigation district to a municipality, for example), involving more extensive water movement than off-stream re-allocation. Therefore, third party and environmental effects may occur. These are evaluated through an extensive approval process, discussed in Chapter four. The Water Act also specifies that up to ten percent of a water license transfer can be withheld to protect the aquatic environment or to implement a water conservation objective (Water Act, 1999). By fall, 2004, there have been 20[4] applications for the permanent transfer of water rights. Only six of the 20 applications can be described as market transactions.

Under the Irrigation Districts Act of 2000, the owner of irrigated land can transfer water licenses to other irrigators within the same irrigation district. Transfers of all or a

[4] Transfer applications by two municipalities were handled jointly and are treated as one.

portion of a district's water license outside the district is possible, but only if a plebiscite is held and a majority of irrigators agree. Therefore these transfers are rare, occurring on occasion when blocks of unused water rights are sold and the funds are used for infrastructure upgrades. Individual transfers outside the district are not practiced.

Unlike transfers under the Water Act of 1999, transfers within irrigation districts do not involve water moving among vastly different users, over long distance, or involving more extensive water movement than off-stream allocation. Third party effects and environmental effects of water transfers are not potentially as onerous as transfers under the Water Act. This helps to significantly simplify the approval process.

Under the British North America Act of 1867 and the Constitution Act of 1982, the federal government maintains legislative authority over water in such spheres as fisheries, navigation and the regulation of inter provincial and international trade (Veeman, 1985). However, the division of power over inter provincial bodies of water is quite uncertain. As Percy notes, in practice, the provinces can regulate both quality and quantity of water on a day by day basis, but the federal government could intervene in this management at any time by legislation (Percy, 2000).

The provincial government's *Water for Life Strategy* of 2003 establishes the foundation for the government's water management plan for the next decade. From a public consultation process that took place between November, 2001 and June, 2002, a set of principles emerged. At the top of the list is the principle that "(a)ll Albertans must recognize there are limits to the available water supply" (AENV, 2003c, p. 6). A goal of the strategy is to ensure reliable, quality water supplies for a sustainable economy. An associated medium term outcome, from 2007-2008 to 2009-2010, is that all sectors

demonstrate best management practices and improved efficiency and productivity associated with water use (AENV, 2003c, p. 27). One of the actions required to fulfill that outcome is to monitor, evaluate and report on the water allocation transfer system (AENV, 2003c, p. 27).

2.6 Irrigation Districts and Private Irrigators

Private irrigators account for less than one-quarter of total irrigated area in southern Alberta – approximately 277,000 acres compared to 1.2 million acres within irrigation districts (AAFRD, 2000b). Private irrigators operate under very different administrative systems than do irrigators located within irrigation districts. While legislation now allows both to sell their water rights, either on a permanent or temporary basis, the system under which they sell their water rights varies significantly as well.

Private irrigators were originally established under the 1931 Water Resource Act. They, like municipalities and irrigation districts and industries, hold a water license. Based on the 1931 Act, water held by private license was non-transferable, site-specific and use-specific without any significant pricing or fee-based allocation mechanism (Horbulyk & Lo, 1998). Within the South Saskatchewan River Basin there are 7,600 private license holders consisting of industries, households, municipalities and private irrigators. Together, private irrigators and irrigation districts account for 1,900 licenses (K. Murphy, personal communication, May 13, 2003) and 75 percent of the total volume of SSRB allocations (AENV, 2002b)

The first-in-time, first-in-right principle ensures that, during times of water shortage, water is allocated to senior over junior right holders. The Water Act of 1999

grandfathered the license dates, leaving existing water rights undisrupted. Since Alberta Environment administers the legislation it also reviews license application and issues them. License holders do not pay for the water itself. When a license is approved, a one-time payment for the license is levied, based on the volume of water involved. Conveyance of the water is the responsibility of the irrigator. Irrigators must independently establish and maintain their own irrigation infrastructure, including the system used to transfer water from the stream to their property.

Licenses are legally tied to specific parcels of land and historically have remained with the property when the land is sold. There is evidence that previous water transfers that accompanied the land have been priced at (implicit) prices that reflect the future value of water use capitalized into the total price paid for the parcel of land (Adamowicz & Horbulyk, 1996). By allowing water rights to be tradable, the Water Act of 1999 transforms "historical licenses into marketable commodities" (Horbulyk & Lo, 1998, p. 245).

Unlike private irrigators, irrigators within irrigation districts do not hold water licenses individually. The irrigation districts hold the irrigation license and manage the water infrastructure and administration. The Irrigation Act regulates the districts and is administered by the Department of Agriculture, Food and Rural Development.

Each irrigation district operates independently and the manner in which their functions are carried out can vary significantly, due to their differing size and physical characteristics (Southeast Alberta Regional Planning Commission, 1982). The size of irrigation districts can range from as large as 371,000 assessed acres in St. Mary River Irrigation District [SMRID] to as small as 1,000 acres in the Ross Creek Irrigation

District (AAFRD, 2000b). Irrigators have their irrigable area on the district's assessment role and these irrigators constitute the district's ratepayers. Irrigators pay a flat fee per acre for administration costs and some rehabilitation of infrastructure, varying from as high as almost $18.00 per acre in the SMRID to as low as $7.50 per acre in the Eastern and United Irrigation Districts (AAFRD, 2002). Irrigators do not pay for the water itself.

2.7 Conclusion

Geographically, Alberta's water supply is concentrated in the north while water demand is concentrated in the south. This fact, combined with persistent and increasing water demands arising from population, industry and agricultural growth, means water management challenges will intensify over time. Irrigation has a long history in Alberta. Agricultural producers and the secondary industries they serve are dependent on it and local economies have reaped economic benefits from it. Federal and provincial government funding have created extensive irrigation infrastructure and provincial assistance for rehabilitation and maintenance continues. New legislative instruments that provide for the creation of water markets permit economic instruments to be used in managing irrigation water. While providing producers greater flexibility in water management, ultimately, government's objective, derived from the *Water for Life Strategy*, is greater water conservation, greater water productivity and efficiency and more effective ways to manage water supply and demand.

Chapter Three

Economics of Irrigation Water Management

3.1 Introduction

In recent years a significant body of literature has focused on the effectiveness of various water allocation instruments (Johannson, 2000). This attention to water management is not surprising given the juncture at which water managers around the world find themselves. Indeed, they are under pressure to reform water allocation methods because of intensifying competition for urban, industrial and environmental purposes. Budgetary constraints and less tolerance for environmental damage are making supply side solutions to water shortages, such as building dams, much less feasible and acceptable. Since water used for irrigation consumes by far the largest amount of water world-wide, irrigation water management is the object of reform (Abu-Zeid, 2001; Varela-Ortega, Sumpsi, Garrido, Blanco and Iglesias, 1998).

This review is intended to draw together literature relating to the allocation of irrigation water. It attempts to compile the literature which has emerged around allocating water through administered pricing systems and secondly, through market-based instruments in the form of informal and formal markets. The subject matter is divided into four sections. In the following three sections the context to this subject is highlighted by describing global water constraints and the conditions that are providing the impetus for change in water management practices. This is followed by an enumeration of water supply and demand characteristics that serve to emphasize the

uniqueness of the resource and the resultant challenges in managing it. The final section explores current pricing and allocation instruments, including administered pricing and water markets. In addition to discussing the characteristics of the market for temporary and permanent trades in water, attention is also given to transaction costs related to permanent trades. This section also provides an analysis of irrigation water markets in three jurisdictions where markets have been established in varying degrees - Australia, Chile and California. The last section presents conclusions.

3.2 Global Water Constraints – Impetus for Change

"Irrigation agriculture is the largest consumer of water all over the world, accounting for an average of 65 percent in developed countries and up to nearly 90 percent in some developing countries" (Abu-Zeid, 2001, p. 527). It is not surprising therefore, that irrigation water is the target of water management reform world-wide. Varela-Ortega et al. (1998) describe agriculture as "becoming the focus in which all analysts are pointing as the culprit of the nation's water problems as well as capturing most of the attention to introduce better policies aiming at increasing water use efficiency" (p. 194).

For most of human history irrigated lands expanded at a faster rate than did populations (Johannson, 2000). Until the 1970s and 1980s irrigation infrastructure grew as increased demand was met by increased supply (Bjornlund, 2003d). Irrigation land coverage, however, peaked in 1978 and has fallen off nearly six percent since then (Postel, 1994). The list of factors contributing to this decline include: reduced public investment in irrigation due to high government debt loads, political resistance, rising real

costs of irrigation development and declining real prices for food (Rosegrant & Svendsen, 1993), the loss of irrigation coverage due to salinization, urban sprawl and growing sectoral competition (Johannson, 2000) and a significant change in public opinion with respect to environmental values (Haddad, 2000; Bjornlund, 2003d). Bornlund (2003d) states:

> Modern environmental policies, which emerged during the late 1960's, evolved into comprehensive environmental management strategies during the following three decades, and started to affect policies and laws (Bosselmann and Richardson, 1999). This process was driven by a strong change in public opinion with respect to environmental values, together with a better understanding of interrelated issues. The same three decades also saw a sharp increase in the marginal cost of supplying new water as the water industry entered a mature phase (Randall, 1981), as well as a decrease in the public willingness to fund such work due to the shift in public opinion (p. 1).

As irrigation utilizes so much water, reducing its consumption by small amounts can alleviate shortages in other sectors, particularity cities. For example, Haddad (2000) notes: "(i)f cities in California were to get 15 percent of what agriculture in California currently uses, urban water availability would rise by more than half. This would be more than enough to meet new urban demands well into the twenty-first century" (p. xvii). Gonzalez-Romero and Rubio (1993) indicate that a ten percent improvement in agricultural water use is almost equivalent to all urban consumption. In studying irrigation practices throughout the world, Briscoe (1997) observes that there is a "remarkable" degree of similarity in the nature of "the problem" (p.14). "The political economy of contemporary public irrigation systems in, say, India, is remarkably similar in many respects to the political economy of public irrigation systems in the Western United States" (p.14). While institutional arrangements relating to water management across countries are quite dissimilar (Briscoe, 1997), a number of countries find that their

water institutions are outdated and no longer meet contemporary societal needs (National Research Council [NRC], 1996).

Frequently the literature refers to the increasing emphasis on demand-side solutions, away from supply-side solutions, or to "knowledge intense" and away from "capital-intense" solutions (Jin & Young, 2001, p. 226). Remedies sought through the enhancement of supply, used for decades in the past, are not as readily available. Construction of dams, for example, is no longer feasible in some countries due to fiscal constraints and increasing opposition because of the environmental damage that occurs. In some countries, even conservation practices in some sectors have been largely exhausted. Haddad (2000) notes: "(w)hile the amount of water that cities can truly conserve is still debated, certainly the reservoir of potential conservation is much lower at the beginning of the twenty first century than it was even a decade earlier" (p. xviii).

There is an emerging global consensus on the principles of effective water management (Briscoe, 1997). Water reforms are an official World Bank policy and as such, are an integral part of new projects in developing countries (Bjornlund & McKay (2002). Key elements of such reforms are market mechanisms and full cost recovery pricing (Bjornlund & McKay, 2002). The three "Dublin principles" that emerged from the International Conference on Water and the Environment in 1992 emphasize the "holistic" management of water, the importance of local involvement in its management, and the treatment of water as an economic resource (Briscoe, 1997, p. 9). That statement is, according to Briscoe (1997), the most explicit one in defining the principles of effective management.

Dosi and Easter (2000) observe that in a large majority of countries, pricing schemes are being implemented to recover operation and maintenance costs, and in some cases a portion of capital costs. Water management is gradually being decentralized, and turned over to private enterprises and non-governmental organizations (Dinar & Subramanian, 1998). Indeed, during the 1980s and 1990s key organizations such as the United Nations, Organization of Economic Cooperation and Development [OECD] and the World Bank promoted a host of policy instruments including pricing mechanisms, property rights, water markets, devolution of ownership and operation of water infrastructure and public education programs (Bjornlund & McKay, 2000a).

Johannson (2000) summarizes these developments in saying:

> While reform efforts differ across countries in terms of actual coverage and effectiveness, the currently observed water sector institutional changes at the international level are remarkable for their commonality of focus and direction. These include a shift from source development (supply management) to allocation (demand management), wide acceptance of privatization and decentralization of control, adoption of integrated approaches to sector-wide management, and an increased focus on economic viability and physical sustainability (p. 25).

3.3 Supply and Demand Characteristics of Water – Challenges to Management

A host of supply-side and demand-side characteristics make water a unique and challenging resource to manage. On the supply side, water is "fugitive" – it moves around and changes from vapor to liquid to solid, from rain to snow, from rivers to oceans (Bauer, 1998). The bulky nature of water makes it difficult to move the commodity upstream and outside river basins (Easter, Becker & Tsur, 1997). Water supply is also variable. An analysis of 35 developing countries, for example, concluded that nearly half experienced 40 percent variability in rainfall (Cestti, 1989).

Water, from both underground and surface sources, is often viewed as an open-access good and as such, over-exploitation can occur by people pursuing their own self-interest (Johannson, Tsur, Roe, Doukkali & Dinar, 2002; Easter & Feder, 1997)[5]. Lack of information on the value of water is also common and leads to less than efficient allocations. As Johannson et al., (2002) note, incomplete information or "asymmetric information" and "moral hazard" (Laffont & Tirole, 1993) arises when information is private or unavailable. In the absence of adequate information, people base their decisions on their own private information, and society incurs costs associated with monitoring and enforcement (Johannson et al., 2002).

Livingston (1998) states water can be "rife with externalities" (p. 20), an issue addressed in a number of sources (OECD, 1999; Easter et al., 1997; Johannson, 2000). The most common externalities of irrigation water involve salinity and run-off pollutants that can have negative effects on other users, and on ecosystems more generally (OECD, 1999). One report notes that irrigated agriculture accounts for more than 40 percent of the pollution in lakes with impaired water quality (U.S. Environmental Protection Agency, 1992). Other effects include reduced down-stream flows. Water pricing, including taxes, are commonly considered an effective way of internalizing these externalities (OECD, 1999; Johannson et al., 2002; Baumol & Oates, 1995). Another method, as discussed later in this chapter, is to impose transaction costs on water buyers and sellers. One could regard these costs as a tax that could internalize externalities and achieve an efficient outcome (Colby, 1990)

[5] For further information on the public good characteristic of water see Johannson et al (2002), Haddad (2000), Dinar et al (1997), Abu-Zeid (2001) and Millman (1956).

Irrigation activity has social impacts that can be either positive or negative. The OECD (2002) reports that social costs of irrigation water, which include water pollution, over-exploitation, salinity problems and the undervaluation of water resources, are far from negligible. The positive social effects include, for example, maintaining the rural landscape and tradition, supporting local economies, and enhancing food security levels (OECD, 1999).

Finally, water projects are usually associated with large investments (Dinar, Rosegrant & Meinzen-Dick, 1997). The supply of water often requires a "dedicated delivery system", unusable for any other purpose (Easter & Feder, 1997, p.263). Large - scale hydro and irrigation projects typically exhibit increasing returns to scale giving rise to natural monopoly (Spulber & Sabbaghi, 1998; Easter & Feder, 1997).

Demand for a commodity is reflected in the willingness to pay for the last unit of it or in the marginal benefit that accrues to the user. In the case of water, several demand-side factors prevent water from being treated like many another commodities. These characteristics, enumerated below, are derived from a number of sources that deal with this issue (Easter et al, 1997; Thompson, 1997; Abu-Zeid, 2001; Haddad, 2000). First, water is not a homogeneous good, it varies in quality. Different users will tolerate this water quality differently and this will influence their willingness to pay for water. Second, the willingness to pay for water varies seasonally and annually, including demand for irrigation water, which varies with the growing season. Some sectors, such as the hydroelectricity sector, require large quantities of water but consume only a small fraction of it (Easter et al, 1997). Finally, people hold particular social attitudes about

water unlike their attitudes about other commodities (Thompson, 1997; Abu-Zeid, 2001; Haddad, 2000). Abu-Zeid (2001) notes:

> Access to water is also viewed as a basic human right, a financial obligation, a social necessity and a critical environmental resource. These various views make the selection of a set of prices and pricing mechanisms that adequately address all the views exceptionally difficult (p. 535).

3.4 Economic Instruments

3.4.1 Administered Pricing

Theoretically, the most efficient and socially optimal means of pricing a factor is through marginal cost pricing (Dinar et al., 1997). Marginal cost pricing, or opportunity cost pricing, implies that the price of water should be set equal to the marginal cost of providing it (Johannson et al., 2002). The advantages of marginal cost pricing are well documented in the literature (Briscoe, 1997; Thobani, 1998; Dinar et al., 1997; Johannson 2002: Saleth, 2001; Milliman, 1956). When marginal costs and marginal benefits are equal, the most efficient price is established and the difference between the total value of water supplied and the total cost of providing it is a maximum (Dinar et al., 1997).

Marginal cost pricing in general includes charges for: collection, transportation, treatment, distribution, monitoring and enforcement, headworks, and any social costs and scarcity value (Dinar et al., 1997). Saleth (2001) stresses the need for prices to reflect long-run marginal costs that includes operation and maintenance costs, capital costs and the social cost of externalities. The OECD (1989) also emphasizes the need for the establishment of long-run marginal cost pricing that capture all opportunity costs. The OECD (1989) refers to: "resource use costs" (the goods and services forgone by the

commitment of economic resources to the construction and operation of the supply system), "natural resource depletion costs" (cost necessary to maintain the quality and reliable availability of the basic water resource) and "any damage cost arising from consumption and production of the water service" (adverse effects on the enjoyment or production possibilities of other water service users) (p.92).

Unfortunately, from an administrative point of view, marginal cost pricing is virtually impossible to implement because of several practical and political problems it poses. Thobani (1998) notes that no country has been able to successfully implement opportunity cost pricing of water administratively. She states: "(e)ven if government could find an inexpensive way to measure and monitor water flow, there are tremendous difficulties in measuring the opportunity cost of water since it varies according to location, water quality, season, year, reliability and use" (p.35).

One of the key limitations of marginal cost pricing is in defining marginal cost itself (Saunders, Warford & Mann, 1977) and then determining all the marginal costs (Johannson et al., 2002). Spulber and Sabbaghi (1998) note that marginal cost is "multi-dimensional in nature" it includes such variables as water quality and quantity; it varies with the period over which it is measured (long run and short run); and the composition of fixed and variable costs, as determined by short and long term demand, has a significant impact on marginal issues.

Briscoe (1997) states where there is competition among high-value users, and opportunity cost is therefore high, pricing according to such a principle would be unreasonable. A study by the International Committee on Irrigation and Drainage concluded that in addition to information requirements that are onerous, such prices

"would be perceived as expropriation by those who currently use the water", and such a practice would "defy common sense" because it would mean farmers in Chile, Australia and California would be asked to pay more than ten times the cost of providing the services they receive currently. (Briscoe, 1997, p. 5). Thobani (1998) notes that where water rights exist, an additional problem arises because land prices embody the capitalized price of water rights. Finally, water pricing mechanisms are not very effective in redistributing income and thereby achieving equity goals (Abu-Zeid, 2001; Johannson et al., 2002; Tsur & Dinar, 1997). Equity objectives relate to fairness of allocation across various groups in society and "may or may not be consistent with efficiency objectives" (Dinar et al., 1997 p.4). For example, under marginal cost pricing, a shift in supply due to drought will raise water prices and that could adversely affect marginal farmers (Dinar et al., 1997). In fact, prices based on marginal costs are often too high for low income farmers (Dinar et al., 1997; Saleth, 1998; Easter et al., 1997).

As the marginal cost pricing principle is both impractical, due to onerous informational requirements, and undesirable, due to important considerations such as equity and political and public acceptability, governments have deliberately made decisions at various times to subsidize agricultural water, at the expense of other economic sectors or of the general tax-payer (OECD, 1999). The OECD (1999) states:

> Although full-cost pricing will usually lead to improvements in both economic efficiency....and environmental efficiency....there are sometimes valid social, environmental, or economic reasons for continuing to subsidize agricultural water activities. These competing policy objectives need to be balanced against the desire for increased efficiency (p. 48).

Irrigation water pricing does not adhere to first-best solutions as prescribed by the classical economic framework and second-best or third-best outcomes often result from

special interest group pressures or political economy based decisions (Johannson, 2000). Administrative costs are also a factor. A variety of pricing and administrative strategies are therefore currently practiced that do not adhere to the marginal cost principle, but which are the most acceptable solutions from an administrative and policy perspective. These strategies attempt to combine both efficiency and equity and can involve such policies as government subsidies, free service, or adopting a differential pricing structure based on income (Dinar et al., 1997). These instruments include: volumetric pricing, output and input pricing, area pricing, tiered pricing, two-part tariff pricing, betterment levy pricing and volumetric pricing with a bonus (see OECD, 1999 and Tsur & Dinar, 1997 for more detail).

The role of government or a central decision-making body should be limited and well-defined:

> There is a growing realization that water management provides a bundle of services that can be divided up, with some of the services better (more efficiently) provided by the private sector (Easter et al., 1997). By unbundling services, the public sector can maintain its role where it is most important, i.e. protect against monopoly power, negative externalities, the under-provision of public goods, and the overuse of open access water. The private sector and market forces can then be used to help better manage and allocate water services (Dosi & Easter, 2000, p.5)

3.4.2 Water Markets

3.4.2.1 General Characteristics

A market requires that a number of conditions be satisfied to work. For it to be considered competitive, there needs to be many buyers and sellers, each with complete information on the market rules and each facing similar costs; a diversity of users; low

transaction costs; independent decision-making by these parties; decisions not having any effect on the outcome of others; and the parties being motivated by profits (Easter, Rosegrant & Dinar, 1998; Dinar et al., 1997). There are also requirements of a legal and institutional nature: the rights to use water separately from land and for a lengthy period of time; procedures to register, monitor and enforce the rights; institutional and organizational arrangements that broaden the market and make it more competitive; and a mechanism to resolve conflicts (Dosi & Easter, 2000).

Although externalities are common to water, the Coase theorem states that when government establishes the rights to use a resource, externalities will be internalized and the free exchange of the rights will achieve efficiency if transaction costs are zero (Hyman & Strick, 2001). In unhampered markets, opportunity costs prevail. Water will be allocated according to each user's marginal benefit such that total benefits or total welfare are maximized.

Haddad (2000) stresses that markets enhance individual freedom inasmuch as users are not accountable to, or reliant on, government. He notes that one could envisage, for example, environmental groups purchasing water rights in order to preserve a wetland or increase a waterways' springtime flow. Without a market mechanism they would have to rely on government to undertake that activity. Markets can ultimately increase policy options by expanding the number of alternatives through market-based solutions (Haddad, 2000).

But water markets are controversial for several reasons, as enumerated by Bauer (1997):

> ....their potential benefits include greater efficiency and flexibility of water use and less state intervention and expenditure: while their drawbacks include social

> and environmental externalities, vulnerability to high transactions costs, and other common examples of "market failure" (p. 639).

Also, water markets do not regulate themselves. Institutional and organizational arrangements are needed for markets to function as efficiently as possible (Easter et al., 1997). These water organizations and institutions can be either private (irrigation companies for example) or public (municipalities, regional water districts or government departments) (Livingston, 1998). They can also be "instrumental in either fostering water markets or in presenting barriers to market development" (Livingston, 1998, p. 25). What have emerged over time are various water markets ranging from "rudimentary to sophisticated" systems (Livingston, 1998, p.20).

Formal water markets have proven much more difficult to establish than informal water markets. Few formal markets can be described as thriving. Therefore, much of the analysis of formal markets focuses on why this type of market is inhibited. As formal water markets frequently involve water permanently moving between jurisdictions, sometimes over long distances, and between sectors, factors such as geography and lack of adequate infrastructure can present major impediments to an efficient market outcome. These factors can be compounded by cumbersome and constraining laws and procedures, poor information networks, and culture and attitudes. Transaction costs bear heavily on this water transfer process by virtue of the permanency of the transfer and the sheer formality that accompanies this process. Communities also fear the possibility of economic decay and loss of the irrigation base that supports the existing irrigation infrastructure.

Despite the litany of factors that constrain formal markets, it is anticipated that they will grow in importance and become more common in the future because of the need

for long-term security of water by certain users, and the ability to have flexible water movement to attain long-term structural adjustments in the economy.

Informal markets are much more unconstrained and common. They occur where easily accessible water supplies are required for short-term water requirements. These informal markets are limited in scope – within the same district and among similar users - and are found where water allocation at the local level is a problem and the transaction costs of establishing formal markets are high (Easter et al., 1998).

As with administered water pricing policies, water markets are not a panacea for all water problems. The prospect of attaining a first-best allocation via markets is unlikely given the multitude of factors required for such a solution - the institutional structure necessary for market-based policy, external effects across users, temporal interdependencies, large fixed investment costs and uncertain supplies (Ahmed & Sampath, 1988; Rosegrant & Schleyer, 1996; Easter et al., 1997). Market mechanisms do not automatically protect specific sectors of the economy, society or specific geographic regions, they do not protect uses of a resource that promote general rather than individual welfare, and they can move a society's "relationship" with water in a direction that society would not have preferred had it been given a choice (Haddad, 2000, p.45). Finally, depending on whether the market is informal or formal, transactions costs can be significant. Hence, where water markets exist, governments exercise some degree of regulatory power to mitigate some of the problems associated with market activity and water. Ideally, their role should include:

> 1) treating various water interests without bias, 2) serving as a water broker, thereby lowering the transaction costs of water trades, 3) allowing the price of water to vary according to its changing economic value, and 4)

> ensuring that water transfers do not impose uncompensated externalities on other water users (Livingston, 1998, p. 25).[6]

3.4.2.2 Transaction Costs

Transaction costs impact price and therefore affect the level of market activity (Saliba & Bush, 1987). The costs can be so onerous that they impede the development of the market because many potential trades are prevented from occurring (Thobani, 1998; see also Archibald & Renwick, 1998; Briscoe, 1997; Thompson, 1997). Transaction costs have typically been viewed as "wasteful and something to be minimized" (McCann, Colby, Easter, Kasterine & Kuperan, (in press)).

However, others argue that transaction costs cannot be simply viewed as impediments to trade and market efficiency, and as serving no useful purpose. Saliba and Bush (1987) and Colby (1990) contend that they have a valid role in promoting efficiency. They are required to evaluate the impact of any third party effects, ensure the public interest is upheld, allow affected parties an opportunity to voice concerns and ensure transparency in the process (Colby, 1990).

Colby (1990) suggests transaction costs be viewed as a tax that serves to internalize externalities. She states, given the public good nature of many water uses and negative externalities that are commonly associated with water transfers, private marginal costs are likely to diverge from social marginal costs. Hence, if transaction costs are considered as a type of Pigouvian tax[7], private decision makers are forced to account for social costs. Efficiency is enhanced. This is not to say, however, that high transaction

[6] Livingstone notes that the organization could be either private or public.
[7] A.C. Pigou argued that externalities produce a difference between social and private returns, and a system of taxes and subsidies could be used to internalize these externalities.

costs should be supported simply on the basis that they may improve water allocation patterns (Gardner, 1990). Further, there are likely to be efficient and inefficient types and magnitudes of transaction costs (McCann et al., in press).

Water markets are sensitive to transaction costs (Girrido, 1998, 2000) and therefore have important implications for market activity. Economic theory tells us buyers will not undertake a transfer unless returns to water in their intended use at least cover both the price paid to the seller and all the transaction costs borne by the purchaser (Saliba & Bush, 1987). Similarly, sellers will not participate unless the price they receive compensates them for the returns forgone in transferring water rights plus any transaction costs they incur (Saliba & Bush, 1987). Furthermore:

> For markets to be effective, transaction costs must be kept low. To keep these costs low, the appropriate institutional and organizational arrangements need to be in place, as well as flexible infrastructure and management...(Easter et al., 1998 p. 282)

Briscoe states: "(b)ecause transaction costs are so important, the choice of institutional arrangement for dealing with these is crucial" (Briscoe, 1997, p. 21).

Transaction costs vary considerably according to whether the market is informal or formal. Costs include the time, effort and cash outlays involved in locating someone to trade with, negotiating terms of trade, drawing contracts, and assuming risks associated with the contracts (Hyman & Strick, 2001). Where government regulations are involved, as they are in the formal water transfer process, transaction costs also include the time, effort and any cash outlays involved in identifying legal and hydrological characteristics of water rights such as priority dates and return flow obligations (Saliba & Bush, 1987). Other requirements could include surveys to determine suitability of soil for irrigation

purposes, land title searches, and costs of undertaking public notice and public review processes.

Transaction costs can multiply where legal challenges arise. These occur most often with transfers out of agriculture, compared to transfers among farmers, and in areas where water is scarce and valuable (Colby, 1990). Colby (1998) states these costs are becoming more common and they are significant:

> Disputes prompted by competition for scarce water supplies have proliferated worldwide, generating enormous costs and uncertainties for affected parties (p. 77).

McCann and Easter, (2004) argue that these costs alone underestimate the real cost of market transactions because they focus only on the cost incurred once a market exists. They believe costs should also include those associated with the development of the market mechanism itself (McCann & Easter, 2004). Thompson has undertaken work in this area, developing an Institutional Transaction Cost framework of analysis (Thompson, 1997).

Archibald and Renwick (1998) categorize transaction costs into administratively-induced cost and policy-induced costs. The former include the cost of searching for trading partners and negotiating the terms of exchange and other contract provisions - cost typical of any transfer of property (Archibald & Renwick, 1998). Policy-induced costs are the sometimes extensive and onerous costs imposed on buyers and sellers in obtaining approval for water transfers. Policy-induced costs are imposed on participants in the formal water market but not in the informal market, where only administratively induced costs are involved. Some market analysts believe policy induced costs constrain formal market performance (Archibald & Renwick, 1998; Easter et al. 1998).

Bjornlund (2002b) and Howe et al., (1990) observe that water prices are related to transaction costs – the higher the volume of water traded the lower the transaction costs on a per unit bases and hence, a willingness to pay higher prices for larger volumes of water. Transaction costs can also vary over the lifetime of a program, decreasing over time due to learning and the presence of fixed costs which are incurred primarily at the beginning of a program (Falconer, Dupraz & Whitby, 2001).

McCann and Easter (2004) enumerate the results of various studies focusing on transaction costs. Colby's study (as cited in McCann & Easter, 2004) reveals that in the western United States, transaction costs average six percent of the price paid by the applicant to transfer water but vary by state, and can reach as high as 12 percent in Colorado. A study of transaction costs in New Mexico by Brown, DuMars, Minnis, Anderson-Smasal, Kennedy and Urban (as cited in McCann & Easter, 2004) concludes that they constitute about 13 percent of the price paid (1992). Hearne & Easter (as cited in McCann & Easter, 2004) found that transfer costs in Chile represented between seven and 23 percent of the transaction price. Finally, overhead costs involved in operating the California Water Bank, as estimated by Howitt (as cited in McCann & Easter, 2004), were about eight percent of water purchase cost. In summary, studies have estimated transaction costs vary from a low of six percent of the price of water to a high of 23 percent (McCann & Easter, 2004)[8].

[8] Caution has to be used in comparing these results because of inconsistent definitions and measurement of transaction costs.

3.4.2.3 International Water Market Experience

Generally, countries have had more success in implementing informal rather than formal water markets. Informal markets have been widely implemented in various countries in the world including Australia, Chile, California, Spain and many Asian and southeast Asian countries such as India and Pakistan (Saleth, 1998; Meinzen-Dick, 1998; Rosegrant & Binswanger, 1994). Relative to the formal market process, informal markets are appealing because of their simplicity and low transaction costs. They are inherently easier to administer because:

> .....informal sales will likely be among farmers in the same water district and in many cases among farmers served by the same canal. In addition, these sales are not likely to be anonymous, and enforcement of the contract will not be provided by the legal system but rather will be based on reputation and personal trust (Easter et al., 1999, p. 101).

Formal markets have been established in only a few jurisdictions (Bjornlund, 2003c). California, Australia and Chile, studied in more detail below, have had limited success in establishing them. The creation and management of institutions needed to administer and implement formal markets is time-consuming and costly. Studies such as Bjornlund (2003a), Bauer (1998), and Haddad (2000), have found that in jurisdictions like California, permanent markets have been hampered because of high transaction costs, legal barriers to trade, fear of long-term detrimental effects to farming communities and deeply-embedded distrust among farmers, cities and government. In Australia, impediments are less related to transaction costs, legal barriers or lack of trust but more due to policy uncertainty, trade restrictions and tax implications. In Chile, geography and culture are major impediments.

Australia

Australia, described in many ways as being in the forefront of implementing the new water management paradigm, has perhaps the most actively working water markets in the world (Bjornlund, 2003d). There, demand for change originated from users, not government, and arose because of several mitigating factors: over commitment of water supplies, water logging and rising salinity levels in soils and streams, declining land and water quality and a significant loss of natural habitat (Sturgess, 1997). Infrastructure was deteriorating and public attitudes towards financing irrigation were also changing. Australia's water sector was exhibiting many of the classic problems of mature water economies (OECD, 1999).

The Australian Government adopted a number of significant water system reforms in the 1980s and 1990s. A movement to full cost recovery of water was instituted, water property rights were separated from land titles, enabling the transfer of water entitlements between land and title-holders, and the volume of water extracted from the huge Murray-Darling Basin was capped in 1997 at 1993-94 levels of allocation. It is expected that a new cap, "CAP Mark 2", will be forthcoming, further lowering the volume of water available for irrigation use.

Traditionally, water authorities announced water allocation as a percentage of water rights at the beginning of the season, based on water availability in storage and historical inflows during the season. Now water allocations are announced at the beginning of the season based on what is available in storage and then revised monthly as the season progresses, shifting risk management to irrigators (Bjornlund, 2003e).

Finally, water market activity has been facilitated by institutions that simplify and expedite the water trading process. These include: water exchanges within irrigation areas, the National Water Exchange, and an interstate water-trading program. Disputes over water rights are handled within an administrative, rather than judicial, framework (Bjornlund, 2002a).

Trading of irrigation water rights in Australia occurs under a similar regulatory framework as Alberta. For example, in South Australia irrigation districts hold their own water license under the Water Resources Act of 1997 and can trade rights in whole or in part under that Act. Trade of irrigation water rights within irrigation districts is governed by the Irrigation Act of 1994. Trade occurs within the district but, unlike Alberta, the Australian system provides some flexibility in trading outside irrigation districts. District irrigators can apply to the district board to trade their part of the district's license to another license holder. Restrictions do, however, apply as to how much can be traded. In South Australia, for example, this is capped at two percent of the district's total entitlement. Under the new National Water Initiative of 2004 these restrictions have to be removed within the next five years or so.

For irrigators, the changes outlined above have entailed higher water prices, thus higher levels of cost recovery, and improved incentives to conserve water (Dinar et al., 1997). The introduction of transferable water entitlements has also facilitated greater water efficiency. The OECD (1999) notes:

> Interestingly, one of the key consequences of moving toward full-cost recovery pricing was that water reallocation via the trading of entitlements was given a central role as a means to general efficiency gains. Since each State had somewhat different pricing policies before the reforms were launched, the movement towards market pricing also required that some way was found to

> reallocate water to more efficient users – and trading offered the obvious solution. (p.16)

Bjornlund (2003a) observed that initially, water markets were "thin" and prices were erratic, likely significantly influenced by the parties involved and their bargaining strength (Bjornlund & McKay, 1996). Over time, as the market matured in Australia, many irrigators began treating water like any other input in the production of a commodity for profit (Bjornlund, 2003a). The input is bought or sold, depending on commodity prices and the price of water (Bjornlund, 2003a).

Bjornlund's, and Bjornlund's and McKay's numerous studies of water market activity in Australia provide the greatest detail of the characteristics of market activity and its participants. Based on the type of irrigation equipment used along the River Murray in Southern Australia, water moved from sellers using less efficient equipment to buyers who use relatively more efficient equipment (Bjornlund & McKay, 2000a). Also, trade moved water to higher value uses: to viticulture, horticulture and vegetable producers from lower value cropping properties (Bjornlund & McKay, 2000a). Based on the principle of declining marginal value, price is expected to be inversely related to volume bought and sold. Bjornlund's and McKay's studies confirm this principle. They note that sellers receive less per unit of water when selling large volumes compared to small volumes (Bjornlund & McKay, 1998).

Studies within the Goulburn-Murray Irrigation District (GMID) in northern Victoria revealed that in comparing buyers and sellers, sellers had smaller properties and were younger in age than were buyers (Bjornlund, 2002b). There, producers who have never traded water were significantly smaller than those who have traded. One study of irrigators along the River Murray and the Riverland area found water moving out of non-

commercial farming enterprises into commercial farming (Bjornlund & McKay, 1996). These same sellers were parting with marginal, unused portions of their allocation. Non-participants use most of their water every year (Bjornlund, 2003c).

Of the mechanisms that facilitate trade, the National Water Exchange facilitates trade between more distant parties while neighbors prefer private dealings. The National Water Exchange facilitates transfers of relatively small volumes of water while larger traders make their own arrangements or use brokers (Bjornlund, 2003b).

While water markets for temporary trading are very active in Australia, the market for permanent trades is still limited. The GMID study found informal market trades handled about ten times as much water annually as did the formal market (Bjornlund, 2003d). As Bjornlund (2002c) states:

> Temporary markets have grown explosively during the last five to six years, a process which has been significantly enhanced by the emergence of water exchanges in both New South Wales and Victoria (Bjornlund, 2002a). The use of permanent water markets has also grown but at much lower volumes (p. 165).

Bjornlund and McKay (2001a) attribute this result to several factors including uncertainty over water allocation, given the probability of the implementation of an additional CAP, limitations on trade out of irrigation areas, tax implications that favor temporary trade over permanent trade, and erosion of the capital value of the property if water is sold permanently[9]. Concerns regarding the impact that large water movement can have on communities have also been a major factor in slowing this progress (Bjornlund, 2003b).

It is argued, however, that permanent water trades, and the security of water supply that they provide, are necessary for long-term structural adjustment in Australian

[9] For a full discussion of these factors see Bjornlund (2002c).

irrigation (Bjornlund 2003b) Studies have concluded that movement of irrigation off unsuitable soils under inefficient irrigation practices is needed for long-term viability, generating economic as well as environmental benefits (Bjornlund, 2003b; Cullen, Whittington & Fraser, 2000). Evidence from water markets in South Australia and Victoria show that progress in adopting permanent market mechanisms is slow but continuing (Bjornlund & McKay, 1999, 2000a, 2002)

Chile

The underpinnings of water markets in Chile emerged under significant political and economic reform, triggered by the 1973 military coup. Then, a free market system replaced a system dominated by the state, where, prior to the coup, the economy was highly regulated, key prices were fixed, and the state owned all the electrical companies, almost all the urban water services and over 90 percent of the irrigated land (Schleyer, 1992). Following the coup, state-owned farms were distributed to 60,000 peasants and a few thousand former land owners (Shleyer, 1992). When water rights were transferred to private property and the Water Code of 1981 was formalized, a system of transferable water rights not attached to the land was finalized. Water right holders must belong to a users' organization whose function it is to distribute water according to rights; collect fees for administration, rehabilitation and maintenance of infrastructure; and to resolve conflicts among members (Schleyer, 1992). Bauer (1998) characterizes the institutional framework in Chile as one where markets are based on a neoclassical economic approach, backed by a judicial system with minimal state intervention.

A range of opinions as to the relative success or failure of water markets is found in the literature. Bauer (1998) concludes that water right trading has been minimal in most of the country. Schleyer (1992), however, reports that active markets exist in temporary sales of water between neighboring farms, on the same canal, with different water needs. Briscoe, Salas and Pena (1998) have observed that within well-regulated river basins in arid areas of Chile water moves from low to high value uses and prices are responsive to temporary and long-term changes in availability. Between 1973 and 1992 grape cultivation more than doubled and fruit cultivation nearly quadrupled as land shifted out of grain, corn and oilseed, and cattle-raising to the high value, more water intense commodities (Schleyer, 1992). And according to one source, one of the "greatest achievements" has been the ability of cities to buy water without having to buy or expropriate land (Schleyer, 1992, p.76).

Little water market activity exists in part of the country where water is abundant, where high transaction costs exist due to hydraulic regulations, where institutional shortcomings and uncertain property rights exist (Briscoe, 1996). Briscoe (1996, 1997); Briscoe et al., (1998), and Bauer (1998) enumerate many institutional constraints. To begin, water disputes end up in the judicial system which has been characterized as slow, costly and inconsistent in its rulings (Briscoe et al., 1998). This process is alleviated to some extent by user organizations settling some disputes outside court. River basin management in some areas is lacking and in some instances manifests itself in tension and disputes between hydro and irrigation users, based on requirements of non-consumptive and consumptive water users under the Water Code. In some instances water trade to non-agricultural users is restricted or outright prohibited, limiting the scope

of the market. In such situations "the opportunity costs are obviously truncated, with important resulting distortions to the economic signals" (Briscoe, 1996, p.22).

The geography of Chile - many small, steep river basins separated by hills - is not conducive to the easy movement of water. The distribution system tends to be inflexible and costly. If water moves from one canal to another, for example, all gates in both canals have to be altered (Bjornlund & McKay, 2002).

Finally, cultural and psychological influences in the countryside also inhibit water right sales:

> It would be hard to exaggerate the real and symbolic importance of irrigation in this semi-arid country, where it has taken centuries of labor and willpower to bring water to dry lands and transform them into productive fields...(H)istory, combined with the constant threat of drought, reinforces Chilean farmers' ingrained determination to hold onto their water supplies at almost any cost (Bauer, 1998, p. 63).

California

The endowment of water among regions of California is very uneven – 70 percent of the water supply exists in the northern one-third of the state while 70 percent of the water demand occurs in the southern portion (NRC, 1996). This has necessitated large inter-basin transfers (Howitt, 1998). The infrastructure that facilitates this movement is extensive, so that the state can move water from almost any farming region to almost every major city (Haddad, 2000).

Irrigation districts and individual farmers in California have claims to large portion of California's water in the form of renewable long-term contracts for permanent rights (Haddad, 2000). The allocation and administration of water supplies in the western United States are governed by an extensive and complex system of water rights and doctrines (NRC, 1996). It is beyond the scope of this review to describe this system in

detail (see Burton, 1992). However, Haddad (2000) stresses that California's system of water law is more complicated than in most states because it recognizes the rights of both riparian users (owners of land adjacent to waterways) and appropriators (parties that have built conveyance systems from waterways to the place of use). Under either doctrine, the easiest way to transfer water rights is to transfer land rights and include the water rights in the deal; in the case of riparian rights, it is the only way since these rights are considered appurtenant to, or inseparable from, the land (Haddad, 2000).

A three-way competition among urban, agricultural and environmental use of water had been growing since the mid-1980s (NRC, 1996). By 1987 any water surplus from normal rainfall conditions was gone and the six year drought that followed brought the tight supply situation into stark focus (Howitt, 1998), creating what Briscoe describes as "a confluence of 'natural' challenges (scarcity or pollution) and institutional reform-mindedness..." (Briscoe, 1997, p.10). By 1991 it was clear that some form of reallocation was required to minimize the damage to the State's agricultural and urban economies (Howitt, 1998). Urban and rural water agencies, searching for supplies, realized that it would be in all their interests to act as a block of buyers and form a unified strategy. Thus began the formation of the State's Drought Water Banks (Haddad, 2000). These banks have operated in 1991, 1992, 1994 and 1995, and earlier, in 1977. As a buyer of water, the Drought Water Banks, operated by the California Department of Water Resources, served as a monopsony (Haddad, 2000).

A Congressionally imposed warning stressed that no undue benefit or profit should accrue to water sellers through the Water Bank system. The Bank therefore established a price that was "meant to yield to farmers a net income similar to what they

would have earned on the farm plus an incentive to participate in the program" (Haddad, 2000, p. 52). Banks also prioritize buyers and determine what water could be disposed of in the bank. For these reasons the Banks did not represent a normal market, where willing buyers and sellers exchange goods at agreed prices (Bjornlund & McKay, 2002).

Short-term water exchanges, including those facilitated by the Drought Water Banks, are very common in California. There are various levels of activity of this type. Farmers have been active buyers and sellers within their irrigation districts for decades, water districts frequently trade water among themselves, and many urban districts have participated as buyers in the Drought Water Banks (Haddad, 2000; Dosi & Easter, 2000). Dosi and Easter (2000) report that hundreds of thousands of acre-feet of water are transferred annually in California, occurring mostly within the same irrigation district or system and are in effect for less than a year. Temporary transfers are capable of satisfying some urban and industrial water demands, providing an injection of cash into the local farming area but not having long-term detrimental effects on employment (Howe, 1997).

Long-term, permanent transfers in California are rare – about 25 in the last 20 years, mostly in response to urban demand (Dosi & Easter, 2000). This lack of activity is attributed to several factors. Archibald and Renwick, (1998) and Thompson (1997) describe the arduous and tangled web of federal, state and local legal and regulatory requirements (including those that protect vested rights and third parties) under which water transfers must be conducted in California. There are also federal and state laws that limit water transfers outside their borders (Dosi & Easter, 2000). Haddad (2000) underscores how tedious the water transfer process can be, for example: there were three long-term interregional rural-to-urban transfers, all intended to move water towards

California's southern coastal region, all involving water "wholesalers" as buyers and each taking years to negotiate and requiring more than one formal agreement. In no case did water rights actually change hands.

Cummings and Nercissiantz (1992) argue that certain changes have facilitated transfers of water in the state[10]. However, others contend that regulations and laws have prevented water markets in California from developing and future market developments will be limited (Archibald & Renwick,1998; Dosi & Easter, 2000). Political pressure by special interest groups prevent significant improvements in allocating water more efficiently and state laws that govern the allocation of water have proven difficult to modernize (Howe, 1997). These not only inhibit transfers from taking place but substantially raise the transaction costs involved in the process. Transaction costs may be raised to such an extent that only the most economically beneficial transfers occur (Archibald & Renwick, 1998). Thompson (1997) agrees, saying government involvement in water distribution has deterred water transfers in a variety of ways including the role of governmental water organizations, the government's subsidization of water supplies and the public ownership of water transportation facilities.

Another factor that inhibits markets is lack of trust (Thompson, 1997). Thompson observes that California farmers are unwilling to transfer water rights for fear that a court or administrative agency will deem the transfer showed the farmer did not really need the water. Even if legislation provides that water leases will not constitute grounds for forfeiture, Thompson states that fears still remain that some other legal doctrine will

[10] At one time transfers of water beyond the boundaries of an irrigation district were disallowed. Congress has since authorized the delivery of project water to urban areas in the vicinity of irrigation projects. The interpretation of the appurtenance requirement has been relaxed as well, such that the Bureau of

result in loss of water rights. Water users do not trust government's word. Where water markets are not yet well established, potential water sellers, who may reap some profit, often come under "intense public criticism" (Thompson, 1997, p.8).

Bjornlund and McKay (2001b) stress that opposition to water trade in the U.S. has often been based on social or cultural grounds and as a result, water is too important to be evaluated exclusively on economic grounds. Water and society are so intertwined and complex, especially in arid regions of the world, that communities feel threatened by changes to water allocation systems (Brajer & Martin, 1990). Ultimately societal acceptance is a prerequisite for a successful market (Brown, 1997).

Similar to the situation in Australia, Easter et al. (1999) predict that the need for permanent trades and inter-jurisdictional water exchanges is likely to increase – in California because they anticipate nonagricultural demands for water will continue to grow. Formal water markets are likely to become more common in time. Dosi and Easter (2000) also believe that, generally, there will be a trend towards more permanent trades because shifts in demand to urban uses will require a more assured water supply based on long-term commitments and even permanent trades. Many farmers are beginning to find that they can make more money selling water to urban areas than by growing crops (Dosi & Easter, 2000). Institutional arrangements, however, are needed that help clarify water rights and streamline the procedures for determining if there are third-party effects (Dosi & Easter, 2000).

Reclamation is allowing a large number of transfers within irrigation districts as well as among irrigation

3.5 Conclusion

World-wide, irrigation has two critical features in common: it is a massive consumer of water and the mechanisms to manage it are inadequate. Therefore there is a need to consider changes in how water is allocated and utilized. Numerous supply and demand side characteristics however, make irrigation water challenging to manage. The supply side characteristics include the fugitive, bulky and variability nature of the resource, its public good characteristics, the absence of knowledge of its true value, and externalities produced by it. Demand side characteristics relate to the heterogeneous quality of water, the seasonal and annual fluctuations in willingness to pay, consumptive versus non-consumptive uses, and unique social attitudes about water. At the one extreme, governments can administer strict allocation and pricing schemes that adhere to marginal cost principles or, alternatively, government can limit their intervention and allow the market to determine allocation and price. In practice they do neither. An inherent flaw in the marginal cost pricing approach is the impossibility of defining marginal costs and collecting the necessary data to implement it. An inherent flaw in the market-based approach is that issues revolving around the public good characteristics of water, externalities, and equity and social goals are ignored. Water management defies either extreme policy. The result is that there are numerous approaches to irrigation water management with various degrees of government involvement. However, they all share a common problem – under new and persistent demands for water, mechanisms developed in the past are resulting in problems of water shortages in high demand areas. Given the myriad of private and social goals society attempts to attain through water, under demand

districts and municipal/industrial users (Cummings & Nercissiantz, 1992).

and supply pressures, ultimately "a balance between private forces and government regulation to protect third party interest, including environment concerns, must be found" (Bjornlund & McKay, 2002, p.18).

The impetus for change in water management, as the experience in Australia and Chile demonstrates, is captured by Briscoe when he says the possibilities for reform are greatest:

> ..... when there is a confluence of "natural" challenges (scarcity or pollution) and institutional reform-mindedness, as exemplified by Chile in the 1980's and Australia today. The basic point here is simple – creative responses in dealing with water as an economic resource will only happen when there is a problem to be addressed, when that problem is perceived as important, and when there is a political climate conducive to reform (Briscoe, 1997, p.10).

This "confluence" of challenges and existence of reform-mindedness coalesced in Australia, California and Chile in unique ways. The attendant evolution of water markets within these jurisdictions demonstrates how water management policies emerge within the distinct political and institutional framework of the state. Of the three jurisdictions, Australia seems to have had the greatest success, perhaps because Australia has taken more of a regulatory approach than have Chile and the United States. Several components necessary for an effective market are present in Australia. The country has tradable water rights that are separate from the land. Lengthy and costly judicial processes, characteristic of California and Chile, are not common in Australia as such issues are handled via administrative systems. Culture and geography also do not constitute as significant barriers to trade compared to those of Chile. Lack of trust between parties, while evident in California, does not figure predominantly in Australia. Low transaction costs are further maintained in Australia by relatively sophisticated information sharing networks, enhancing the efficiency of the water transfer system. The numbers of water

users are sufficiently large and diverse to provide the scope needed for an active water market.

Few empirical studies of the operation and impact of markets in southwestern United States or Chile exist (Bjornlund & McKay, 2002). There is, however, evidence that in these jurisdictions, as well as Australia, water markets prompt water right holders to sell water to higher value users: in Australia and Chile primarily from lower to higher value commodities and in California from rural to urban use. In Australia, studies have shown water also tends to move from less to more efficient irrigation users. Non-traders of water in Australia tend to be smaller in size than traders and use all the water they have, indicating little excess supply.

Chapter Four

Procedures

4.1 Introduction

This chapter is divided into two sections – procedures for examining the market for temporary trade in water rights are discussed in Section 4.2 and the procedures for evaluating the market for permanent trades in water rights are discussed in Section 4.3. Each section contains the following components. The first, second and third subsections provide the context to the study, the survey procedures, and the analytical procedures used to evaluate each of the markets. Development and discussion of the specific hypotheses are described in subsection four.

4.2 The Informal Market

4.2.1 Context

The SMRID is the largest of 13 irrigation districts in Alberta. In fact, it is the largest irrigation district in Canada. The district comprises three blocks of land in Southern Alberta: a western block in the Lethbridge area; a central block in the Burdett-Bow Island area; and an eastern block in the Medicine Hat area (Figure 4.2.1).

ST. MARY RIVER IRRIGATION DISTRICT

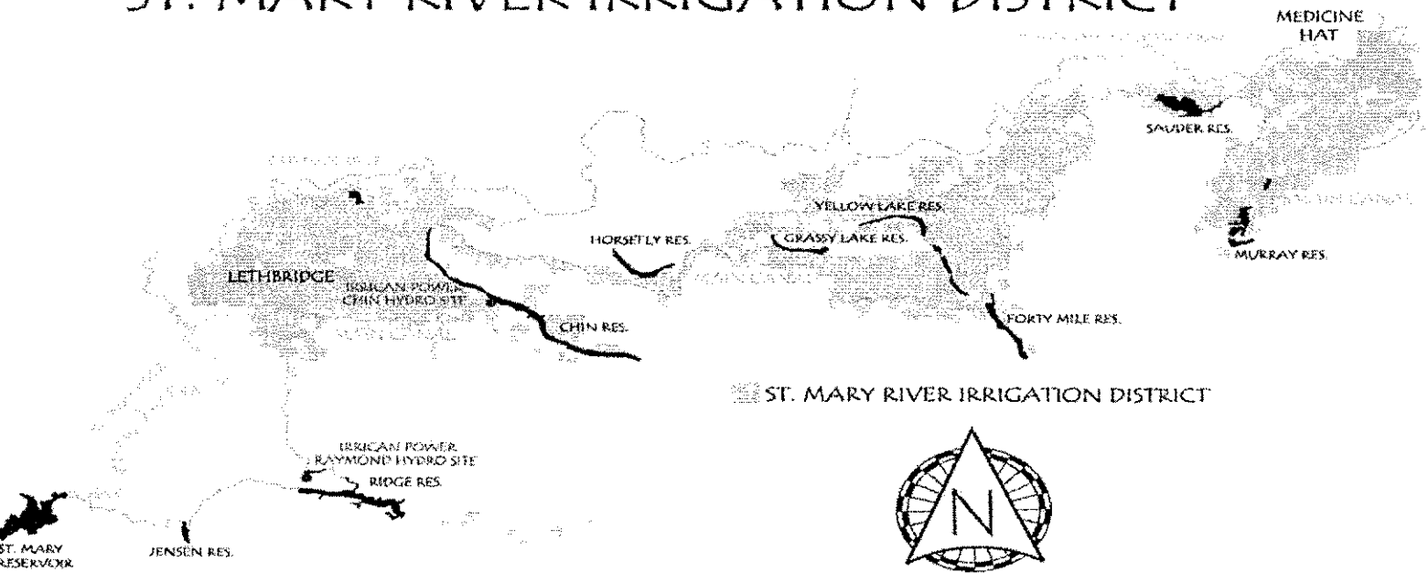


Figure 4.2.1 St. Mary River Irrigation District

Source: http://www.smrid.ab.ca/smrid/smrid.pdf.

Extensive conveyance infrastructure allows water to move anywhere within the SMRID. It distributes water to 1,800 producers on approximately 371,000 acres of land south of the Oldman and South Saskatchewan rivers between Lethbridge and Medicine Hat. Water moves through 1,280 miles of canals and pipeline. The main conveyance system is the SMRID main canal, extending 176 miles with a capacity to carry 3,200 cubic feet of water per second at the start of the system (SMRID, 2004). The SMRID also has five major off-stream storage reservoirs with a capacity of 300,000 acre feet (SMRID, 2004). Aside from irrigation, the SMRID supplies potable water to towns, villages and rural residences as well as industrial water supply for commercial operations within the district (SMRID, 2004).

Producers in the SMRID have always been able to transfer irrigation water allocations among their own parcels of land. It was not until the passage of the Irrigation Districts Act of 2000 that it was possible to transfer water from one producer to another. This legislation provides the means to improve efficiency of water use through market processes.

As one would expect, precipitation levels and irrigation water use are inversely related. Calculations from historic rainfall and irrigation statistics in table 4.2.1 below show that during low precipitation years (where average annual rainfall is below eight inches), total irrigation water use is about 60 percent higher than in high precipitation

years[11]. Irrigation water used per acre in the low precipitation years also has been about 60 percent higher than during high precipitation years - an average of 14.4 acre inches compared to 9.1 acre inches. These data also reveal that the maximum water allocation of 18 acre inches has been reached only in one year since 1993, in 2000 when drought conditions began to materialize and rationing was not implemented. As that data shows, the SMRID has sufficient water to meet its needs in most years and in fact, normally has unused water capacity. Water therefore is not typically a scarce commodity in the SMRID.

[11] The year 2001 is excluded in this calculation since water rationing was in effect that year.

Table 4.2.1

Historic Rainfall and Irrigation Data – St. Mary River Irrigation District, 1993-2003

Year	Total Average Rainfall – May to August (inches)	Assessed Acres	Irrigated Acres	Total Irrigation Water Used (thousand acre-inches)	Average Acre-Inches per Acre Applied
1993	14.3	353,111	262,942	1,230	4.6
1994	6.8	353,483	337,092	4,482	12.4
1995	10.1	356,478	290,432	2,837	7.9
1996	4.4	358,000	339,098	5,098	15.0
1997	6.5	360,659	342,234	5,209	15.2
1998	11.0	361,251	342,758	4,422	13.0
1999	8.4	367,431	355,988	4,219	11.9
2000	3.1	370,393	361,512	6,702	18.5
2001	3.1	370,903	339,666	3,615	10.4
2002	13.8	371,319	342,053	2,091	6.1
2003	4.4	372,316	351,257	3,794	10.8

Note. Rainfall data in column two are from http://www.climate.weatheroffice.ec.gc.ca for weather stations in Lethbridge, Taber and Medicine Hat. Irrigation data in column three, four, five and six are from SMRID Annual Reports: 1993 to 2003.

Signs of an impending water shortage began to appear during the summer of 2000. High temperatures, long growing season and below average precipitation in 2000 followed two consecutive years of continually declining rainfall and very low watershed runoff volumes (AAFRD, 2001a). By early 2001 the storage level at the St. Mary River

Project was less than half its normal level of 500,000 acre feet. The level had fallen to 203,000 acre feet (St. Mary Irrigation District [SMRID], 2001a). In January, 2001, the SMRID administration alerted its irrigators to the supply constraints, saying:

> At this time it is anticipated that there will be a near average snow pack and reasonable precipitation for the 2001 irrigation season. However, there is a possibility of a water shortage in 2001 and the Districts are preparing plans and a rationing system to cope with the situation (SMRID, 2001a, p.1).

As early as April, 2001, SMRID management announced water rationing measures. For SMRID assessment roll acres, allocations initially were reduced from the regular allocation of 18 acre inches to eight. When forecasts showed an improvement in water supply over earlier forecasts, water allocation was increased in June, 2001 to 10 acre inches[12]. During the May to August period the SMRID area received on average 3.1 inches of precipitation, about a third of the average rainfall of the previous ten years of 8.3 inches. This was the first time water had been rationed in 13 years.

When water rationing was announced to producers in the April, 2001 newsletter, irrigators also were informed of the ability to transfer water allocations to other irrigators in the SMRID. The transfer process consisted of the following requirements (SMRID, 2001b):

- the owners of the parcels were required to sign a 2001 Water Allocation Transfer form,
- the transfer form had to be signed at a SMRID office,
- a copy of the agreement would be given to the water supervisor(s)
- transfers could be undertaken any time during the irrigation season

[12] Irrigation districts can hold more than one water license and have expanded irrigated acreage under additional water licenses. For purposes of rationing in 2001 all irrigators were allocated water on an equal basis so no individual irrigator was completely cut off of water that year.

- under special circumstances, water allocation transfers could occur among users in the SMRID, the Raymond Irrigation District (RID) and the Taber Irrigation District (TID).
- there were no transfer fees

Major objectives of this research are to determine the extent of water market activity in southern Alberta during the 2001 drought, the extent to which the characteristics of the market conform to economic principles and characteristics of markets elsewhere and identify improvements that can be made to the system. To meet these objectives, irrigators within the SMRID were surveyed to gauge the extent of market activity and their experiences with the transfer process. Findings from previous research (see Chapter 3) were used as the bases to formulate a series of hypotheses. Results from the survey could then be assessed to determine if markets function in a similar fashion.

4.2.2 Survey Procedures

The SMRID was chosen for the survey because preliminary discussions with irrigation officials indicated that the SMRID experienced more market activity then did other irrigation districts. The SMRID is also the largest irrigation district in Alberta and has a significant amount of diversity of crop production.

Survey methodology was taken from two sources: Mail and Telephone Surveys, The Total Design Method (Dillman, 1978) and Marketing Research (Aaker & Day, 1983). Several measures were taken to maximize the number of returns. First, the

questionnaires were kept short – one page, double sided. Second, the questionnaire preparation included several stages of drafting, review, and pre-testing. Third, the questionnaires were distributed at a time of year when most producers were not in the field or undertaking preparations for field operations (late November to early December). Fourth, the covering letter was written by the general manager of SMRID, and stressed the importance of water-related research at the University of Lethbridge and potential improvements to the water transfer system that could be identified through the study. Fifth, a reminder post card, sent two weeks after the original survey, prompted the return of additional questionnaires.

The University of Lethbridge requires all studies involving human subjects be approved under the Human Subject Research Approval policy. This approval is required to "ensure that ethical principles and standards respecting the personal welfare and rights of subjects have been recognized and accommodated" (University of Lethbridge, 2003, p. 1). Approval to conduct the SMRID survey was granted on November 3, 2003.

Survey questions were of three different types. A group of questions was designed to yield basic information about water market activity – quantity of water bought and sold, month of transfer and price, for instance. A second group of open-ended and subjective questions sought to gain an appreciation of the types of attitudes people hold about water transfers. These questions asked, for example, people's views on the potential benefits of water transfers. The third category of questions was designed to provide information about the respondents themselves including such factors as age, education, and years of farming.

Discussions with officials from SMRID revealed that 222 water transactions were registered in 2001. Some of those farmers bought and sold water more than once and some participated as both buyers and sellers. Others had subsequently sold their property. As a result of these factors, 151 unique buyers and 114 unique sellers of water were identified. Questionnaires were sent to all of these buyers and sellers. Approximately 1,500 producers in SMRID did not engage in water market activity in 2001. Of those, half, or 750 irrigators, were surveyed using a systematic random sampling technique. Every second irrigator from an alphabetic list of irrigators was chosen and sent a questionnaire. This resulted in questionnaires being sent to 1,015 irrigation farmers in the SMRID on November 28, 2003, with separate questionnaires sent to buyers, sellers, and non-participants. On December 12, 2003 a reminder notice was sent to all producers who had received a questionnaire.

The questionnaires for sellers, buyers and non-participants are found in Appendix A, Appendix B, and Appendix C, respectively. The covering letter is found in Appendix D.

4.2.3 Analytical Procedures

The three categories of survey questions required three types of analysis. With respect to the group of questions designed to yield information on water market activity, descriptive analysis, using averages and percentages, was used to analyze these results. Data were transferred from the questionnaire to an Excel spreadsheet and subsequent functions involving price calculations (the average, standard deviation and mean) and consolidation of data into categories, were performed using that program.

The second group of questions was open-ended and subjective and the emergent coding technique of content analysis was used (Neuendorf, 2002). As the responses were from southern Albertans and were unique, no pre-existing useful standard classification or coding scheme existed, hence a new one was created. Using Neuendorf's (2002) emergent coding technique, individual responses were read and condensed into groups with common ideas, allowing for ease of understandability and an ability to identify main themes.

Information from the third category of questions, providing data on the characteristics of the respondents, was combined with the first and second categories to allow for cross-sectional analysis of the data. To undertake this stage of the analysis, data from the Excel spread sheet were converted to the Statistical Product and Service Solutions (SPSS). Age, education level, years of farming, irrigated acreage, and volumes of water bought or sold were used in cross tabulations as potential explanatory variables when assessing various responses.

4.2.4 Hypotheses

The efficiency of irrigation water markets tends to be judged on the basis of the degree of market activity and the productivity increases arising from water moving to higher value uses. Experience gained through water markets elsewhere in the world - Australia, California, Chile, for example, tells us that informal markets have been relatively easy to create, due to low implementation costs, compared to transactions in the formal market. Temporary markets have succeeded in moving water to higher valued uses. Transactions costs are low and legal challenges are rare. Due to the temporary

nature of these trades, cultural and economic consequences tend to be less of an issue, compared to formal trades.

Haddad (2000), Brehm and Quiroz (1995), and Easter et al. (1999) found that the area over which temporary water sales are made usually is limited in scope, and occurs mostly among producers within the same irrigation district and often among those served by the same canal. The main features of the early stages of water markets are that they tend to be "thin" and water prices erratic (Bjornlund, 2003e). Based on the principle of declining marginal returns, studies predict that water prices per unit will decline with the size of the transfer (Bjornlund and McKay, 1998).

In the early stages of market development, limited experience and information exchange on water prices means that knowledge of the water market and what water is worth is scant. One might expect, for example, that knowledge of the water market is negatively correlated with age, but positively correlated with education, farm size and quantity of water transferred. One might also expect that water market activity will intensify as water shortages increase.

The ease with which buyers and sellers locate each other, negotiate price and quantity, and implement trades affects the extent of transaction costs. Easter et al. (1999) found that enforcement generally is based on reputation and personal trust, not legal means. Water tends to move from low to high value uses (Bjornlund & McKay, 1998, 2001b). Legal and cultural barriers do not significantly constrain informal water market activity to the same degree as with formal water market activity (Bjornlund, 2003b). Studies by Bjornlund and McKay (1998) and Bjornlund (2002b) show that efficiency gains can be realized through water transferred from sellers using relatively inefficient

irrigation equipment to buyers who have more modern and efficient irrigation equipment. Conservation efforts thereby can be enhanced through this process.

More in-depth studies of buyers and sellers, mainly from the Australian water market, reveal that buyer's main reason for buying water has been to manage drought (Bjornlund, 2003e). Seller's main reason for selling water has been due to excess supply and the income opportunity available to them (Bjornlund & McKay, 2000a, 1996). Sellers tend to have smaller irrigated acreage relative to buyers and sellers are younger than buyers (Bjornlund, 2002b). Non-participants use most of their water every year (Bjornlund, 2003c).

Based on the findings from previous studies, the following series of hypotheses were developed. This part of the study focuses specifically on the temporary sale of water rights, or the informal market[13]. For this reason, all hypotheses are coded with an 'I' as an abbreviation for informal market.

Hypothesis I-1:
Water sales were limited in scope, usually among producers within the same irrigation district and often served by the same canal.

Haddad (2000) and Dosi and Easter (2000) observed significant quantities of water sales in California occurred between farmers within the same irrigation district or system and were in effect for less than a year. In Chile temporary transfers took place

[13] The hypotheses are established using a univariate approach, i.e. looking at the relationship between pairs of variables without controlling for other influential variables. A more comprehensive analysis would undertake a multivariate approach to include the impact of additional factors. Data limitations restrict taking this latter approach. Caution needs to be exercised when using these results for policy purposes.

mainly between farmers on the same canal (Brehm & Quiroz, 1995). In Australia trades occurred almost entirely between competing agricultural users (Bjornlund, 2003d). Data from this study will be used to determine if the same tendencies occurred in the SMRID in 2001.

Hypothesis I-2:

In 2001, the informal market was "thin" and water prices were erratic.

Bjornlund's study (2003e) of the Goulburn-Murray Irrigation District [GMID] in northern Victoria (Australia's largest irrigation district) show the market started out with low volumes during the first seven years: from 25,000 mega litres[14] per year since 1991, rising to 200,000 mega litres per year since 1997/1998. A study of the Lower Murray and Riverland region in the early stages of market development also confirmed similar slow market activity (Bjornlund & McKay, 1998). A study along the River Murray in Southern Australia from 1987 to 1996 found trade steadily increased in volume and price (Bjornlund, 2002a). Brown, McDonald, Tysseling and Dumars (as cited in Bjornlund, 2002a) found in the Western United States that the more advanced and competent the market, the higher the volume traded and the higher the prices.

The study of the Lower Murray and Riverland region in Australia found price determination influenced by the market being in the early stages of development and farming communities just becoming accustomed to the "possibilities that it generates" (Bjornlund & McKay, 1998, p. 1567). Bjornlund & McKay (1998) reported at the time of

[14] This represents one million litres.

the study the market was "relatively thin", which led to some dispersion in market prices (p.1569). Over time, trade along the River Murray in South Australia steadily increased and price dispersion decreased in percentage terms (Bjornlund & McKay, 2002).

Survey findings will be used to confirm whether water markets in the SMRID in 2001 were thin and exhibited erratic price behavior.

Hypothesis I-3:

Water price per unit declined with the size of the transfer in the SMRID in 2001.

Based on declining marginal value, some analysts (Bjornlund & McKay, 1998) expect that prices paid by buyers will be inversely related to volume bought. Sellers therefore should receive less per unit of water when selling large volumes, compared to small. In their study of the Lower Murray and Riverland region of Australia, Bjornlund & McKay (1998) found evidence to support this hypothesis:

> Both buyers' and sellers' models indicate that the price per unit of water is reduced with the size of the transfer, indicating declining marginal value of water. The functional form in the buyers' model shows that buyers of small quantities of water pay a premium...These small quantities of water are therefore likely to generate a very high marginal profit per unit of water applied. The functional form in the sellers' model shows that the sales price declines with the size of the transfer in a linear form (p. 1569).

Data from the survey will be used to determine whether water prices are inversely related to volume bought in the SMRID in 2001 – the lower the volume, the higher the price and the larger the volume, the lower the price.

Hypothesis I-4:

Knowledge of the water market in the SMRID in 2001 and what water was worth was limited.

Bjornlund & McKay (1998), in their study of the Lower Murray and Riverland region in Australia, found that price was influenced by the market being in early stages of development. Information regarding supply and demand seemed to be limited and farmers seemed uncertain about the value of water. Findings from the survey will be used to determine the knowledge of the water market including the relative value of water in the early stages of market development within the SMRID.

Hypothesis I-5:

Knowledge of the water market is positively correlated with education, farming experience and quantity of water transferred and negatively correlated with age.

Evidence of the importance of these factors from studies of markets elsewhere is not available. Since water markets are a new and relatively innovative concept in Alberta, it is expected that knowledge may be greater for more formally educated producers, those who have larger operations, and those who exchanged larger volumes of water. It is also expected that younger producers, perhaps more open to new concepts, would have more knowledge of the water market. This hypothesis will be tested against data obtained through the SMRID survey. (Respondents were asked to rate their knowledge of the water market, thus it is recognized that the results relate to respondent's own perception of their knowledge).

Hypothesis I-6:

Water market activity intensified as the water shortage increased.

Based on economic principles, one would expect water market activity to increase as supply constraints increase. Bjornlund's recent study (2003e) of the Goulburn-Murray Irrigation District in northern Victoria, Australia, found that the lower the seasonal allocation, the larger the proportion of total water used was obtained from the market.

Precipitation in the SMRID in 2001 averaged only 3.1 inches over the main growing season from May to August, as shown in table 4.2.1. More detailed month-by-month rainfall data show how this rainfall was dispersed over several months. Averaging the rainfall from weather station data from the Lethbridge, Taber and Medicine Hat area shows that less than half an inch fell in May. That was followed by 1.7 inches, on average, in June, one inch in July, and no precipitation, on average, in August. Data from the SMRID survey will be used to determine whether water market activity increased as water constraints intensified over the course of the summer.

Hypothesis I-7:

Simple information systems and limited bureaucratic procedures characterized the informal water market for water in the SMRID in 2001.

Along the River Murray in South Australia, for both sellers and buyers the most common method of getting information was through newspapers or friends and family. The buyers obtained their information from alternate sources more often than did the sellers (Bjornlund & McKay, 2001b).

In Bjornlund's and McKay's study (2001b), they discovered that first-time buyers and sellers within the GMID did not find the transfer process to be problematic. Fifty-five percent of buyers and 75 percent of sellers found it easy or very easy. In the Murray Region of New South Wales, 44 percent of buyers and 59 percent of sellers found the process easy or very easy (Bjornlund & McKay, 2001b). Irrigator's perception of the administrative process for temporary trade within New South Wales and Victoria became more and more favorable over time as irrigators grew more accustomed to the process (Bjornlund & McKay, 2001b).

Data from the SMRID survey will help determine the information sources most commonly used by market participants, and whether participants found the informal water transfer process easy.

Hypothesis I-8:

Enforcement of contracts in the SMRID was based on reputation and personal trust, not legal means.

This hypothesis is based on the characteristics of the informal market as described by Easter et al. (1999): sales tend to be among farmers in the same water district, among people who know each other and enforcement is based on reputation and trust. This hypothesis will be tested against the data from the SMRID survey.

Hypothesis I-9:

Water moved from low to high value uses in the informal market in the SMRID in 2001.

Studies of water trades within the Murray-Darling Basin of Australia showed water moving to higher value uses - approximately 64 percent going to vineyards, 7 percent to horticulture production and 21 percent to vegetable production. On the selling side, 21 percent of water sold was unused and 47 percent was for pasture or broad acre crops (Bjornlund & McKay, 2001b). The Lower Murray and Riverland study showed water moving into horticulture, viticulture, and vegetable production (over 90 percent of water purchased) whereas 73 percent of sales involved water moving out of pasture, broad acre farming and non-farming uses (Bjornlund & McKay, 1998).

Although the types of crops grown in southern Alberta are much different than those in Australia, irrigation allows producers within the SMRID to grow a variety of crops. Some crops, such as potatoes and sugar beets, require more water than do other crops, such as feed barley and canola. Also, some crops, such as processing potatoes and sugar beets, are much higher in value than others. Table 4.2.2 demonstrates these unique crop features by showing optimal water allocation by crop as well as gross returns per acre for some select crops. The variability in crop water requirements and crop values provide the rationale for water reallocation and water transfers. Data from the SMRID survey will be used to ascertain whether water moved from low to higher values uses in 2001.

Table 4.2.2

Optimal Water Allocation and Gross Return by Crop

Crop	Optimal Water Allocation (inches)	Yield Per Acre	Expected Price per Unit ($)	Gross Return per Acre ($)
Feed Barley	16.3	82 bushel	2.61	214.02
Canola	17.5	35 bushel	5.91	206.85
Spring Wheat	19.2	62 bushel	4.65	288.30
Sugar Beets	21.2	24 tonne	32.25	774.00
Processing Potatoes	22.8	13.04 tonne	130.00	1,695.20

Note. Data in column two are optimal average amounts of water that would be required by these specific crops from 1925 to 1995 (Irrigation Branch, AAFRD). Data in columns three and four are for irrigated land for the year 2000 from publication AAFRD (2001b). Column five provides gross returns per acre, an indicator of the relative value of each of the major crops. The value of the marginal product of water would be the ideal measure of return to water applications; however these data are not available.

Hypothesis I-10:

Culture and attitudes did not significantly affect temporary market activities in the SMRID in 2001.

Culture and attitudes can impede informal water markets. In a workshop conduced by Bjornlund (2002c) in Tatura, Australia, participants argued that, traditionally, irrigators do not see themselves as water traders but as farmers and will therefore consider the value of water in terms of how it aids crop production. It would be "against their culture and tradition" to sell the water to gain an income rather than grow a crop (Bjornlund, 2002c, p.8).

Irrigators, however, seem to view temporary sales as less threatening then permanent sales of water (Bjornlund, 2003b). Experience in establishing water trades in New South Wales underscored community concerns regarding the impact on local communities when large volumes of water were traded away (Bjornlund, 2003b). This resulted in initial sales of water on a strictly annual or temporary basis. The same community concerns prevented the early introduction of trade in permanent water rights in Victoria (Bjornlund, 2003b). Permanent trading of water rights was introduced only after the necessary regulations were put into place. Bjornlund stated that research in Australia and the U.S. clearly show that irrigation communities are suspicious of permanent water transfer activity (Bjornlund, 2003b).

In the SMRID most producers tend to have a common farming heritage and face similar opportunities and constraints. Whether or not they share common attitudes that can impede the informal market in the SMRID in 2001 will be determined through an analysis of the survey findings.

Hypothesis I-11:

Water was transferred from sellers who used relatively inefficient irrigation equipment to buyers who used relatively more efficient systems.

The Lower Murray and Riverland study by Bjornlund and McKay (1998) demonstrated that water moved from producers with the least efficient irrigation technology to producers with more efficient irrigation technology. Eighty-three percent of water sold moved out of furrow irrigation and overhead sprinklers and into more efficient technology – 71 percent moved into microjet, drip irrigation, under canopy, and

centre pivot (Bjornlund & McKay, 1998). The most efficient irrigators in this study represented a large proportion of all transactions but a much smaller proportion of water transferred (Bjornlund & McKay, 1998).

An additional study of the characteristics of buyers and sellers in the Torrumbarry Irrigation Districts and the Pyramid-Boort Irrigation Districts showed buyers had more efficient irrigation and drainage infrastructure and sellers had less efficient irrigation and drainage infrastructure (Bjornlund, 2002b).

Producers within the SMRID used a variety of irrigation equipment ranging from low-efficiency surface systems to high-efficiency pivots. Table 4.2.3 below demonstrates how efficiency is enhanced through irrigation equipment types.

Table 4.2.3

On-Farm Application Efficiency[15] of Different Types of Irrigation Equipment in Southern Alberta, 1999 (%)

Irrigation System	Application Efficiency
Surface – Undeveloped	30
Hand Move	65
Lateral Wheel (4)	70
Pivot – High Pressure	74
Pivot – Low Pressure	80

Note. Data in column two are taken from AIPA (2002, p. 101)

[15] Efficiency in delivering water to the soil root zone.

The results of the SMRID survey will help determine whether the findings reported by Bjornlund and McKay (1998) and Bjornlund (2002b) were similar to what happened in southern Alberta in 2001.

Hypothesis I-12:

The main reason for buying water in the informal market in 2001 was to manage the drought.

Within the GMID in Australia, a survey of buyers found that 82 percent indicated the main reason for temporary water purchases was the lack of availability of water (Bjornlund, 2003e). This factor was reflected in water market activity: when allocations were relatively high, trade accounted for around 5 percent of total water use but, during five years of drought, trading increased to 18.2 percent of total water use (Bjornlund, 2003d). Other interesting but less important factors emerged from the GMID survey. Twenty six percent of buyers quoted good commodity prices and 16 percent said a one-off opportunity to sell more of a certain crop were important reasons to buy (Bjornlund, 2003d).

As table 4.2.1 showed, in 2001 average rainfall over the course of the summer was 3.1 inches, about one-third the average of 8.3 inches received in the previous ten years. During 2001, all the irrigation water allocated (ten acre inches) was, on average[16], used. This likely produced a tight water supply situation for some high water use crop

[16] Total irrigation water used divided by total irrigated acreage.

producers, such as potato producers (as table 4.2.2 demonstrates), prompting water market activity. The hypothesis that buyers purchased water to manage the drought will be tested against the data obtained from the SMRID survey.

Hypothesis I-13:
The main reasons for selling water in the SMRID in 2001 were the existence of surplus water and an opportunity to increase income.

In the GMID study, which focused on the 1992 to 1996 period, 60 percent of water sold was unused by the sellers (Bjornlund & McKay, 2000a). Bjornlund and McKay, (1996) found in their study of sellers in the Lower Murray and Riverland regions that 49 percent of respondents stated the need for money was the most important reason to sell.

As table 4.2.2 demonstrates, different crops grown in southern Alberta require different quantities of water for optimal growth. Some producers may have found they had excess water and some producers would have experienced a water shortage. This may have produced a situation for sellers where excess water could be sold, providing an income opportunity not normally available to them. The hypothesis that the main reasons for selling water in the SMRID in 2001 were the existence of surplus water and an opportunity to earn more income will be tested against the survey data.

Hypothesis I-14:

Sellers of water in the SMRID in 2001 had smaller irrigated acreage than buyers.

Bjornlund discovered in his study of the Torrumbarry Irrigation Districts and the Pyramid-Boort Irrigation Districts that buyers had large commercial properties while sellers had smaller properties and a large component of 'life-style' properties (Bjornlund, 2002b). Another study of the transfers along the Murray River and the Riverland area found water moved out of non-commercial farming into commercial farming (Bjornlund & McKay, 1996).

One could speculate that in the SMRID in 2001, sellers had relatively small irrigated acreage and may have been lifestyle farmers. The buyers may have constituted producers with relatively larger irrigated acreage. This hypothesis will be examined using the date from the SMRID survey.

Hypothesis I-15:

Sellers of water in the SMRID in 2001 were younger than were buyers.

Bjornlund's study of the Torrumbarry Irrigation Districts and the Pyramid-Boort Irrigation Districts revealed sellers were younger than buyers (Bjornlund, 2002b). It is hypothesized that the same phenomenon would be exhibited in southern Alberta.

Hypothesis I-16:

Those who did not participate in the water market in 2001 use most of their water every year.

Bjornlund recently found in his study of the GMID in Australia that non-participants used most of their water every year, indicating that there is limited excess water among the producers who never traded (Bjornlund, 2003c). This phenomenon will be examined using the data obtained from the survey of 2001 water trading activity within the SMRID.

4.3 The Formal Market

4.3.1 Context

Sections 81 and 82 of the Water Act (1999) provide the legal basis to transfer water licenses on a permanent basis. These sections establish the conditions under which a transfer will be approved and provide the basis for many of the procedures required in the process. The authority to approve transfers lies with the Director[17]. An application for a transfer of an allocation of water must first be made to the Director. Under his/her authority, the license considered for sale must be deemed in good standing. As the Act states, this means the license has not expired, is not under suspension, considered for cancellation, or subject to an investigation. The license cannot be a temporary diversion

[17] The use of the term "Director" implies a person that is designated as a "Director" for purposes of the Act. There is flexibility in permitting more than one decision-maker for various provisions of the Act (E. Hui, personal communications, February 15, 2005). For purposes of water transfers, the Director is an individual designated to approve water diversion projects and licenses under the Water Act. These designated individuals are District Approval Managers. There are three regional managers and six district managers in the province. (S. Yeung, personal communications, January 5, 2005).

of water or the result of a previous transfer where the allocation was to revert back to the original owner.

The permanent transfer of a water license has to be permissible under an approved water management plan. For transfers within the South Saskatchewan River Basin, this refers to *The South Saskatchewan Water Allocation* (AENV, 2003b) document and the *South Saskatchewan River Basin Water Management Plan (Phase One- Water Allocation Transfers)* (AENV, 2002a). The overarching purpose of the management plan is to "resolve water management issues such as the availability of water for future allocations and river flows needed for protection of the aquatic environment" (AENV, 2002a, p. i). The management plan, which focuses specifically with the water allocation transfer process, provides the Director "with guidance on factors that must be considered in making certain decisions" (AENV, 2002a, p.1). The list consists of twelve factors, among them the potential and cumulative effects on the aquatic environment, household users, traditional agriculture users[18] and other higher and lower priority licensees; the effect on operations of reservoirs and other water infrastructure; the suitability of land for irrigation; linkages between surface and ground water; and effects on the *Master Agreement on Apportionment* (AENV, 2002a, p. i, ii). Provisions for the consideration of environmental effects are specifically addressed in the Water Act. If the Director is of the opinion that withholding water is required to protect the aquatic environment, he/she may withhold up to ten percent of the allocation[19].

[18] The Water Act (1999) defines a traditional agricultural user is a person who owned or occupied farm land on January 1, 1999.

[19] Alberta Environment admits that this holdback provision plus any license cancellations will not produce significant environmental benefits (AENV, 2003b).

The Water Act also provides for the cancellation, and reduction in size, of licenses. These provisions, under Sections 54 and 55 of the Act, provide for cancellation of a license if the license has not been used for a period of three years and if there is no reasonable prospect of the license being used. The Act also provides for a reduction in the size of a license by any unused portions. Since 1894, 1.5 million acre-feet of license has been cancelled in the province, mainly in the southern area (D. McGee, personal communication, December 8, 2004).

Transfer application and approval procedures are outlined in the *Administrative Guideline for Transferring Water Allocations* (AENV, 2003a). The approval process can be divided into three stages. Stage one involves the preparation of an application form and the preparation and submission of required documents. These include:

1. Submission of the "Application Under The Water Act For Transfer of an Allocation of Water Under a License". This form requires information on the name and address of the buyer and seller, quantity of water to be transferred, whether the transfer is permanent or temporary, the point of diversion, water source, quantity to be transferred, new rate of diversion and purpose of use, whether the license is in good standing and whether the transfer has been authorized by an approved water management plan.
2. A recent certificate of title for all parcels of land involved in the transfer.
3. Written consent from the landowner if the transferee is not the owner of the new land.
4. Written consent from the landowner if the existing license is in a different name.
5. A copy of the license from which the transfer is being made.

6. A plan showing the layout of the new works, including: point of diversion, point of use, a detailed description of the works and water requirement, and an irrigation feasibility report if irrigation water use is involved.

Stage two includes the public review process, which can vary depending on the transfer. The administrative guidelines state: "(t)he Director determines the form and manner of review with consideration of the scope of impacts and issues within the proposed transfer" (AENV, 2003a, p. 8). At the minimum, this process requires the parties to place a notice in the local and in some cases, regional newspaper(s). This may be sufficient for less extensive transfers. The guidelines state: "an open house may not be required ...(for) small projects involving moving a short distance on the same stream without a change in ownership or purpose or diversion timing" (AENV, 2003a, p.16). Where the scope of impact and issues are deemed more extensive, the Director may require an open house to be held where discussions about the impact of the water license transfer can take place. The costs of stage one and two are the responsibility of the buyer and seller. The third stage, Alberta Environment's assessment and review, is usually carried out at the same time as the public review and public notice process and is paid for by the provincial government.

Material submitted to Alberta Environment to support a water license transfer is considered in the public domain and can be viewed by the public. If the license is in good standing and is within an area managed under an approved water management plan, the application will be reviewed by Alberta Environment. If the license transfer is approved, the buyer is subject to a one-time license fee which is based on transfer volumes. The

license retains the priority date originally assigned to it. Decisions made on transfer applications can be appealed before the Environmental Appeal Board.

4.3.2 Survey Procedures

As of October, 2004, there were 20 applications filed with Alberta Environment for permanent water license transfers[20]. The list of water right transfer applications, and facts about each of the cases, was obtained from records held at the Alberta Environment office in Lethbridge. Only six of 20 applications can be described as market transactions, i.e. involving transfers between separate parties for money. Of the 14 non-market transfers, eight involve changing the point of diversion, two involve adding or changing the points of diversion and four involve changes to the transfer system. These are not market transfers in nature but require Alberta Environment's approval because all have potential third-party effects. Three of the six applications involving market transactions had been approved by October, 2004. The remaining three were at various stages in the approval process.

Approval to conduct interviews with buyers and sellers was obtained under the Human Subject Research policy at the University of Lethbridge on October 6, 2004. Approval to conduct interviews with the participants was obtained through personal telephone conversations and their signature on a consent form. Personal visits to the site of each buyer and seller were made during the month of October, 2004.

[20] Transfer applications by two municipalities were processed jointly and are treated as one.

4.3.3 Analytical Procedures

As noted above, very limited activity has taken place to date in the formal market where permanent water rights can be traded. With such few transactions to work with, statistical procedures are inappropriate. Instead, a case study approach was used. Since one of the purposes of this study is to provide advice to provincial policy makers and law makers and administrators, the overarching case study methodology is a "responsive evaluation" approach that:

> ...seeks expressly to uncover and then address the concerns of program stakeholders in the setting being evaluated toward the improvement of practice in that setting. From this responsive perspective, program improvement is more likely if local rather than remote concerns are addressed in the evaluation and if local rather than remote values are explicated and used to make program judgments (Fontana & Frey, 1998, p. 388).

Stake (1994) notes "(w)ith much qualitative work, case study research shares an intense interest in personal views and circumstances" (p. 245), and is characterized by the use of open-ended interviews, on-site observations, participant observations and document review (Fontana & Frey, 1998).

The first step in this part of the study was to develop a series of hypothesis from knowledge gained from formal water markets elsewhere. The case study findings were then compared to the expectations embodied in the hypotheses. This approach is described by Huberman and Miles (1994): "(w)hen a theme, hypothesis, or pattern is identified inductively, the researcher then moves into a verification mode, trying to confirm or qualify the findings" (p. 431).

As there is some general familiarity with the cases, based on interviews with government officials and administrators, and review of government documents, the study design was "tight" and more deductive. Huberman and Miles (1994) state: "(t)ighter designs are indicated when the researcher has good prior acquaintance with the setting, has a good bank of applicable, well-delineated concepts, and takes a more explanatory and/or confirmatory stance involving multiple, comparable cases" (p. 431).

Since more than one case is studied here, a "collective case study" approach, as described by Stake (1994) was utilized. Cases were examined to provide "insight into an issue or refinement of theory" (p. 237). The cases were looked at in depth, scrutinized and detailed but the cases themselves were of secondary interest in that their purpose is to advance our understanding of something else (Stake, 1994). The issues chosen were based on what can be learned through the opportunities the case studies offer, allowing the cases to tell their own story (Stake, 1994).

Based on these objectives, the interview technique chosen was the semi-standardized interview design, developed by Berg (1995). This design falls between Berg's standard interview structure, where formally structured questions are used, and the un-standardized structure, where the interview is completely unstructured. In this study the hypotheses under examination required the use of a number of predetermined questions and topics, with a fairly well-established notion of what one expects to discover. However, participants were provided latitude to digress as the interviewer probed beyond standardized answers and allowed the interview process to unfold (Berg, 1995).

Data gathering consisted of on-site interviews; follow-up telephone calls to clarify, or seek additional, information; government document reviews; and interviews with government officials and administrators. As noted by Morse (1998) and Huberman and Miles (1994) data analysis begins as soon as the data collection process commences and continues through the data collection process and beyond. This joint process of data collection and analysis guides the data collection process, avoiding the collection of unnecessary data (Morse, 1998). Researchers, therefore, need to continually review notes, summarize material, note patterns and themes, group concepts and detect connections (Huberman & Miles, 1994).

Huberman and Miles (1994) advise that as the study continues, the researcher needs to condense the data, summarizing the salient information about the case studies, in order to think about the meaning. Morse (1998) notes, as the study progresses, theoretical insights and linkages between categories increase as ones' understanding of the findings become clearer and more obvious. The conceptual framework and hypotheses remain in the forefront:

> As the analysis continues, the researcher can identify relationships that connect portions of the description with the explanations offered in the working models. The researcher attempts to determine the significance of the various elements in the working models and to verify these by checking through field notes, interview transcripts and documents (Guba & Lincoln, 1994, p. 214).

Drawing conclusions involves extracting meaning from the data, using a range of techniques: comparison and contrasts between cases, noting patterns and themes that emerge and looking for negative cases (Huberman & Miles, 1994). These techniques are utilized in this study. Gherardi and Turner describe this stage as "data transformation"

where data are collapsed, clustered, sorted and linked over time (as cited in Huberman & Miles, 1994).

4.3.4 Hypotheses

Although knowledge of the formal water market is limited, some characteristics of this type of market have emerged. Easter et al. (1999) state that formal markets will occur where water is moving over long distances, as between districts; between unique users, as between agricultural and urban users; and where legal water rights are developed that can be verified and defended in court. Governments exercise some degree of regulatory control in managing the process and, in so doing, work to ensure transfers do not impose negative externalities on other users.

Early formal markets tend to have some of the same characteristics as do early informal markets. Bjornlund (2002a) found formal markets to be thin and price dispersion high. Although activity tends to be limited, water appears to move to higher value uses. Generally, formal water market activity in Chile and California has involved movement of water from rural to urban use and, in Australia, from low value to high value crop and dairy production.

The ability to transfer permanent water entitlements facilitates long-term economic adjustment. As Bjornlund (2003d) states:

> The net effect of such reallocation is structural change within the irrigation community, and an increase in the volume of output, as well as the gross margin per unit of water used. Such development will increase employment and economic activity with the communities and improve their social and economic prospects (p. 6).

Where water is traded between agricultural users, water tends to move from less water efficient irrigation systems to more water efficient irrigation systems (Bjornlund, 2003d). In Australia, it was also found that where soil quality is a problem, formal water markets are seen as a means to reallocate water to more productive soils (Bjornlund, 2003d).

It is expected that because permanent water rights often are traded over long distances, systems that facilitate the flow of information on supply, demand and price, facilitate trade and reduce transaction costs.

Where demand for water is high and expected to increase, formal water markets may be viewed as an instrument allowing for greater security of water supply, especially for urban, industrial and environmental purposes.

Transaction costs affect price of the transferred water (Saliba & Bush, 1987). In the formal water market, it has been argued that on a per unit basis, price will be higher the larger the transfer volume (Howe, Weber & Lazo, 1990). The reasoning is that larger transfers reduce transaction costs since they eliminate the need for a number of separate transactions. Since many transaction costs are not dependent on volume, transaction costs also are spread over a larger number of units (Howe et al., 1990). These two factors should increase the buyers' willingness to pay higher prices for larger volumes (Bjornlund, 2002a)[21]. In the opinion of the market participants themselves, transaction costs for permanent transfers often are viewed as too high.

The actual amount of transaction cost will be estimated and compared to estimates noted in Chapter three. For the purposes of this analysis, the framework adopted for

[21] Bjornlund notes buyer's and seller's bargaining strength also determines price but this factor is not considered in this study.

evaluating transaction cost is the one developed by Archibald and Renwick (1998). They aggregate transaction costs into two broad categories: administratively-inducted transaction costs (AICs) and policy-induced transaction costs (PICs). The AICs are relatively limited and include: the cost of searching for trading partners and negotiating the terms of exchange and other contract provisions. These costs are common whenever any property transfer occurs (Archibald & Renwick, 1998). PICs are more extensive, and include the costs involved in obtaining approval for the transfer: the costs of identifying any legal and hydrological characteristics of the water-use right, complying with laws and other institutional requirements, and assessing and mitigating potential third party impacts (Colby, 1990). AICs and PICs together encompass transaction costs involved in market transactions. As noted earlier, estimates of transaction costs vary from as low as six percent of the price of water (Colby, 1990) to as high as 23 percent (Hearne & Easter, 1995).

The approach to the estimation of transaction costs was strictly quantitative. Dollar values of explicit administrative induced costs and policy induced costs were calculated based on cash outlays for such expenses as lawyer fees, survey fees and telephone charges. In all cases, the implicit costs associated with the buyer's and seller's time also were estimated. A dollar value on their time was estimated based on a survey of participants who were asked to estimate the opportunity cost of their time. Based on the results from nine respondents, an average of $30.00 per hour was used.

This part of the study is focused specifically on the permanent sale of water rights, or the formal market. For this reason, all hypotheses include an 'F' as an abbreviation for formal.

Hypothesis F-1:

Formal water markets are thin in southern Alberta.

Bjornlund and McKay (2000a) found in the GMID both temporary and permanent trades were taken up slowly. Trade in the formal market was "subdued" during the first years and leveled off at around one percent of total entitlements, or less than one-tenth of trade on the informal market (Bjornlund, 2003e, p.5). In the Murray Region of New South Wales, permanent trade also was reported to have taken hold very slowly and moved marginal volumes of water compared to that involved in temporary trades (Bjornlund, 2003e).

It was noted above, only six transactions that involved "arms length" or formal transfers have taken place in southern Alberta to date. The study will determine the volume of water transferred as a percentage of total entitlements within the South Saskatchewan River Basin and compare that figure to volumes traded in the informal water market of the SMRID in order to evaluate the hypothesis that formal water markets are thin.

Hypothesis F-2:

Dispersion of prices for water in the formal market in southern Alberta has been high.

Bjornlund's (2002a) study of GMID from 1992 to 1996 showed dispersion between minimum and maximum prices remained high throughout that period. The

standard deviation of quarterly mean prices in South Australia, as a percentage of quarterly mean prices, was about 18 percent from 1987 to 1992, down to 12 percent from 1992 to 1995 and to six percent from 1995 to 1996 indicating that price dispersion decreased as the market matured (Bjornlund, 2002a). Therefore, it is anticipated that high price dispersion will be found in the early stages of this southern Alberta market.

Hypothesis F-3:
Trade in the formal market in southern Alberta has moved water to higher value uses.

In South Australia permanent transfer moved water to high-value viticulture, horticulture and vegetable producers. In Victoria 69 percent of the water in permanent transfers moved to dairy farms. There, 26.3 percent of water sold had been used by lower-value sheep and 44.5 percent by lower-value cattle producers (Bjornlund & McKay, 2000a). Along the River Murray, vineyards purchased 36 percent of the water while other horticulture and vegetable producers purchased most of the rest (Bjornlund & McKay, 2002).

Potentially, irrigation water within southern Alberta can move from low-value to high-value crops as well as from agricultural production to higher-value domestic or industrial use. The case studies will evaluate whether this is occurring in the formal water market of southern Alberta.

Hypothesis F-4:

Sellers of permanent rights for water in southern Alberta are motivated because they have unused water.

In the GMID and River Murray of Australia, most water sold was unused (Bjornlund & McKay, 2000a). A study of early formal market activity in the Torrumbarry Irrigation Districts and the Pyramid Hill-Boort area found many sellers used the introduction of trading to sell an asset, one that they have never used and have no intention of ever using (Bjornlund, 2003c). It is expected that this has occurred in southern Alberta and the case study analysis will determine the validity of the hypothesis.

Hypothesis F-5:

Water trade facilitates long-term economic adjustment in southern Alberta.

Bjornlund & McKay (2000b) reported that consolidation and amalgamation of farm properties and water entitlements take place continuously and water markets help to facilitate an orderly and efficient process.

In the GMID, where irrigators have permanent pastures and other significant investments, Bjornlund & McKay (1999) found that "irrigators purchase water both to secure their existing production and expand their irrigated area, to make their properties more viable as part of the general structural adjustment toward larger more efficient farmers" (p. 11) . Along the River Murray in South Australia when asked to rate reasons

for buying water, "expanding reasons" were rated as most important, and increased in importance, reflecting the growth in viticulture and some horticulture.

More detailed studies in the GMID provided information on the amount of purchased water used for expansion purposes. Forty-three percent of water purchased was used for expansion. Along the River Murray, 9.8 percent of water was purchased by new enterprises involving vineyard, horticulture and vegetable production (Bjornlund & McKay, 2000a).

In Chile water rights transactions have consisted mainly of purchases of water rights from farmers by the urban water and sewage companies (Schueler, 1992). In California it is reported that farmers increasingly are willing to transfer water under significant urban, industrial and environmental demand, and to make significant changes in farming technology in response to higher prices of water and other inputs (NRC, 1996).

As demonstrated by the cases in Australia, California and Chile, long-term economic adjustment is being facilitated by water transfers. Whether this is occurring in southern Alberta is an important hypothesis to test in this study.

Hypothesis F-6:

Permanent rights for water have moved from less water efficient irrigation equipment to more water efficient equipment.

Bjornlund (2002a) reported that GMID water moved to properties that have re-use systems, surface drains and laser grading to a far greater extent than did the selling properties. Along the River Murray water moved to more efficiently irrigated farms using

methods such as under canopy, drip and mixed irrigation and was sold by farms with furrow irrigation and overhead sprinklers (Bjornlund & McKay, 2000a). Of all buyers along the River Murray, 56 percent used potentiometers to monitor and manage irrigation compared to 14.6 percent of sellers, indicating that buyers were more efficient in their water use than were sellers (Bjornlund & McKay, 2000a).

As noted in table 4.2.3, irrigation equipment varies considerably in efficiency in southern Alberta. As with the informal water market in southern Alberta, this study will evaluate the hypothesis that water moves from less water efficient irrigation equipment to more efficient equipment.

Hypothesis F-7:
Systems that facilitate the flow of information on supply, demand, and price, facilitate trade and reduce transaction costs.

One would expect that because permanent transfers of water rights can occur over long distances, the need for mechanisms that assist the flow of information would be essential to facilitate trade and reduce transaction costs. Mechanisms like the Drought Water Bank in California and the Water Exchange in Australia facilitate information exchange, but primarily in the temporary market.

Administrative impediments to trade, discussed in workshops in Australia, revealed that lack of transparency in the market was an area of concern (Bjornlund, 2002c). This was particularly the case in South Australia because no water exchange operated in that state and therefore no public access to information about supply and demand existed (Bjornlund, 2002c). Initiatives to remedy that situation have taken place

since. In South Australia, introduction of WILMA (Water Information Licensing and Management Assistance) will provide information about water trading and prices paid throughout the state (Bjornlund, 2002c). In Victoria, "Water Move", a state-wide, on-line exchange will provide information about supply, demand and prices and facilitate permanent transfers (Bjornlund, 2002c).

This study of permanent water rights trading in southern Alberta will determine what information systems are used by market participants and evaluate the transaction costs imposed on sellers and buyers. The hypothesis that systems that facilitate the flow of information assist trade and reduce transaction costs will be evaluated against the study's findings.

Hypothesis F-8:
Southern Alberta buyers of permanent rights to water are motivated by the need to ensure long-term security of water supply.

This factor is especially pertinent where demand pressures from urban and industrial growth result in need for long-term water security through permanent water transfers. The California scenario as described by Haddad (2000) is instructive. California's population is forecast to grow from roughly 32 million in 1995 to 47.5 million in 2020 (Haddad, 2000). He notes that because industries require water to cool equipment, for cleaning purposes, as inputs to production and for consumption by employees, decisions as to where to locate will depend on long-term water availability. They require a constant and reliable year-round supply of water. New water resources for environmental needs also are growing. These include, for example, efforts to restore

salmon runs on the San Joaquin River and wetlands regions (Haddad, 2000). This study will evaluate the hypothesis that southern Alberta water right buyers seek long-term security of supply, possibly for similar purposes – environmental, industrial and domestic – as noted above.

Hypothesis F-9:

Transaction costs in the formal water market in southern Alberta result in per unit water prices being higher the larger the transfer volume.

Bjornlund (2002a) studied the impacts on water prices of policy changes that affected transaction costs in South Australia and the Goulburn-Murray Irrigation District [GMID]. He reported that during the first study period small volumes traded at higher prices than did high volumes, which may appear contrary to expectations presented in the hypothesis above. However, transaction costs were low for smaller volumes because under these sales, buyers did not have to produce an irrigation drainage and management plan as a part of the transfer. This lowered the transfer costs and increased the willingness to pay. In addition, Bjornlund (2002a) believes that many of the buyers of small volumes were hobby or "lifestyle" farmers who were willing to pay a premium in pursuit of their "non-economic" objectives (p. 41). During the second study period, small volumes traded at lower prices. At that time, however, the department tightened the transfer procedures for small transfers, significantly increasing per unit costs for small transfers, and decreasing the willingness to pay for small volumes (Bjornlund, 2002a).

The formal water market approval process in southern Alberta is somewhat complex, involving several stages. This study will determine whether, as the hypothesis

states, transaction costs affect per unit water prices. More specifically, the study will determine whether higher prices are being paid for larger volumes of water.

Hypothesis F-10:
Participants in the formal market for water view transaction costs as high and an impediment to trade.

In Chile's central and southern regions, the nation's agricultural "heartland", Bauer reported that water markets were fairly inactive due to transactions costs and other obstacles (Bauer, 1997, p.652). Another study by Brisco et. al. (1998) found in the Maule district of Chile high transaction costs were created by costly judicial procedures, often taking years to conclude. Outcome of cases were also unpredictable and inconsistent, compounding high transaction costs by uncertainty.

In the GMID in Australia, Bjornlund and McKay (2001b) reported that it was apparent that while irrigators in general did not find the transfer process to be a major problem, they found the permanent transfer process far more complex than the temporary process. In three state workshops in Australia [22] Bjornlund (2003a) reported that participants stressed that the "administratively lengthy, complicated and thereby costly processes of permanent trade, compared to the relative ease, certainty and low cost of the temporary market, especially since the introduction of the Water Exchanges, were significant drivers of the temporary relative to the permanent market" (p.12). Bjornlund (2003a) reported: "39 percent of the permanent buyers said that an important reason for using the temporary market for subsequent purchases was the difficulty of the permanent

[22] Tatura, Victoria; Deniliquin, New South Wales; and Kinston on Murray in South Australia in March 2002

transfer process, and 32 percent referred to the high cost of permanent trades" (p. 13). Fifty percent said that "an important reason for changing to the temporary market was that with the Water Exchange in place it was so easy" (p 13). Among the permanent sellers, who had used the temporary market for subsequent sales, "59 percent referred to the ease of use of the Water Exchange as an important reason, while only 9 percent referred to the difficulty of the permanent transfer process..." (p. 13). Bjornlund (2003a) concludes "it is the buyers who have to face the difficulty of the administrative processes" (p.13). All three jurisdictions referred to a "chronic shortage of staff" within relevant departments as a major cause of delay (Bjornlund, 2002c, p.12). This factor would add considerable cost to the transaction process.

A review of procedures for permanent transfer of water rights in Alberta in Chapter 3 revealed a process in Alberta that requires several stages of document and survey preparation and collection plus public and government review. Thus, it is expected that transaction costs, as a percentage of water prices, will be high relative to findings of other studies. Participants also are likely to view transaction costs as high. An evaluation of the validity of these statements will be conducted in this study.

Hypothesis F-11

Transaction costs were relatively high in the early stages of the formal market in southern Alberta.

Falconer et al., (2001) noted that transaction costs may decrease over time due to learning and the presence of fixed costs which are incurred primarily at the beginning of a program. Arrow's study of these factors in the manufacturing sector (as cited in McCann & Easter, 2004) confirmed these views. Transaction costs at the early stages of

formal market development may therefore be relatively high. Given the early stage of development of the southern Alberta water market, one might expect transaction costs to be high relative to previous studies[23].

[23] Estimates from previous studies do not specify the stage of the program for which the data pertain so comparisons are not precise.

Chapter Five

Results

5.1 Introduction

The results are derived from the SMRID survey of temporary trades of water rights and the case studies of permanent trades of water rights. Analyses of the results relate directly to the hypotheses presented in Chapter four and are presented in this chapter in two sections – the informal market in Section 5.2 and the formal market in Section 5.3 respectively. Section 5.4 provides an interpretation of the results.

5.2 Summary of Hypotheses and Findings in the Informal Market

Overall, forty percent of irrigators surveyed responded to the SMRID survey, according to the following categories listed in table 5.2.1. Twenty-six percent of buyers surveyed responded to the survey with a slightly higher percentage, 31 percent, of sellers responding. Forty five percent of non-buyers and non-sellers responded to the survey.

Although the rate of return of the survey was relatively high, the small number of buyer and seller responses did not provide adequate numbers to conduct a rigorous statistical analysis. Nevertheless, a great deal of evidence relating to the hypotheses was obtained and is detailed below.

Table 5.2.1

Survey Response Rates for Buyers, Sellers and Non Buyers/Sellers, SMRID Survey, 2003

Participants	Surveyed	Returned	Percent of Surveyed Returned
Buyers	151	39	26
Sellers	114	35	31
Non Buyers/Sellers	750	335	45
Total	1015	409	40

Where cross-tabulations of results were used in the ensuing analysis, Pearson chi-square statistics indicated a weak relationship between the dependent and independent variables. The cross-tabulation results are statistically insignificant and therefore cannot be generalized to the entire population. Nonetheless, some findings specific to the survey respondents are interesting and are noted in the results. These results also assist in developing a general picture of what might have happened within the SMRID in 2001, as presented in the interpretation of results (Section 5.4).

Hypothesis I-1:

Water sales were limited in scope, usually among producers within the same irrigation district and often served by the same canal.

Water transfers are confined to producers within a single irrigation district, except under special circumstances and under strict procedures. In 2001 water transfers were allowed to occur within SMRID and between SMRID and Raymond Irrigation District

and Taber Irrigation District. However, records at the SMRID office show transfers between SMRID and the other two irrigation districts amounted to a negligible amount: 227 acre feet. Those transfers occurred between SMRID and the Taber Irrigation District. Transfers therefore were limited in scope with virtually all sales occurring within the same irrigation district. However, these sales are not, as the hypothesis states, necessarily served by the same canal (J. Tamminga, personal communication, September 10, 2004).

Hypothesis I-2:

In 2001 the informal market was "thin" and water prices were erratic.

Data provided by SMRID officials confirmed that the water market in 2001 was thin. Out of approximately 1,800 SMRID irrigators, 222 transactions occurred in 2001, representing 12.3 percent of irrigators. In terms of water volume, 10,500 acre feet of water were transferred, representing 3.5 percent of 301,250 acre feet of water allocated to 340,000 irrigated acres that year. Internal transfers among parcels of land by the same producers were somewhat higher – approximately 15,500 acre feet or 5.1 percent of the water allocated to irrigated acres.

Using price data obtained from buyers and sellers, the average price for water transferred was $79.06 per acre foot. Prices were highly variable, similar to price behavior in new water markets elsewhere. Prices ranged from as low as approximately $20 per acre foot to as high as $140 per acre foot. The coefficient of variation[24] for water

[24] The coefficient of variation is expressed as the standard deviation as a percentage of the arithmetic mean. The value is useful for comparisons between the variability of two or more distributions (Yeomans, 1968).

prices was 37.95 By comparison the coefficient of variation for the price of a well established agricultural commodity, canola, in 2002 was 12.24.

Hypothesis I-3:

Water prices per unit declined with the size of the transfer in the SMRID in 2001.

Price data from the SMRID survey does not support this hypothesis. SMRID buyer and seller data were divided by volume: those who transferred under 100 acre feet and those who transferred 100 acre feet and over. The average price of the low volume water was approximately $69 per acre foot. The average price of the higher volume water was approximately $89 per acre foot. This conclusion was further confirmed when volumes are further segregated into buyer and seller categories. Buyers of low volume water amounts paid an average price of about $76 per acre foot and the higher volume at an average of about $91 per acre foot. Low volume sellers of water received approximately S64 per acre foot and large volumes sellers received $85 per acre foot.

A possible explanation for this behaviour lies in the purpose of the water and the fact the water is purchased in large blocks, not marginal units. Large volumes of water within SMRID were used predominantly for high value potato and other specialty crop production. Eighty two percent of large water volume buyers used the water specifically for potato and/or other specialty crop production. Only one large volume buyer used water for an oilseed crop. Of the small water volume buyers, only 43 percent indicated it was used for potato and/or other specialty crop use. About one-quarter of these buyers

used the water for lower-value cereal and oil production and about half used the water for forage crops.

Hypothesis I-4:

Knowledge of the water market in the SMRID in 2001 and what water was worth was limited.

To evaluate this hypothesis, sellers and buyers were asked to rank their perception of their knowledge of the market for water and what water was worth on a scale of one to five - one being *very knowledgeable*, five having *no knowledge*. As shown in table 5.2.2, the largest proportion of sellers ranked their knowledge as "three" or *moderate*. This constituted about 40 percent of responses. This finding was similar for buyers where the majority, 39 percent, also ranked their knowledge as *moderate*. Less than 30 percent of sellers and buyers considered their knowledge as *somewhat* or *very knowledgeable* (level one or two). In general these results indicate water market participants were not confident in their knowledge of the water market and what water was worth in 2001.

Table 5.2.2

Ranking of Knowledge of Water Market and What Water Was Worth, Sellers and Buyers, (%)

Ranking	Percentage of Seller Responses	Percentage of Buyer Responses
Very	9	6
Somewhat	18	22
Moderate	36	39
Minimal	27	19
None	9	14

Hypothesis I-5:

Knowledge of the water market was positively correlated with education, farming experience and quantity of water transferred and negatively correlated with age.

The cross-tabulation results for sellers confirms the hypothesis that respondent's perception of their knowledge of the water market is positively correlated with education, farming experience and quantity of water transferred and negatively correlated with age. The data displayed in figure 5.2.1 below highlight the percentage of respondents who rated themselves in the top two knowledge categories, *somewhat* or *very knowledgeable*, of the water market. These were higher for producers of age less than 55 years of age where 36 percent ranked their knowledge in the top two categories, compared to 22 percent for those aged 55 and over.

Twenty nine percent of those with some post secondary education ranked themselves as *somewhat* or *very knowledgeable* compared to 21 percent with grade 12 or less education. These findings are shown in Figure 5.2.2.

Sixty-seven percent of those with irrigated acreage of 640 acres or more ranked themselves as *somewhat* or *very knowledgeable* compared to 21 percent with less then 640 irrigated acres. This is shown in figure 5.2.3.

By volume sold, as shown in figure 5.2.4, 33 percent that sold 100 or more acre feet of water ranked themself as *somewhat* or *very knowledgeable* compared to 25 percent who sold less than 100 acre feet.

Figure 5.2.1:

Seller's Ranking of Somewhat or Very Knowledgeable by Age

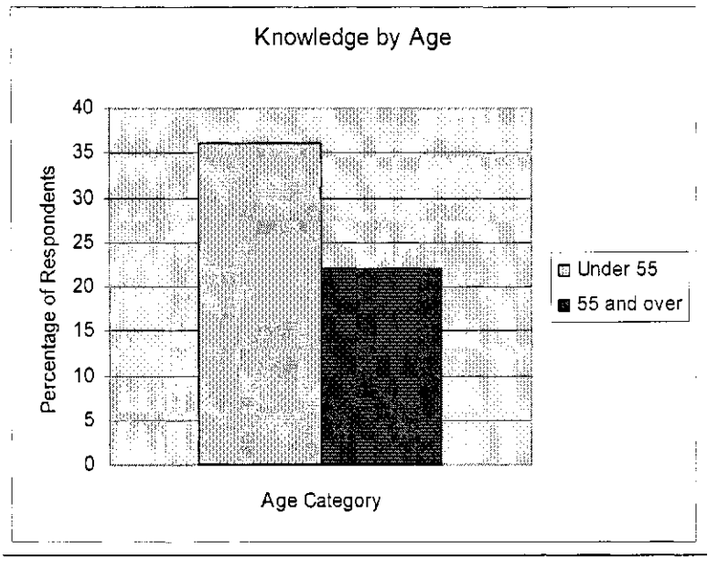


Figure 5.2.2:

Seller's Ranking of Somewhat or Very Knowledgeable by Education

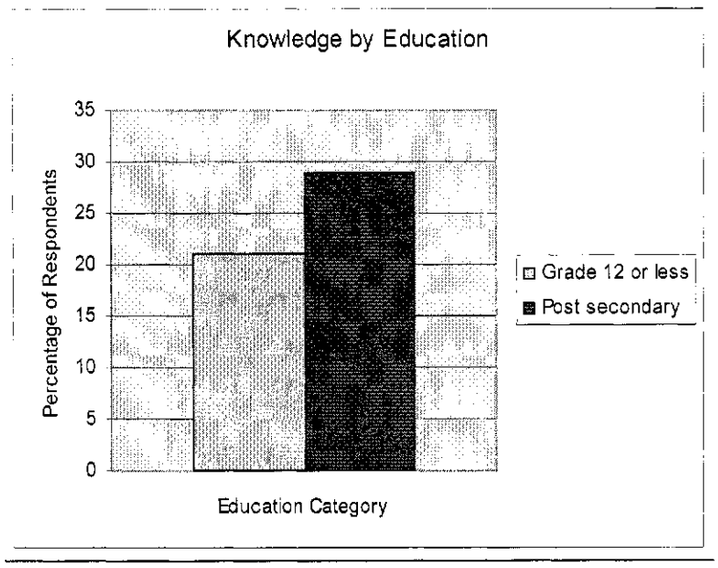


Figure 5.2.3:

Seller's Ranking of Somewhat or Very Knowledgeable by Farm Size

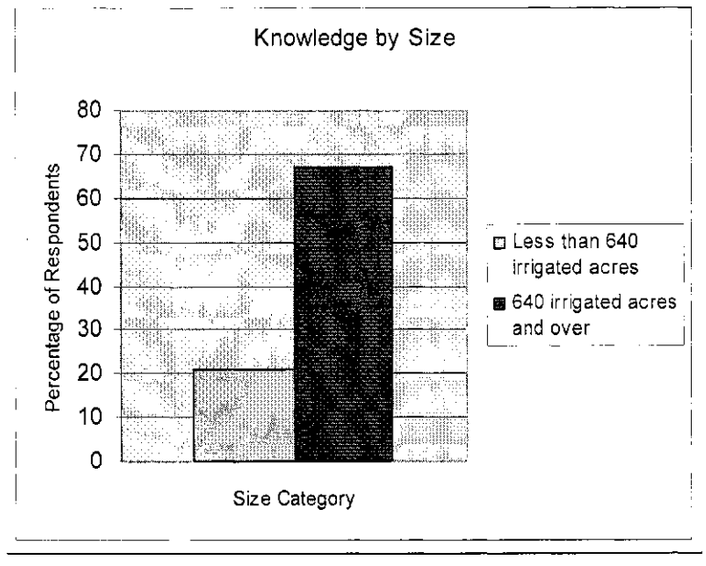
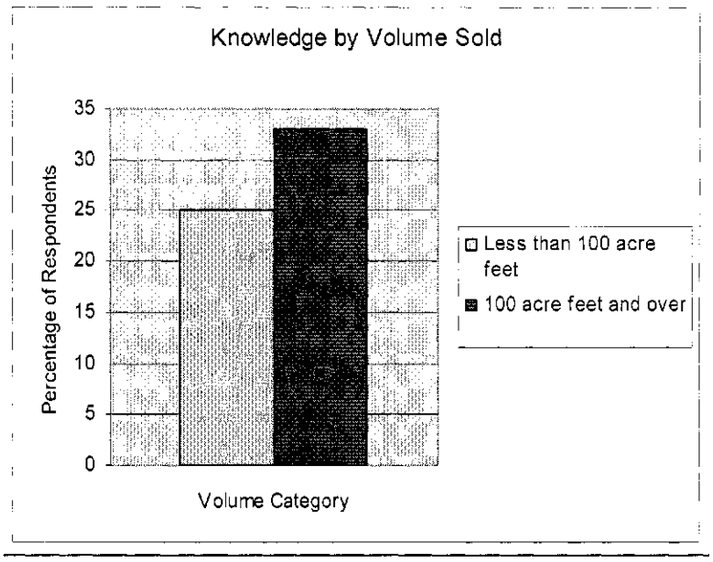


Figure 5.2.4:

Seller's Ranking of Somewhat or Very Knowledgeable by Water Volume



The results for buyers also confirm the hypothesis above, except where perception of knowledge is cross-tabulated with age. Unlike sellers, the older the buyers were, the more knowledgeable they felt they were of the water market. Fifty percent of buyers age 55 and over ranked their knowledge as *somewhat* or *very knowledgeable* compared to 25 percent of buyers less than 55 years of age. This is shown in figure 5.2.5. These findings are not only contrary to findings of sellers, they also conflict with expectations.

One possible explanation may be related to additional findings about the characteristics of buyers (under hypothesis I-15). Buyers, on average, farmed almost three times the irrigated acreage of sellers, they had more years of experience in farming and they operated more efficient irrigation equipment than sellers. These characteristics may have resulted in what appear to be highly productive and efficient buyers naturally

apprising themselves of new opportunities like water transfers; and in this instance, especially those over 55 years of age.

A relatively strong positive relationship between knowledge and post secondary education, and between knowledge and size of operation, emerged. Forty three percent of buyers with some post secondary education said they were *somewhat* or *very knowledgeable* compared to only nine percent of buyers with grade 12 or less education. This is shown in figure 5.2.6.

By size, as shown in figure 5.2.7, 43 percent of those with 640 or more irrigated acres ranked their knowledge as *somewhat* or *very knowledgeable* compared to 19 percent of those with less than 640 acres.

By volume bought, shown in figure 5.2.8, 33 percent of buyers who purchased 100 acre-feet or more water ranked their knowledge as *somewhat* or *very knowledgeable* compared to 22 percent who bought less than 100 acre feet.

Figure 5.2.5:

Buyer's Ranking of Somewhat or Very Knowledgeable by Age

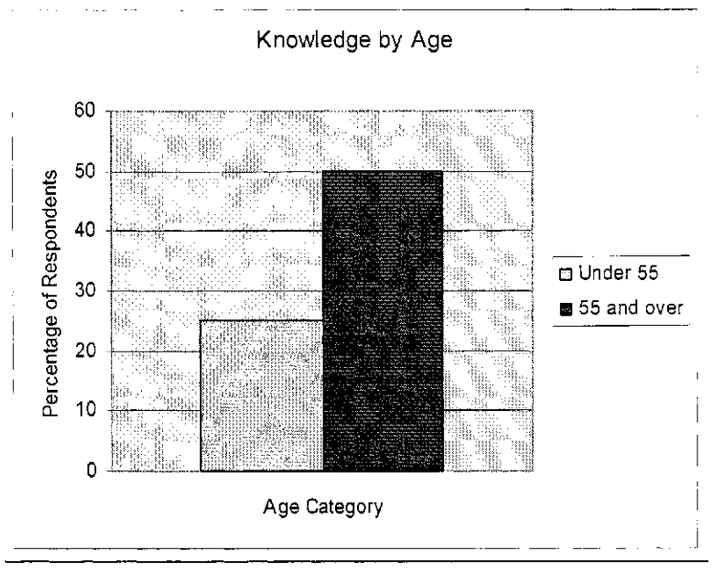


Figure 5.2.6:

Buyer's Ranking of Somewhat or Very Knowledgeable by Education

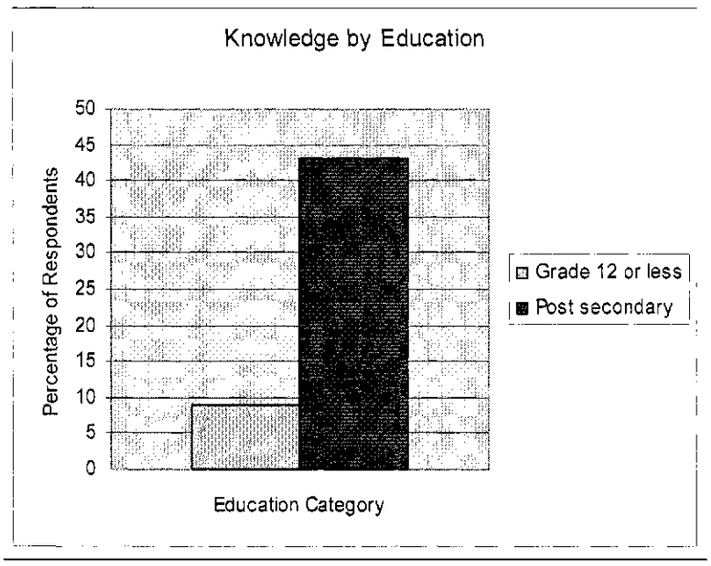


Figure 5.2.7:

Buyer's Ranking of Somewhat or Very Knowledgeable by Farm Size

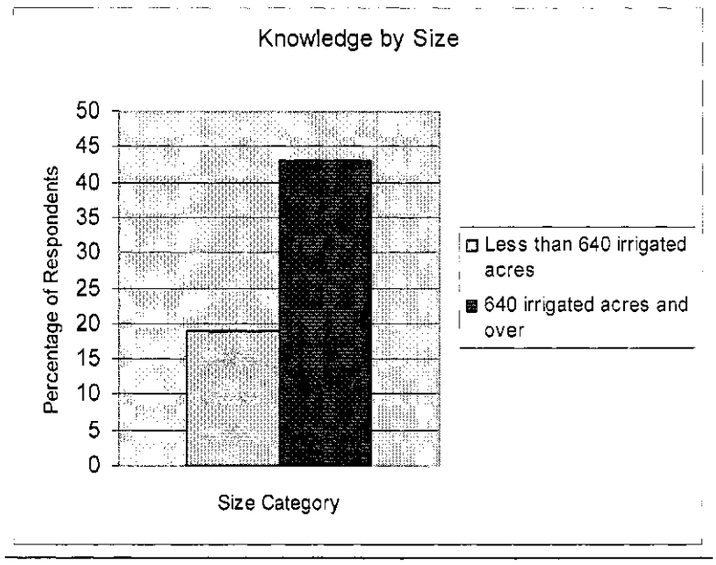
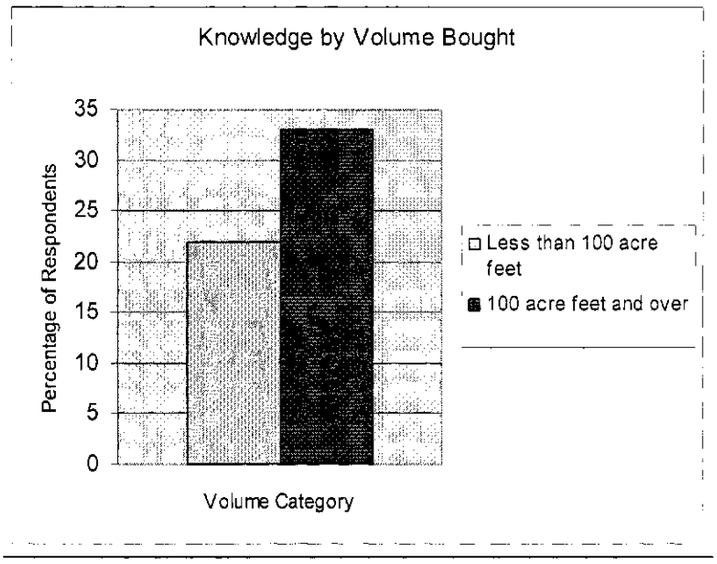


Figure 5.2.8:

Buyer's Ranking of Somewhat or Very Knowledgeable by Water Volume



Hypothesis I-6:

Water market activity intensified as water shortage increased.

Data on the months when the water transfer deals were made is shown in table 5.2.3. The drought was anticipated early in the growing season and water rationing was announced in April so deal making started early. About 40 percent of deals were made during the spring or the March, April and May period. However, the data demonstrates that as the drought intensified, an increasing number of deals were made. Sixty percent of deals were made in June, July and August when dry conditions persisted and there was minimal to no precipitation. As noted earlier, June precipitation totaled 1.7 inches, when precipitation levels are averaged over the Lethbridge, Taber and Medicine Hat area. In

July this average rainfall fell to one inch and by August there was no precipitation in the SMRID.

Table 5.2.3

Water Transfer Deals, by Month (%)

Month	Percent of Total
February	1
March	1
April	12
May	25
June	16
July	24
August	19

Hypothesis I-7

Simple information systems and limited bureaucratic procedures characterized the informal water market in the SMRID in 2001.

As expected, relatively simple and informal mechanisms were used by buyers and sellers to locate each other within the SMRID. Results are shown in table 5.2.4. Close to 60 percent of buyers and sellers located each other through word of mouth. The remaining 40 percent of sources used were relatively evenly spread among newspapers, real estate agents and the irrigation district office. Bulletin boards were used the least. In addition, as table 5.2.5 demonstrates, sellers found the process of finding a buyer easy,

with over 90 percent ranking the process as either fairly easy or very easy. Buyers, however, seem to have found the process relatively more difficult: only 52 percent indicated that finding a seller was fairly easy or very easy, as shown in table 5.2.6. Time would have been critical to buyers therefore buyers may have judged the system more critically than sellers who would not have been as severely affected by any time delays.

Table 5.2.4

Locating Buyers and Sellers by Information Source (%)

Type	Percentage of Respondents
District Office	14
Real Estate Agent	13
Bulletin Board	7
Newspaper	12
Word of Mouth and Other	57

Table 5.2.5

Seller's Ranking of Ease of Finding a Buyer (%)

Ranking	Percentage of Respondents
Very Easy	53
Fairly Easy	38
Neutral	6
Somewhat Difficult	3
Very Difficult	0

Table 5.2.6

Buyer's Ranking of Ease of Finding a Seller (%)

Ranking	Percentage of Respondents
Very Easy	22
Fairly Easy	30
Neutral	24
Somewhat Difficult	24
Very Difficult	0

Hypothesis I-8:

Enforcement of contracts in the SMRID was based on reputation and personal trust, not legal means.

The hypothesis states that in keeping with the informal nature of this water market most agreements are expected to be verbal. The survey findings, contained in table 5.2.7, were contrary to this hypothesis. Over half the buyers and sellers within SMRID, 53 percent, entered into a written contract. Only forty percent used a verbal contract.

Table 5.2.7

Deals by Written or Verbal Contract (%)

Type of Contract	Percentage of Respondents
Written	53
Verbal	40
None	8

Using cross-sectional data analysis, written contracts were used more frequently by larger irrigators and where the volume of water bought or sold also was relatively large. Table 5.2.8 contains these results. These large irrigators may be accustomed to formal means of conducting business. Where volumes of water transferred were large, and significant amounts of money exchanged, the parties probably preferred some legal security.

Table 5.2.8

Contract Type by Farm Size and Water Volume (%)

Contract Type	Size – Irrigated Acreage		Volume of Water	
	Less than 640 acres	640 acres and over	Less than 100 acre feet	100 acre feet and over
Written	44	63	50	69
Verbal	49	32	46	31

Hypothesis I-9:

Water moved from low to high value uses in the informal market in the SMRID in 2001.

Similar to water markets elsewhere, water within the SMRID tended to move from low to high value crops. Results in table 5.2.9 show almost 50 percent of water sold was transferred from relatively low-value wheat and barley acreage. Another 34 percent of the acreage was transferred from forage. Over 40 percent of the water bought was applied to potato acreage, a relatively high value crop. Another 26 percent was applied to "other" crops, which comprises mainly high-value specialty crops. Twenty four percent of the purchased water was applied to forage, possibly bought by alfalfa growers who may have been producing two or three cuts of alfalfa that season.

Table 5.2.9

Water Transferred From and To Crops (% of acres)

Crop Type	Water Transferred From (% of acres)	Water Transferred To (% of acres)
Wheat	26	3
Barley	21	2
Canola	6	3
Potatoes	0	43
Forage	34	24
Other Specialty	12	26

Hypothesis I-10

Culture and attitudes did not significantly affect temporary market activities in the SMRID in 2001.

To determine whether attitudes played a role in the 2001 water market, the analysis focused specifically on non-participants and their reasons for inactivity in the market. The survey first sought to determine whether two factors - lack of knowledge of the ability to transfer water, and an inability to buy or sell water if they attempted to do so – were significant. It turned out that neither of these factors was significant. Almost 90 percent of non-buyer and non-seller respondents indicated that they were aware of the ability to transfer water. Very few, between six and seven percent of respondents, indicated they tried to purchase or sell water but were unable to do so. Two unsuccessful

purchasers indicated they were unable to find water and five indicated water was too expensive so they declined to purchase. Of the three unsuccessful seller respondents, one indicated he could not find a buyer and two indicated "other" reasons for being unable to sell some of their water.

Non-participants were then asked: do you feel there are benefits to being able to transfer water? Eighty five percent of the 293 producers in the non-participant category responded positively to this query. Of the 173 respondents who provided written explanations, summarized in table 5.2.10, the benefit they noted most frequently, 40 percent of the time, was the ability to transfer water to higher value/higher water use crops. Fourteen percent noted internal transfers, within their own property, as being the main benefit of transfer. Another 10 percent favoured transfers for each of the following three reasons: flexibility and efficiency, opportunity to dispose of excess supply, and personal financial reasons. Five percent identified helping others as an important benefit.

Table 5.2.10

Benefits of Water Transfers by Non-Participants (%)

Reason	Percentage of Respondents
Higher value/water use crops	39
Internal transfers	14
Flexibility/efficiency	10
Don't need for own crops	10
Personal financial	10
Increased crop yield	7
Helping others	5
Useful, but some reservations	2
Dry years	1
Other	2

Of the negative responders, only 15 percent provided reasons why they held this view, including water should be left in the river, water charges based on volume should be levied, water transfers will cause a bidding war and create an uneven playing field, and transfers ultimately will reduce allocations.

When non-participants were asked whether farmers should have the opportunity to buy and sell water in drought years, 82 percent responded affirmatively. When asked whether they personally would buy or sell water if drought occurred again, 45 percent indicated they would. One-quarter of those qualified their answer by indicating their

participation would depend on factors including water allocation, the price of water, commodity prices and/or the types of crops they were growing.

Fifty five percent of non-participant respondents indicated they would not buy or sell water. Of responders who provided reasons for their answer, 77 percent indicated they need all the water themselves or they have small farming operation. Twenty one percent indicated they are opposed to the practice, suggesting some but very limited attitudinal negativity towards transfers.

Cross-tabulation of results show views about water markets of non-participants differ according to the age of producers and the number years in operation. One might expect younger producers with fewer years of farming to be more open to the practice of buying and selling water. This was borne out in the statistics, contained in table 5.2.11, although the differences are not statistically significant. Generally, younger producers, 85 percent, and those with relatively few years of farming, 90 percent, provided a positive response when asked whether they think farmers should have the opportunity to buy and sell water in drought years. This compares to 79 percent of older farmers and 82 percent of those with relatively more years of farming responding positively to this question.

Table 5.2.11

Agree with Water Transfers During Drought, by Age and Years of Farming Categories

(%)

Response	Age		Years of Farming	
	Less than 55	55 and over	Less than 10	10 and over
Yes	85	79	90	82
No	15	21	10	18

Hypothesis I-11

Water was transferred from sellers who used relatively inefficient irrigation equipment to buyers who used relatively more efficient systems.

This hypothesis is confirmed by the data, shown in broad categories in table 5.2.12. Almost half of sellers, 48 percent of respondents, indicated they used relatively inefficient wheel move irrigation system on those crops from which water was sold. Another 12 percent of seller's land was under one of the least efficient systems, flood. Another 18 percent moved from non-irrigated acreage.

Meanwhile, the vast majority of buyers, 75 percent of respondents, used the purchased water on acres that were under pivots, the most efficient irrigation system. Less than a quarter of buyers used wheel move systems compared to almost 50 percent of sellers.

Table 5.2.12

Buyer's and Seller's Irrigation Systems (%)

System	Percentage of Sellers	Percentage of Buyers
Pivot	21	75
Wheel Move	48	22
Flood	12	3
Non-Irrigated Land	18	0

Hypothesis I-12

The main reason for buying in the informal market in 2001 was to manage the drought.

To evaluate this hypothesis, buyers were asked to rank, on a scale of one to five, the importance of three reasons for selling and buying water. The reasons listed were: *insurance against drought, water was inexpensive, and extra water was easy to find.*

The importance of the informal market in managing drought was confirmed by the data, contained in table 5.2.13. Eighty-three percent of respondents ranked *as insurance against the drought* as being *somewhat* or *very important*. About 50 percent ranked *extra water was easy to find* as being *somewhat* or *very important*. Compared to the other two factors, respondents ranked *water was inexpensive* as being relatively less important.

Table 5.2.13

Ranking of Reasons for Buyers to Purchase Water (%)

Ranking	Water as Insurance	Water was Inexpensive	Water was Easy to Find
Very Important	72	18	17
Somewhat Important	11	21	34
Neutral	14	46	31
Not Very Important	0	7	17
Not Important At All	3	7	0

When the factors were cross-tabulated with farm size, all three factors were ranked as more important by large irrigators, relative to small. Table 5.2.14 shows that while *insurance against the drought* ranked high for large and small, large irrigators viewed *water was inexpensive* and *extra water was easy to find* as relatively more important compared to small irrigators.

Table 5.2.14

Somewhat Important or Very Important Ranking of Reasons for Purchasing Water by Farm Size (%)

Reason	Less than 640 irrigated acres	640 and over irrigated acres
Insurance against drought	80	88
Water was inexpensive	31	50
Extra water was easy to find	44	62

Hypothesis I-13

The main reasons for selling water in the SMRID were the existence of surplus water and an opportunity to increase income.

To test this hypothesis, sellers were asked to rank, on a scale of one to five, the importance of three possible reasons for selling water: *water* (was) *not needed for own crops*, *selling water was a good income opportunity*, and *water was worth more selling it than applying it to my own crops.*

The data in table 5.2.15 confirm the hypothesis that sellers were motivated by income opportunities presented by possessing excess water. Of the reasons for selling water, *a good income opportunity* was ranked most frequently as *somewhat* or *very important* – almost 70 percent ranked the factor that way. Excess supply also figured prominently. Sixty percent ranked *not needed for own crops* as either *somewhat important* or *very important.* Only forty percent ranked *water was worth more selling it than applying it to their own crops* in the *somewhat* or *very important* category.

Table 5.2.15

Seller's Ranking of Reasons for Selling Water (%)

Ranking	Did Not Need for Own Crops	Good Income Opportunity	Water Worth More Selling than Applying to Own Crops
Very Important	40	41	31
Somewhat Important	20	28	11
Neutral	17	7	21
Not Very Important	10	3	14
Not Important At All	13	21	24

When asked to rate the importance of various factors in selling water, a noticeable difference in ratings emerged according to size of farm. As shown in table 5.2.16, small irrigators ranked all three factors as either *somewhat important* or *very important* approximately 40 to 70 percent of the time. For the larger irrigators the only factor ranked as *somewhat important* or *very important* was that they did not need the water for their own crops. The other two factors were ranked much lower.

Table 5.2.16

Somewhat Important or Very Important Ranking of Reasons for Selling Water by Farm Size (%)

Reason	Less than 640 irrigated acres (percent of respondents)	640 and more irrigated acres (percent of respondents)
Did not need total allocation for own crops	55	33
Good income opportunity	71	0
Water worth more transferring it than applying to own crops	41	0

Hypothesis I-14

Sellers of water in the SMRID in 2001 had smaller irrigated acreage than buyers.

This hypothesis was confirmed in the survey data. Water sellers were, on average, much smaller in terms of irrigated acreage, than were buyers. The average irrigated acreage of sellers was 574 acres and of buyers, 1727 acres. The survey did not seek to confirm whether sellers were non-commercial "life style" operations or whether buyers were commercial farms.

Hypothesis I-15

Sellers of water in the SMRID in 2001 were younger than buyers.

This hypothesis was not confirmed by the data. On average, buyers within SMRID were seven years younger than sellers. These buyers also had an average of three

more years of farming and a greater percentage had more formal years of education beyond grade 12. Table 5.2.17 contains these findings.

From previous findings it was discovered that buyer's farms were also larger in size, in terms of irrigated acreage, than were seller's farms. Buyers, therefore, generally were younger, had more years of farming on relatively large irrigated acreage, had more years of formal education and operated more efficient irrigation systems than did sellers.

Table 5.2.17

Characteristics of Sellers and Buyers

Characteristic	Sellers	Buyers
Average Age	56	49
Average Years Farming	23	26
Education Level (%) of total:		
Grade 12 or less	49	32
Diploma	30	21
Undergraduate Degree	12	32
Graduate Degree	9	15

Hypothesis I-16

Those who did not participate in the water market in 2001 use most of their water every year.

The findings within the SMRID support this hypothesis but not completely. As noted earlier, fifty five percent of non-participants indicated they would not buy or sell water in the future. Of responders who provided reasons for their answer, 77 percent indicated they need all the water themselves or they have a small farming operation. Therefore, non-participants tend to use most of their water every year. However, twenty one percent of written responses cited opposition to the practice as being the reason, suggesting some, albeit a small degree, of resistance based on attitude.

5.3 The Formal Market

The case studies are described in Section 5.3.1, followed by an analysis of findings related to proposed hypotheses in Section 5.3.2.

5.3.1 Case Study Findings

Case #1: Water Right Transfer from Irrigation District to Water Co-operative[25]

The Water Co-operative (Co-op) was formed in 1999 with a mandate to obtain additional water for the 150 farmsteads and 15 Hutterite Colonies that comprise its

[25] Interviews were held with the irrigation district manager and office administrator on October 13, 2004 and with the President of the Water Co-operative on October 20, 2004.

membership. This membership stretches over 750 kilometers where dryland farming and cattle production are the primary production activities. Co-op members hold from one to twenty shares in the organization, each representing two gallons of water per minute on an ongoing basis.

For domestic and livestock use, members of the Co-op were using an antiquated, labor-intense system of hauling water by truck or extracting it from wells. The Co-op had hoped to provide water through the development of an extensive piping system. Federal and provincial assistance would be provided but only when additional water had been acquired.

Members were initially asked to provide $200 per share towards expenses[26] and as an expression of interest in the project. Ultimately the cost of the project per share would be $25,000 in total, with costs shared one-third each by the federal government, provincial government and the shareholder.

Since further water allocation from the southern tributaries was not an option, due to the moratorium imposed in 2001[27], the Co-op began searching for licenses of about 2,000 acre feet of water from holders who had senior priority. Finding one or more license holders, willing to sell the rights to such a significant quantity of water with a senior priority, was difficult. With no central source of information on buyers and sellers, the Co-op began their search by obtaining a list of all license holders in southern Alberta from Alberta Environment. An engineering firm also was commissioned to help search for a source. In all, an estimated 100 hours was spent in this search process.

---

[26] These proceeds helped pay for a feasibility study costing $1.3 million on a federal-provincial-co-op cost share basis.

[27] In December, 2001, a moratorium was imposed on additional allocation of surface water from the Belly, Waterton and St. Mary rivers.

Meanwhile, an irrigation district, that ultimately would become the water license seller, found it had excess water. The irrigation district was able to prove to Alberta Environment that conservation measures had resulted in water savings equal to or in excess of the amount of the transfer. The license was very senior, dating to 1919. The transfer would be over a long distance, about 150 kilometers. A district board member became aware of the Co-op's need for a water license through information in a local newspaper.

Negotiation of the price and quantity of water was a time-consuming process extending over six months and involving travel and meetings between boards of directors and administrators. The Co-op's intent of finding 2,000 acre feet of water was not quite achievable. After the irrigation district reviewed their water requirements, the amount it agreed to sell was 1,300 acre feet.

Lack of activity in the formal water market meant information on water prices, based on the permanent transfer of a considerable volume of water at a senior license level, was non-existent. As a benchmark, prices of water rights traded on the temporary water market during the 2001 drought, were used. The buyers estimate 50 hours, and the sellers estimate 160 hours, was spent on this process. The Co-op also commissioned a lawyer to assist in the negotiations, at a cost of $2,500. The price that was eventually established for the permanent transfer of water rights was $600 per acre foot.

Time of extraction of the water from the river was an issue. The irrigation district commonly struggles to fulfill water needs from the Belly River during the fall period. The irrigation district therefore had concerns over additional extractions from the river by the Co-op. This would ultimately be remedied when Alberta Environment stipulated that

the Co-op water extractions must occur prior to May 15, during the high spring run-off period. The water would be held in a reservoir until needed.

Preparation of documents required by Alberta Environment was more onerous for the buyer than for the seller. As the seller, the irrigation district had a well-established water management system. The only change to the existing arrangements involved the transfer of a portion of their water license, which they did not use. The application form was the only documentation required, which took an estimated two hours to prepare. The Co-op, as the buyer, also prepared a section of the application form and engaged a lawyer to prepare and review legal documents. An issue emerged over the diversion of water between basins[28], which also had to be resolved. This stage of the process took the buyer 100 to 150 hours[29].

The public notice and public review process was undertaken by the irrigation district. The public notice process involved the placement of notices in three local newspapers involving a time commitment of four hours and a cost of approximately $900. A public meeting and plebiscite[30], where irrigation district members could vote on the proposed sale, was held. It involved 56 hours of time and a cost of $80 for the hall. Throughout the process the irrigation district engaged a lawyer for a total fee of $3,727. Total costs for the seller were $12,800 and for the buyer, $11,000 or $23,000 in total. This represented 3.1 percent of the price of the water license. Costs are summarized in table 5.3.1.

[28] The Co-op members live within a closed river basin. The Federal government raised issues with the license transfer based on policy and environmental concerns. The issue resulted in a formal separation of the South Saskatchewan River Basin and the Milk River Basin (D. McGee, personal communication, October 8, 2004).
[29] The average, 125, was used for calculations of transaction costs.
[30] 34 people voted in the plebiscite – 33 for and 1 against.

Table 5.3.1

Summary of Administrative and Policy Induced Costs for Transfer of Permanent Water Rights from Irrigation District to Water Co-op, 2004, ($)

Task	Seller	Buyer	Total
Locate Buyer/Seller and Negotiate Price (AICs)	$4,800	$7,200	$12,000
Prepare Documents, Public Notice and Public Review (PICs)	$8,000	$3,800	$11,800
Total	$12,800	$11,000	$23,800

Administrators at the irrigation district felt the process went smoothly. They commended Alberta Environment for the assistance that was provided, including engineering and legal expertise, minimizing the work of the irrigation district. They ranked the process as very easy. When asked whether the length of time of the process was too long, they commented that the most difficult and time consuming step was negotiating price.

The buyer's comments on the process were much less complimentary. They felt the process of finding a seller was time-consuming and difficult. There was no central source of information to find available water suppliers. They felt the process of determining whether a license is in good standing was poorly managed and operates under inconsistent rules. They suggested that Alberta Environment could do a better job in "weeding out" unused licenses as these could be an important source of licenses for

buyers[31]. They thought the public review process was a "waste of money" where too many people become involved and where special interest groups find an arena for their cause. They also felt Alberta Environment was understaffed and individuals working there lacked the necessary authority to make decisions.

Case #2 – Water Right Transfer from Hobby Farmer to Specialty Crop Producer and Processor[32]

The hobby farmer had water rights on 320 acres of land which had been irrigated in earlier years under a wheel move system. While the hobby farmer had sold the land, he retained the water rights on it. The farmer hoped to sell the total rights of 300 acre feet of water for $120,000. The water right was listed for sale with a real estate agent but the eight month listing did not produce any buyers. The seller's neighbor, a diverse specialty crop grower, provided the connection to the buyer.

The buyer, an onion producer and processor, was searching for water with the intent of applying it to newly purchased land in order to produce onions that otherwise had to be imported from the United States. The buyer's search for a water right lasted six months, until the seller and buyer connected through the specialty crop grower noted above.

Ultimately the amount of water right sold under the license was determined by Alberta Environment, for reasons discussed below. The price negotiated between the

[31] In fact, when water licenses are cancelled, they are not for sale.
[32] Interviews were held separately with the hobby farmer on October 12, 2004 and with the specialty crop producer and processor on October 15, 2004

buyer and seller was a simple task, taking about two days each to complete. One hundred and thirty seven acre feet of water were sold for $60,000 or about $450 per acre foot. This transfer was over a long distance, about 100 kilometers.

Stage two, the preparation of the application form and required documents, involved considerable time for both parties. Determining that the license was in good standing was a complex process. The seller's title to the water right had not been transferred to the seller at the time the property was sold. This procedure had to be completed. Second, the water right had never been used by the seller during the time he owned the land, about five years. Alberta Environment required the seller to prove he could establish and operate an irrigation system. This involved the seller estimating the cost of the equipment, the pumping system and obtaining a letter of credit from the bank.

As the buyer was intending to use the water right for irrigation purposes, an irrigation feasibility report and Global Positioning System (GPS) mapping had to be prepared, costing $3,450. A diagrammatic layout of the works involved two hours of the buyer's time.

Both parties shared the cost of the public notice process, involving placement of notices in three local papers. The cost for the buyer and seller was about $200 each. The time involved was less than an hour for each. The seller also retained a lawyer who assisted through various stages of the process, costing $500. Costs incurred for long distance calls totaled $200.

Alberta Environment determined that the transfer of the license would increase the diversion rate from the Oldman River and Bow River and negatively affect junior license holders. To mitigate this effect, only a portion of the original license was

permitted for sale. The water license was divided into two, based on the percent of the license from the two rivers. Forty eight percent of the license came from the Oldman River, which Alberta Environment permitted the buyer to purchase. This represented 137 acre feet. Forty eight percent of the license, the percentage originating from the Bow River, was returned to the South Saskatchewan River. Four percent was left with the seller to maintain his yard. The licenses were treated as original licenses, hence the priority date also was changed from 1972 to 2003. The buyer did not express concern over this change in priority date since the water right applies to a small portion of his acreage, about 20 percent in total.

Since this was one of the first water right transfers and because it was unique, the process was lengthy, taking over 18 months to complete. The seller did not anticipate the time and effort it would take to complete this process: "I went into it thinking it was clear-cut. I just wanted to sell what I own". When asked about the Alberta Environment's requirement that he prove he was capable of using the water right, he said "I guess it depends on how hard they want to come down on you regarding the use of the right and taking it away". In total the seller estimates the process required 80 hours of his time.

The buyer was "extremely pleased" with the outcome and not displeased with the process. He is now growing "jumbo" onions on newly irrigated, high quality land; onions that previously he was unable to produce. This results in significantly less dependence on his United States suppliers. He irrigates under a central pivot system.

Costs for the transaction are outlined in table 5.3.2. For the seller the cost was approximately $4,500 and for the buyer, $4,200 or $8,700 in total. This represented 14.5 percent of the price of the water license.

Table 5.3.2

Summary of Administrative and Policy Induced Costs for Transfer of Permanent Water Rights from Hobby Farmer to Specialty Crop Producer and Processor, 2004 (S)

Task	Seller	Buyer	Total
Locate Buyer/Seller and Negotiate Price (AICs)	$240	S480	S720
Prepare Documents, Public Notice and Public Review (PICs)	S4,220	$3,750	$7,970
Total	$4,460	S4,230	$8,690

Case #3: Water Right Transfer from an Irrigation District to two Municipalities[33]

Two small villages, each with a population of about 250 people, had since 1922 obtained irrigation water from an irrigation district. Like irrigation farmers, the municipalities paid a flat per acre fee[34] for conveyance, maintenance and administrative costs. About 500 acre-feet of water were involved. Although the area of the villages is

[33] Interviews were held with the manager and administrator of the irrigation district on October 13, 2004 and with the two town administrators jointly on October 19, 2004.
[34] The fee was $8.25 per acre in 2004.

within the boundaries of the irrigation district, technically, this arrangement was not legal (D. McGee, personal communication, October 8, 2004).

As the water flowed through the villages via ditches, the municipalities had two management problems: monitoring and controlling water use, and residents using easily accessible, but expensive, potable water (from other sources) for lawn and garden irrigation. The municipalities wanted to develop an irrigation system using pipes. Individual water licenses held by the municipalities would help facilitate this (D. McGee, personal communication, October 8, 2004). Under such a system, municipal administrators could meter, and hence, monitor, water use. Easier access to the water also would mean less use of potable water for unintended purposes. The assurance of having specific licenses and "not beholding to anyone else" might help to attract economic activity (D. McGee, personal communications, October 8, 2004). The license had a 1963 priority.

The process of obtaining separate licenses was technically and administratively easy. The transfer did not change the point of diversion or point of use, did not increase water volumes or flow rates and did not involve construction or additional works. In addition, the financial arrangement with the irrigation district would remain unchanged. The process did not constitute a "sale" per se, but the legislation did provide the flexibility needed to improve municipal water management.

Alberta Environment had specific requirements, however, that involved some policy induced costs. Aside from the application form, supporting documentation included a site plan and details of the conveyance structure. The irrigation district and the two municipalities also were required to post notices in local papers. As the new licenses

did not have any effect on the river, a public review in a town hall meeting place, was not required. The district and municipalities also had meetings with their boards and councils. The irrigation district held a plebiscite for its members[35] . Municipal administrators had to review final documents. No lawyers or accountants were involved in the process.

Alberta Environment exercised its right to withhold ten percent of the license. Alberta Environment wanted to "exercise that option" and felt the parties would not be negatively affected (D. McGee, personal communication, October 8, 2004). However, for the municipalities this measure was unexpected. They appealed to Alberta Environment to reverse the decision. They also requested the irrigation district increase the allocation by ten percent. Neither avenue produced results.

Alberta Environment and the municipalities felt that in this unique situation they were charting new territory. Generally, the municipalities felt the work by the irrigation district administrators and Alberta Environment was "very helpful". Although the process took between one and three years[36] the administrators felt this was understandable. In total, the administrators estimated it took 80 hours and 40 hours each of their time to complete the process. Cost for the seller was $1,400 and for the buyer, $2,700 or $4,100 in total, enumerated in table 5.3.3. (Since the water rights were not sold for a price, calculation of the transaction costs as a percent of price could not be made).

[35] 26 people voted in the plebiscite: 25 voted yes and 1 voted no

[36] One municipality started the process earlier than the other. According to municipal administrators, for the first municipality, the process took between two to three years, for the second, one year.

Table 5.3.3

Summary of Administrative and Policy Induced Costs for Transfer of Permanent Water Rights from Irrigation District to Villages, 2003, ($)

Task	Seller	Buyer	Total
Locate Buyer/Seller and Negotiate Price (AICs)	$0	$0	$0
Prepare Documents, Public Notice and Public Review (PICs)	$1,400	$2,700	$4,100
Total	$1,400	$2,700	$4,100

Case #4 – Water Right Transfer from a Retiring Livestock Producer to a Livestock Producer[37]

This transfer was incomplete at the time this study was done. The water right to 60 acres of land is being sold by a retiring livestock producer. This owner is arranging for his retirement - irrigating less, wanting to avoid the manual labor involved with a wheel-move irrigation system and the frustration that comes from an intake system plugging up because of the high algae content of the creek from which the water is extracted. The seller wants to sell the water license separate from the land. The land is located near a major city and may be of high value use for development purposes. The buyer, who rents land from the seller and knows him well, has no irrigation water license on his property. He and his son feel capable of operating the system, which would continue under a

[37] Interviews were conducted jointly with the buyer and seller on October 21, 2004.

wheel-move operation. The water is being used, and will continue to be used, for hay production.

Since the buyer and seller are neighbors and have a rental agreement, the process of searching for a buyer or seller was unnecessary. The agreed-upon price for the license was $12,000 for 90 acre feet of water or $133 per acre-foot. The figure was arrived at through information obtained in informal discussions with another neighbor, also involved in a water transfer[38]. That process took the buyer and seller a day each.

The application form was filed and when Alberta Environment notified the parties of the required supporting documents, a lawyer was commissioned to fulfill that requirement. Alberta Environment has determined the license to be in good standing. As the water license is being transferred to land for irrigation purposes, a feasibility report for irrigation projects must be completed by the buyer. The buyer estimates this will cost him $1,800, which he is not prepared to pay. Alberta Environment also has indicated they want to inspect the buyer's irrigation equipment. Neither of these steps has been completed and the process appears stalled at this juncture.

The buyer is frustrated with the length of time involved in the process. The buyer feels the department is "afraid to make a decision" and claims he is going to go ahead with irrigating the land regardless. He has "quit dealing with the Lethbridge office". In total, the buyer and seller have each spent about six hours in the process, as well as five hours of their lawyer's time.

So far, cost for the seller is $510 and for the buyer, $510 or $1,020 in total, detailed in table 5.3.4. This represents 8.5 percent of the price of the water license.

[38] It was determined that if the water was applied to a hay crop, the cost of the license would be recouped in three years, given that the hay crop would be assured each year.

Table 5.3.4

Summary of Administrative and Policy Induced Costs for Transfer of Permanent Water Rights from Retiring Livestock Producer to Livestock Producer, ($)

Task	Seller	Buyer	Total
Locate Buyer/Seller and Negotiate Price (AICs)	$240	$240	$480
Prepare Documents, Public Notice and Public Review (PICs)	$240	$270	$540
Total	$480	$510	$1,020

Case #5 – Retiring Grain and Livestock Producer and Feedlot Operator[39]

This buyer is a third-generation feedlot operator wanting to obtain a water license for silage and barley production to support an expanding feedlot operation. The water license seller wishes to sell a license for 208 acre feet. The seller is a neighbor, a retiring grain and livestock producer, who frequently does business selling barley and cattle to the feedlot operator. The seller uses a wheel move irrigation system and the buyer would use a pivot system.

There were no costs involved in the buyer or seller locating each other. The buyer and seller would not provide information about price but one might assume it is about

[39] Interviews were conducted jointly with the buyer and seller on October 14, 2004.

$133 per acre foot[40]. An application form has been submitted, taking half an hour each to prepare. Alberta Environment has determined the license to be in good standing. Based on water for irrigation purposes, a risk analysis of third party effects is also complete. A feasibility study for irrigation will be required but has not been initiated. For the buyer and the seller, who have spent in total about 3 hours of time so far, the process has stopped at this point. So far, costs for the seller are S90 and for the buyer, $90 or $180 in total, as shown in table 5.3.5. This represents 0.6 percent of the price of the water license.

Table 5.3.5

Summary of Administrative and Policy Induced Costs for Transfer of Permanent Water Rights from Retiring Grain and Livestock Producer to Feedlot Operator, ($)

Task	Seller	Buyer	Total
Locate Buyer/Seller and Negotiate Price (AICs)	$0	$0	$0
Prepare Documents, Public Notice and Public Review (PICs)	$90	$90	$180
Total	$90	S90	$180

Alberta Environment indicated that part of the delay is because a local advisory committee is recommending against these types of transfers. In other words, public policy is being made at the same time as the application for a license transfer is being

[40] This seller provided advice on price to the seller in case #4 which settled on $133 acre-foot.

considered (D. McGee, personal communication, October 8, 2004). Alberta Environment also says the application is incomplete.

The buyer and seller characterize the process as "frustrating" where Alberta Environment "drags it out so long you get sick of it". They accuse Alberta Environment of "refusing to help unless forced". They also speak of Alberta Environment as being understaffed and people there overworked.

Case #6 Livestock Producer and Hutterite Colony[41]

A Hutterite Colony is seeking an assured source of water for specialty crop purposes "just in case we get into a pickle for water". The colony would use the water primarily for their large garden of about eight acres and a small amount of water for grass and hay production. Aside from buying the license offered to them, they believe they will need additional water for silage and hay production for their dairy operation. They note: "everyone is fighting for water".

The water license seller has several reasons to sell the water license. He finds that when he needs the water most, for his second cut of alfalfa in late summer, the creek is too low and the water is not available. In addition, the river has changed course such that the license holder would need an extra half mile of mainline to convey the water from the river to his property. Third, alfalfa is cheaper to buy then it is to grow with irrigation. Finally, deer are problematic, causing considerable damage to an alfalfa crop. For these reasons, the seller has not used the water license for two years. When the seller did

[41] Interviews were conducted jointly with the buyer and seller on October 22, 2004.

irrigate, he used a hand-move irrigation system. The seller is aware the license can be cancelled.

The buyer and seller are neighbors. The Colony sells eggs to the seller and helps fix the seller's machinery. A deal has been agreed upon – the license for 20 acre feet of water will be purchased for $10,000 or about $500 per acre foot. The price was established with advice from Alberta Environment and is a price near the higher end of the scale, according to the buyer. The license is a senior one, holding a 1946 priority. The irrigation system used on the seller's property is a hand-move sprinkler model. The buyer would use a wheel-move system. In total the process has involved 18 hours of the buyers' time and four hours of the sellers' time for a cost of $90 for the seller and $390 for the buyer, as enumerated in table 5.3.6. The total cost of $480 represents 4.8 percent of the price of the water license.

Table 5.3.6

Summary of Administrative and Policy Induced Costs for Transfer of Permanent Water Rights from Livestock Producer to Hutterite Colony, (S)

Task	Seller	Buyer	Total
Locate Buyer/Seller and Negotiate Price (AICs)	$60	$60	$120
Prepare Documents, Public Notice and Public Review (PICs)	$30	$330	$360
Total	$90	$390	$480

The buyer and seller believe staff turnover at Alberta Environment is causing the process to drag on for almost a year, and is nowhere near completion. The buyer and seller have not received any further notice regarding the next step. The Hutterite colony has had previous dealings with Alberta Environment and feel: "In some cases, they are like a police officer. They go strictly by the book and don't have enough hands-on experience. They do not come from a farm and do not understand the complete process".

5.3.2 Summary of Hypotheses and Findings in the Formal Water Market

Details of the characteristics of the water licenses involved in the transfer process, as well as a summary of the transaction costs, are outlined in table 5.3.7 and 5.3.8 respectively. The main characteristics that have emerged are that formal market activity in southern Alberta is facilitating long-term economic adjustment but the level of activity is very limited. High price variability exists, with the highest water prices being paid for water moving to high value uses under senior licenses. For completed transactions, transaction costs were below or within the lower range of estimates in other studies. However, all market participants felt time delays in the approval process were excessive. Details of these and other research findings are presented in the hypotheses below.

Table 5.3.7

Summary of Characteristics of Permanent Water License Transfers in Southern Alberta

Case	Seller and Buyer	Acre-Feet Water	License Year	Price (acre-feet)	Original Purpose	New Purpose
#1	Irrigation District/Water Co-op	1,300	1919	$600	Unused	Domestic and Livestock
#2	Hobby Farmer/Specialty Crop Producer/Processor	137	2003	$450	Unused	Specialty Crop
#3	Irrigation District/Municipalities	500	1963	n/a	Non-domestic, municipal	Non-domestic, municipal
#4	Retiring Livestock Producer /Livestock Producer	90	1982	S133	Silage	Silage
#5	Retiring Grain and Livestock Producer/Feedlot Operator	208	1983	$133*	Grain	Silage and barley
#6	Livestock Producer/Hutterite Colony	20	1946	$500	Unused	Specialty crop

* Estimated

Table 5.3.8

Summary of Transaction Costs of Permanent Water License Transfers in Southern Alberta

Case	Sellers and Buyers	AICs	PICs	Total	Percentage of Total Price
#1	Irrigation District/Water Co-op	S12,000	S11,800	23,800	3.1 Seller: 1.6 Buyer: 1.4
#2	Hobby Farmer/Specialty Crop Producer/Processor	$720	$7,970	S8,690	14.5 Seller: 7.1 Buyer: 7.4
#3	Irrigation District/Municipalities	$0	$4,100	$4,100	n/a
#4	Retiring Livestock Producer /Livestock Producer	$480	$540	S1020	8.5 Seller: 4.25 Buyer: 4.25
#5	Retiring Grain and Livestock Producer/Feedlot Operator	$0	$180	$180	0.6* Seller: 0.3 Buyer: 0.3
#6	Livestock Producer/Hutterite Colony	S120	$360	S480	4.8 Seller: 0.9 Buyer: 3.9

Note. AIC's refer to administrative induced costs; PIC's refer to policy induced costs.
* Estimated.

Hypothesis F-1:

Formal water markets are thin in southern Alberta.

This hypothesis is confirmed by the findings. Water market activity in the South Saskatchewan River Basin has involved 2,255 acre feet, a negligible amount of the total

allocation of 4,517,000 acre feet. This represents only 0.05 percent of total allocation[42]. This is similar in magnitude to the negligible amount of 3.5 percent of total allocations within the informal market in the SMRID.

Hypothesis F-2:

Dispersion of prices for water in the formal market in southern Alberta has been high.

The average price of water in the formal market case studies was $363.20 per acre foot. Prices were highly variable, ranging from as low as $133 per acre foot to $600 per acre foot. Price dispersion was calculated using the coefficient of variation. The coefficient for the case study trades was 59.74. This was almost twice as high as the coefficient of variation of prices in the informal market, which was 37.95. This was also almost five times as high as the coefficient calculated for canola prices, 12.24.

The highest prices are being paid for licenses with the most senior priority: $600 for a 1919 priority and $500 for a 1946 priority. The lowest price of $133 is being paid for 1982 and 1983 priority licenses. The only anomaly is the newly issued license with a 2003 date for which the buyer paid $450.

The highest prices also are being paid for water destined for high value domestic or specialty crop use, ranging between $450 and $600 per acre foot. Because these were permanent, as opposed to temporary sales, the value of the water right would also reflect

[42] This represents the transfers handled by the Lethbridge office of Alberta Environment. Additional transfers are handled in other Alberta Environment offices within the SSRB hence this figure likely under represents the true figure.

the future stream of income expected to be generated by using the resource.

Hypothesis F-3:

Trade in the formal market in southern Alberta has moved water to higher value uses.

This seems to have been achieved in four of the six cases studied. In the first case, water moved to a significant number of domestic and livestock users under a water Co-op; the second, to a specialty crop producer and processor; the third, to a feedlot operator to enhance silage and barley production; and the fourth, to a Hutterite colony for specialty crop production. In all of these instances, water was moving from situations where it was not used. In two cases water use remained in the same activity – municipal use, and use for hay production.

Hypothesis F-4:

Sellers of permanent rights for water in southern Alberta are motivated because they have unused water.

In half of the cases, unused water rights were being sold. However, this does not appear to have constituted the only factor. Sellers also were motivated to sell water rights because of the "use it or lose it" policy of Alberta Environment whereby the department can cancel a license if it has not been used for a period of three years and if there is no reasonable prospect of the license being used.

Hypothesis F-5:

Water trade facilitates long-term economic adjustment in southern Alberta.

Each case in this study involved buyers adjusting to economic circumstances. In the largest volume license deal involving the water Co-op, the purchaser's domestic water demand was being met by an inefficient well-based water system. Additional water sources were required to make a pipeline feasible. The water came from an unused source.

Two cases where water rights were purchased involved high-value specialty crop production. In both cases water came from unused sources. In another case the purchase allowed a processor to be less dependent on United States producers. In one case, water used for irrigation would help facilitate expansion of a feedlot operation. A factor in the municipalities' attainment of their own license was to facilitate long-term economic growth. In two cases, the license sale was facilitating retirement for the sellers. These cases all reflect the value of these transfers in facilitating long-term economic adjustment.

Hypothesis F-6:

Permanent rights for water have moved from less water efficient irrigation equipment to more water efficient equipment.

This hypothesis is applicable in four cases where water moved from irrigator to irrigator. In one case, the irrigation system remained unchanged, moving from a farm that used wheel-move equipment to a similar irrigation system. In three cases water moved to

more efficient users – one case from a farm that used hand move to a farm that used wheel move, and two cases from farms that used wheel move to farms that used pivots. Hence, water did move to more efficient users in three cases but not in one case.

Hypothesis F-7:

Systems that facilitate the flow of information on supply, demand, and price, facilitate trade and reduce transaction costs.

In two cases, water rights were transferred over long distances and in both instances buyers and sellers experienced difficulty in locating each other. A central registry would have facilitated the process of connecting buyers and sellers in these cases. In both of these cases, the water Co-op and the specialty crop producer and processor, months lapsed before a seller could be located. In all other cases, buyers and sellers were neighbors and costs of locating each other were negligible or zero.

In almost all cases, lack of information on water prices meant buyers and sellers struggled to come up with a fair price. They sought their own information sources – Alberta Environment or neighbors - but these sources were limited in number. Alberta Environment does not collect information on water prices and due to the very small number of water license sales, participants have limited information. Water price information frequently was based on opinion rather than actual data.

Hypothesis F-8:

Southern Alberta buyers of permanent rights to water are motivated by the wish to ensure long-term security of supply.

In every incident of a permanent water license deal in southern Alberta, long-term security of supply was a motivating factor for the buyer[43]. The Water Co-op (case #1) sought a very senior license and attained a 1919 priority for this reason. The Hutterite colony (case #6) is aware of the demands placed on water and is taking measures to assure a long-term supply for its members. The feedlot operator and livestock producer (case #5 and #4) want to increase the productive capability of land to support livestock production. In the case of the feedlot operation, the additional water should facilitate long run expansion plans. The onion grower and processor (case #2) depends on an assured supply of onions and wants to be less dependent on imports. The municipalities (case #3) feel they have greater control over water and more confident in their supply by holding their own license.

Buyers who sought to finance the water right by borrowing would have found financial institutions receptive to the concept of buying water rights as an asset. Preliminary evidence suggests financial institutions are familiar with water right transfers and in some cases have lent money for that purpose[44]. Capital markets do not appear to be a constraining factor.

---

[43] This is not to suggest demand and the marginal value product of water were not important. These factors are analyzed in hypothesis F-2 and F-3.

[44] An informal survey of six financial institutions in Lethbridge on April 11, 2005 indicates lenders are willing to review cases of water right purchases. Two institutions have loaned money for the purchase of water rights, involving six transactions in total, all for permanent water right sales within an irrigation district.

Hypothesis F-9:

Transaction costs in the formal water market in southern Alberta result in per unit water prices being higher the larger the transfer volume.

The hypothesis that water prices will be higher the volume of water traded is revealed to be true for the completed trades. Here 1,300 acre-feet of water sold for $600 per acre foot compared to 137 acre-feet selling for $450. However, the findings in the incomplete cases do not support this hypothesis. The smallest volume, 20 acre feet, sold for $500 per acre foot, very high relative to the two other cases where much larger volumes sold for $133 per acre foot.

A few factors may explain the above observations. First, in all cases, transaction costs may have had little or no bearing on price because water prices were reached early in the transfer process, before many transaction costs were realized or perhaps even anticipated. Second, use of the purchased water was probably a major determinant of price. In all cases where water prices were in the $500 per acre foot range, the water was being bought for high value domestic or specialty crop use. The significantly lower priced water was for hay or grain production. Third, in virtually all cases, the highest prices were being paid for licenses with the most senior priority.

Hypothesis F-10:

Participants in the formal market for water view transaction costs as high and an impediment to trade.

In terms of transaction costs, participants tended to view time delays experienced in the approval process as more of an issue than cash outlays. In no case did the participants feel the approval process was expeditious. In the three cases that have been completed, participants acknowledged that the process was new and were willing to make accommodations. In the three cases pending approval, all participants expressed frustration with the process, although some are deliberately stalling the process out of anger. The delays are preventing them from making economic adjustments as quickly as they would prefer. These high transaction costs are not uncommon in formal water markets and can constitute an impediment to trade. This is one of the main reasons why informal markets are more common than formal ones.

Hypothesis F-11

Transaction costs are relatively high in the early stages of the formal market in southern Alberta.

Research findings do not support this hypothesis. For completed water sales, where money was transferred, transaction costs were relatively low when calculated as a percentage of total price and compared to findings in other studies. In case #1, transaction costs of 3.1 percent were significantly less than the six to 23 percent range found in other

studies. Transaction costs for case #2 fell about midway between the six to 23 percent range, or 14.5 percent. In other cases examined in this study, the incomplete ones, transaction costs ranged from 8.5 to 0.6 percent of price, below or just slightly above the minimum of other study findings. This can be expected, since additional transaction costs will be incurred as the process proceeds.

In both completed cases, buyers and sellers shared an almost equal burden of transaction costs. In case #1 the seller spent 1.6 percent and for the buyer spent 1.4 percent. In case #2 the split was for the seller 7.1 percent and the buyer 7.4 percent.

In case #4 and #5 of the incomplete set, buyers and sellers shared equally in the transaction costs. In the third case (#6), the buyer has assumed a major portion of the cost so far, mainly because of administrative requirements of the colony.

5.4 Interpretation of Informal and Formal Market Results

Out of approximately 1,800 SMRID irrigators, 222 informal market transactions occurred in 2001, representing 12.3 percent of irrigators. Of the total amount of water allocated in the SMRID in 2001, 3.5 percent was marketed. Given these data, the water market within the SMRID in 2001 can be characterized as "thin". This is similar to early water markets experience elsewhere. The coefficient of variation of water prices was high, relative to other commodities, reflecting erratic price behavior that occurred in trades in the SMRID.

The findings support opportunity cost theory - water moved to higher value crops, particularly potato and other specialty crops in the SMRID. High value crops like potatoes and sugar beets are normally grown on a contract basis, as inputs to the local

processing industry. Those producers would have been at risk of not being able to fulfill contracts. The ability to buy water, in addition to being able to transfer water within one's own property, provided adequate water to critical crops. Trades also would have helped stabilize the processing industry in the region.

The findings do not support the hypothesis that prices paid by buyers will decline with volumes purchased. The largest water volumes were purchased and used for very high value potato and specialty crop production. At an average of $89 per acre foot, those buyers paid a premium. Comparatively small volumes were bought and used for lower-value cereal, oil and forage crop production and the relatively lower price paid for this water, $69 per acre foot, reflected this lower-value use.

Similar to evidence from water markets in Australia, water in the SMRID moved to buyers who were using more water efficient irrigation systems relative to those of the sellers. Water also moved from producers with a relatively small number of irrigated acres, suggesting these sellers may be marginal producers, possibly some hobby farmers. The irrigated acreage of the average buyer was about three times larger than that of the average seller. Given that these buyers also had more water efficient irrigation systems, one could expect that these producers aim for high productivity.

The majority of buyers and sellers believe their knowledge of the market for water and what water is worth, was only moderate. This lack of confidence in their knowledge may be attributed to the emergent nature of this market and lack of experience participating in it. As expected, knowledge of the water market for sellers and buyers increased as the number of years of formal education, irrigated acreage, and quantity of water exchanged increased. Knowledge based on age presented a bit of an anomaly:

seller's knowledge was, as expected, higher for younger aged producers but buyer's knowledge was higher for the older aged producers. Further analysis of the characteristics of buyers, however, helps to explain this anomaly.

Many features common to informal water markets elsewhere were borne out by the study results. Water was traded among producers in the same water district, although not necessarily among producers on the same canal. Since the majority of buyers and sellers found each other through word of mouth, the sales were unlikely to be anonymous. While informal, verbal agreements were adequate for almost half the small irrigators engaged in water transfers, written contracts were more common than anticipated. Written contracts frequently were used by the larger irrigators, likely for security reasons. More sophisticated information exchanges such as the Drought Water Banks in California and the exchanges that currently exist in Australia, were not available in the SMRID. Given the limited geographic distance over which water was traded within the SMRID, the informal mechanisms did not, however, appear to impede market activity.

As the hot, dry summer of 2001 wore on and the drought intensified, an increasing number of water transfer deals were enacted, especially during the June, July and August period. During that time, small irrigators, mainly wheat and barley growers, who did not need the water for their own crops, viewed these circumstances as a good income-making opportunity. Some buyers found sellers difficult to locate but large irrigators, who may be particularly well-connected in the community, discovered that additional water was easy to find. Producers set out to buy water to avert the potentially severe impact of the drought, particularly on their high input-cost specialty crops.

Relative to the sellers, those buyers were, on average, younger, had more formal education and more years of farming experience.

To activate the water transfer process, buyers and sellers visited a SMRID office. There they signed a form, providing information on the amount of water transferred and specifics concerning the land involved. When the transferring process was complete, most of the participants concluded that the process was easy. Transaction costs – the cost of finding buyers and sellers, drawing contracts and assuming risks – were minimal. No formal, legal, challenges were made. Producers recognized the benefits to crop yields and specialty crop production and some felt satisfaction in simply helping out others. No practical improvements to the system could be identified

While the vast majority of producers within SMRID were aware of the opportunity to transfer water, most chose not to participate. Of the non-participants surveyed, over half indicated they would continue to be non-participants if a drought reoccurred. Most of these individuals use water for their own purposes or have small operations, perhaps with limited water. The survey detected some opposition to water trades based on culture or attitude but these factors do not appear to constitute a major barrier.

When a drought occurs the SMRID district can anticipate more water market activity relative to 2001. Forty five percent of non-participants surveyed indicated they would participate in the future, given the right commodity and water prices.

Formal water market activity in southern Alberta is small, representing only 0.05 percent of total allocations within the South Saskatchewan River Basin. However, interest is growing and a small number of transactions have been made. This limited

market activity is similar to the level of activity in the early stages of informal or temporary water market activity elsewhere. The high variability in price in this market in southern Alberta also is not atypical.

The average price of $363 per acre foot was significantly higher than the price in the temporary water market - between four and five times higher than the average temporary water market price of $79 per acre foot. Aside from the high marginal value product expected to be generated by the water, the value of the water right would reflect the future stream of income expected to be generated, plus a premium for license seniority. Except for one case, the highest prices were paid for licenses with the most senior priority.

In the formal market, most of the water being sold was not used. Sellers viewed this situation as an income opportunity resulting in behavior similar to that in the informal market. However, formal market sellers also were aware of the "use it or lose it" policy of Alberta Environment. Further, while water trades in the informal market were used primarily as protection against drought, trades in the formal market were for long-term economic adjustment and security of water supply. Generally, water did move to buyers using more efficient irrigation equipment than sellers but this result is equivocal.

Unlike the informal water market where trades occur within a confined area and information flow is relatively easy, water in the formal market can move over long distances and information can be impeded. In the case of water trades in southern Alberta, transaction costs rise considerably when buyers and sellers have to conduct

independent searches for water rights. Still, the majority of permanent trades of water rights involved people who knew each other and experienced minimal search costs.

All the market participants felt time delays in the approval process were excessive and this resulted in varying degrees of criticism leveled at Alberta Environment. Participants who have completed the approval process were relatively more understanding compared to participants still trying to work through the process, who generally feel annoyed and frustrated.

For completed transactions, transaction costs were below or within the lower range of estimates in other studies. This is contrary to the hypothesis that transaction costs will be relatively high in the early stages of the formal market. In the cases analyzed in this study, the absence of legal challenges helped to keep transaction costs low. Also, in the cases studied, transaction costs were almost evenly split between sellers and buyers. For incomplete cases, costs were, except in one case, also evenly split.

The data do not consistently prove the hypothesis that water prices are directly related to water volumes because of transaction costs. Indeed, the largest volume of water, 1,300 acre feet sold for the highest price, $600 per acre foot. However, the smallest volume of water, 20 acre feet, sold for almost as much, $500 per acre foot. Transaction costs probably have less bearing on water price than the value the water is expected to generate in its new use and the seniority of the license.

Chapter Six

Conclusions

6.1 Policy Implications

The ability of producers to buy water on a temporary basis, in addition to being able to move water within their own property, helped ensure high-value crops were successfully grown to meet processing contracts in 2001. The water market that year had many of the characteristics that informal markets exhibit elsewhere and evidence suggests it worked smoothly that year. The distribution system within the SMRID is extensive and allows water to move anywhere within the district. While geography can be a major impediment to trade in other parts of the world, it is not a factor in the SMRID. As well, culture and transaction costs do not appear to be constraining factors.

The Alberta government's objectives of increased productivity and efficiency of water use were supported through informal water market activity. Water moved to higher-value production, thereby increasing productivity. Water also moved from relatively low to relatively high efficiency irrigation equipment. However, based on limited water market activity, these effects likely have been minimal. Unless conditions are created that promote greater water market activity, the government cannot depend on water markets within irrigation districts to make a significant contribution to these goals. Finally, while government's goal of greater conservation may be supported through irrigation water moving to relatively more efficient irrigation equipment, it is not being supported through the sale of otherwise unused water.

While it can be expected that early water markets are thin, the near absence of water scarcity will prevent future market activity of any great extent. If government chooses to promote more market activity, consideration should be given to expanding opportunities to sell water rights outside irrigation districts, possibly to dry land operators on the periphery. Existing water supplies could be made available to a broader base of users. Efforts to increase the processing industry in southern Alberta should also be encouraged and promoted. Processing activity increases water's productivity and constitutes an important source of water demand.

In the formal water market, the expectation that formal markets likely will occur where water is moving over long distances, between unique users, and where legal water rights can be defended in court is partially but not entirely the case in southern Alberta. Water is moving over long distances, but it is also moving between neighbors in very close proximity. Water is moving between unique users, such as irrigation districts to water co-ops, but also is moving between similar users, such as livestock producers who are using the water for hay production. Unequivocally, the water rights are legal and can be defended in court.

Notwithstanding some mixed results regarding the characteristics of the formal water market in southern Alberta, the market is largely behaving in a fashion similar to early formal markets elsewhere. While market activity is very limited, it is enhancing the flexibility of the water management system. Those engaged in the market are selling unused water rights for high value uses, namely domestic use, specialty crop production or feedlot expansion. In that way, water trades are facilitating economic development, helping ensure security of water supply and assisting retirement for some people. In

some, but not all cases, water is moving to buyers with more efficient irrigation systems than sellers.

In the formal water market, well-established water rights and the absence of legal challenges are helping to keep transaction costs low. However, certain transaction costs could be reduced by minimizing the time and effort involved in independent search processes and the time involved waiting for the approval process to run its course. Some central location, perhaps an internet site or bulletin board, could be established that would allow sellers and buyers to post information publicly. Availability of water price data needs to be enhanced and could also be made available through an internet site or bulletin board. Although in some cases, applicants are holding up the approval process, Alberta Environment needs to find ways to expedite the approval process if they are hoping for more wide-spread use of water trades. Potential sellers and buyers might also be reticent to participate if they are uncertain whether the transfer will be approved and/or if they anticipate Alberta Environment will exercise the 10 percent holdback provision.

Similar to findings in the informal water market, government should not anticipate significant progress towards its objectives through formal water market activity. Unless conditions are created that promote greater water market activity, the government cannot depend on the formal water market to make a significant contribution to these goals. Although the Alberta government's goals of increased productivity and efficiency are being supported and formal market transfers are facilitating economic adjustment, the overall impact likely is negligible given the limited amount of market activity. Similar to the informal water market, government's objective of greater water conservation may be supported through irrigation water moving to buyers with relatively

more efficient irrigation equipment but is not being supported through the sale of otherwise unused water. Unused water sales are being prompted by income opportunities that water markets present and, also in the formal market, the government's "use it or lose it" policy.

Over the long term, environmental change may ultimately produce supply constraints that create a more robust water market in southern Alberta. Policy changes can also hasten this development. Borrowing from the Australian experience, these could include broad-based limits on water extraction, water pricing and, as noted earlier, trading outside irrigation districts.

6.2 Further Research

One of the specific actions contained in the *Water for Life Strategy* is to "monitor, evaluate and report on the water allocation transfer system" (AENV, 2003c, p12). This study has attempted to fulfill that task in part by studying the temporary water market within a specific irrigation district and the permanent water market in southern Alberta. The study then seeks to evaluate this market activity against the government's goals of increased water conservation through enhanced water productivity and efficiency.

The *Water for Life Strategy*, however, contains multiple goals which require additional research. For example, the strategy seeks, as one of its actions, to "complete an evaluation and make recommendations on the merit of economic instruments to meet water conservation and productivity objectives" (AENV, 2003c, p. 21). Like governments elsewhere, the Alberta government is interested in making wider use of economic instruments and to explore their potential in a variety of circumstances. The

range of instruments includes taxes, subsidies, prices and others. Since Alberta is on the threshold of a new water management paradigm, seeking water user's views and possible responses to the use of various economic instruments will avoid situations where people feel disenfranchised. Since irrigators dominate water use, an important research endeavor will be to obtain information on the attitudes and anticipated behavior of irrigators managing water under different economic instruments.

Meeting government's water conservation and productivity objectives will require producers to modify their use of irrigation water. Since crop production is a direct function of water, modifications to water use will impact production. An evaluation of that impact is critical. However, vital information on the marginal productivity of water for various crops has not been developed for southern Alberta. Therefore another important research endeavor will be to develop production functions that relate yield of various crops to water and fertilizer applications.

References

Aaker, D., & Day, G. (1983). Marketing research. New York: John Wiley & Sons.

Abu-Zeid, M. (2001). Water pricing in irrigated agriculture. *Water Resource Development,* 17 (4), 527-538.

Adamowicz, W., & Horbulyk, T. (1996). The role of economic instruments to resolve water quantity problems. *Canadian Journal of Agricultural Economics*, 44 (4), 337-344.

Ahmed, A., & Sampath, R. (1988). Welfare implications of tubewell irrigation in Bangladesh. *Water Resources Bulletin*, 24 (5), 1057-1063.

Alberta Agriculture, Food and Rural Development. (2000a). *Sustainable Irrigated Agriculture in Alberta.* Lethbridge, Alberta: Author.

Alberta Agriculture Food and Rural Development. (2000b). *Irrigation in Alberta.* Lethbridge, Alberta: Author.

Alberta Agriculture Food and Rural Development (2001a). *Irrigation Water Rationing in Southern Alberta.* . Retrieved October 1, 2003, from http://agric.gov.ab.ca/irrigate/water_rationing.html.

Alberta Agriculture Food and Rural Development. (2001b). *Agri profits costs and return profile for selected crops, 2000, irrigated crops*. Edmonton, Alberta: Author.

Alberta Agriculture, Food and Rural Development. (2002). *Alberta Irrigation Districts – Alberta Irrigation Information for the Year 2001.* Lethbridge, Alberta: Author.

Alberta Environment. (2002a). *South Saskatchewan River Basin Water Management Plan – Phase One – Water Allocation Transfers*. Publication # T/661. Edmonton, Alberta: Author.

Alberta Environment. (2002b). *Water for Life – Facts and Information on Water in Alberta, 2002.* Publication # I/930. Edmonton, Alberta: Author.

Alberta Environment. (2003a). *Administrative Guidelines for Transferring Water Allocations*. Publication # I/949. Retrieved October 3, 2004, from http://www3.gov.ab.ca/env/water/legislation/Guidelines/Transfer_Guidelines.pdf.

Alberta Environment. (2003b). *South Saskatchewan River Basin Water Allocation*. Publication #704. Retrieved October 3, 2004, from http://www3.gov.ab.ca/env/water/regions/ssrb/phase_one.asp.

Alberta Environment. (2003c). *Water for Life: Alberta's Strategy for Sustainability.* Publication # I/955. Edmonton, Alberta: Author.

Alberta Irrigation Projects Association (2000*). Alberta irrigation....because every drop counts.* Lethbridge Alberta: Author.

Alberta Irrigation Projects Association. (2002). *Irrigation in the 21st Century, (2002), Volume 1: Summary Report.* Lethbridge, Alberta: Author.

Archibald, S., & Renwick, M. (1998). Expected transaction costs and incentives for water market development. In K. Easter & M. Rosengrant & A. Dinar (Ed.), *Markets for Water Potential and Performance* (pp. 95-117). Boston: Kluwer Academic Publishers.

Bauer, C. (1997). Bringing water markets down to earth: The political economy of water rights in Chile, 1976 – 95. *World Development*, 25 (5), 639-656.

Bauer, C. (1998*). Against the current privatization, water markets, and the state in Chile.* Boston: Kluwer Academic Publishers.

Baumol, W., & Oates, W. (1995). *The theory of environmental policy*, New York: Cambridge University Press.

Berg, B. L. (1995). *Qualitative research methods for the social sciences.* London: Allyn and Bacon.

Bjornlund, H., & McKay, J. (1996). Transferable water entitlements: Early lessons from South Australia. *Water*, 23(5), 39-43.

Bjornlund, H., & McKay, J. (1998). Factors affecting water prices in a rural water market: A South Australian experience. *Water Resources Research*, 34(6) 1563-1570.

Bjornlund, H., & McKay, J. (1999). Do permanent water markets facilitate farm adjustment and structural change with irrigation communities? *Journal of Rural Society*, 9(3), 555-572.

Bjornlund, H. & McKay, J. (2000a). Are water markets achieving a more sustainable water use. *Proceedings from the X World Water Congress*, Melbourne, CD-Rom.

Bjornlund, H. & McKay, J. (2000b). Do water markets promote a socially equitable reallocation of water?: A case study of a rural water market in Victoria, Australia. *Rivers*, 7(2), 139-152.

Bjornlund, H. & McKay, J. (2001a). Current issues and future directions for Australian water market policies. *Water*, 28(2), 74-78.

Bjornlund, H. & McKay, J. (2001b). Operational aspects of water markets. *Proceedings from the 3rd Australasian Natural Resources Law and Policy Conference* (pp.50-59). Adelaide.

Bjornlund, H., & J. McKay (2002). Elements of water markets for developing countries – Experience from Australia, Chile and the US. *Journal of Environment and Development Economics*, 7 (4), 767-793.

Bjornlund, H. (2002a). Signs of maturity in Australian water markets. *New Zealand Property Journal*, July, 31-46.

Bjornlund, H. (2002b). The socio-economic structure of irrigation communities – Water markets and the structural adjustment process. *Rural Society* 12(2), 123-145.

Bjornlund, H. (2002c). What impedes water markets. *Proceedings from the Australasian Water Law and Policy Conference* (pp.165-176). Sydney.

Bjornlund, H. (2003a, April). *Drivers and triggers of water markets*. Paper presented to the 20th Convention of the Australian Water Association, Perth.

Bjornlund, H. (2003b). Efficient water market mechanisms to cope with water scarcity. *Water Resources Development* (in press).

Bjornlund, H. (2003c). Farmer participation in markets for temporary and permanent water in Southeastern Australia. *Agricultural Water Management* (in press).

Bjornlund, H. (2003d, August). *Formal and informal water markets – drivers of sustainable rural communities?* Paper presented on the 25th International Conference of Agricultural Economics, Durban.

Bjornlund, H. (2003e, October). *Water markets as risk management and adjustment tools within irrigation communities.* Paper presented to the XI World Water Congress. Madrid.

Bosselmann, K. & Richardson, B. (Eds.). (1999). Environmental justice and market mechanisms – Key challenges for environmental law and policy. *International Environmental Law and Policy Series*, 54. The Hague: Kluwer Law International.

Brajer, V. & Martin, W. (1990). Water rights markets; social and legal considerations; resource's 'community' value, legal inconsistencies and vague definitions and assignment of rights colour issues. *American Journal of Economics and Sociology* , 49 (1) 35-44.

Brehm, M. R. & Quiroz, F. (1995). *The market for water rights in Chile* (World Bank Technical Paper, No. 285). Washington, D.C.: World Bank.

Briscoe, J. (1996, September). *Water as an economic good: The idea and what it means in practice.* Paper presented at the World Congress of the International Commission on Irrigation and Drainage, Cairo.

Briscoe, J. (1997, September). *Managing water as an economic good: Rules for reformers*. Paper presented to The International Committee on Irrigation and Drainage Conference on Water as an Economic Good, Oxford.

Briscoe, J., Salas. P. & Pena, H. (1998). *Managing water as an economic resource: Reflections on the Chilean experience.* (World Bank Discussion Paper, No. 62). Washington, D.C.: World Bank.

Brown, F.L. (1997). Water markets and traditional water values: Merging commodity and community perspective. *Water International*, 22, 2-5.

Burton, L. (1992). Disputing distributions in a shrinking commons: The case of drought in California. *Natural Resources Journal*, 32 (4) 779-816.

Cestti, R. (1989), Water resources: problems and issues for the water supply and sanitation sector. (World Bank Discussion Paper, INUWS). Washington D.C: World Bank.

Colby, B. (1990). Transaction costs and efficiency in western water allocation. *American Journal of Agricultural Economics*, 72, 1184-1192.

Colby, B. (1998). Negotiated transactions as conflict resolution mechanisms: Water bargaining in the U.S. West. In K. Easter, M. Rosengrant & A. Dinar (Eds.) *Markets for Water Potential and Performance* (pp. 77-94). Boston: Kluwer Academic Publishers.

Cullen, P., Whittington, J. & Fraser, G. (2000). Likely ecological outcomes of the COAG water reforms. Cooperative Centre for Freshwater Ecology. Canberra.

Cummings, R & Nercissiantz, V. (1992). The use of water pricing as a means for enhancing water use efficiency in irrigation: Case studies in Mexico and the United States. *Natural Resources Journal*, 32 (4) 731-778.

Denzin, N. K. & Lincoln, Y. S. (1998). Introduction: Entering the field of qualitative research. In N. K. Denzin & Y.S. Lincoln (Eds) Strategies of Qualitative Inquiry (pp. 1-34). London: Sage Publications, Inc.

Dillman, D. (1978) *Mail and telephones surveys the total design method.* New York: John Wiley & Sons, Inc.

Dinar, A., Rosegrant, M., & Meinzen-Dick, R. (1997). Water Allocation Mechanisms – Principles and Examples. (World Bank Working Paper, No.1779). Washington D.C.: World Bank.

Dinar, A., & Subramanian, A. (1998). Policy implications from water pricing experiences in various countries. *Water Policy*, 1, 239-250.

Dinar, A., Balakrishnan, T., & Wambia, J. (1998) Political economy and political risks of institutional reforms in the water sector. (World Bank Working Paper, No. 1987). Washington, D.C.: World Bank.

Dosi, C., & Easter, W. (2000). Water scarcity: institutional change, water markets and privatization. (Nota Di Lavordo, No 102). Retrieved February 10, 2003, from http://www.feem.it/web/activ/_wp.html.

Easter, K., Becker, W., & Tsur, Y. (1997). Economic mechanisms for managing water resources: pricing, permits and markets. In A.K. Biswas (Ed.), *Water Resources – Environmental Planning, Management, and Development* (pp. 579-621). New York: McGraw-Hill.

Easter, K., & Feder, G. (1997), Water institutions, incentives, and markets. In D. Parker & Y. Tsur (Eds.) *Decentralization and Coordination of Water Resource Management* (pp. 261-282). Boston: Kluwer Academic Publications.

Easter, K., Rosegrant, M., & Dinar, A. (1998). The future of water markets: a realistic perspective. In K. Easter, M. Rosegrant & A. Dinar (Eds.) *Markets for Water Potential and Performance* (pp. 277-282). Boston: Kluwer Academic Publishers.

Easter, K., Rosengrant, M., & Dinar, A. (1999). Formal and informal markets for water: institutions, performance, and constraints. *The World Bank Research Observer*, 14 (a) 99-116.

Falconer, K., Dupraz, P., & Whitby, M. (2001). An investigation of policy administrative costs using panal data for the English environmentally sensitive areas. *Journal of Agricultural Economics*, 52(1), 883-103.

Fontana, A. & Frey, J. H. (1998). Interviewing: The art of science. In N. Denzin & Y. Lincoln (Eds.), *Collecting and Interpreting Qualitative Materials* (pp. 47-79). London: Sage Publications Ltd.

Freeman, R., & Veeman, T. (1993). Economic aspects of transferable water rights in Alberta. *Proceedings of the 46th Annual Conference of the Canadian Water Resources Association,* (pp. 261-278). Banff, Alberta.

Gardner, R. (1990). The impacts and efficiency of agriculture-to-urban water transfers: Discussion. *American Agricultural Economics Association,* 72(5), 1207-1209.

Garrido, A. (1998), Economic analysis of water markets in the Spanish agricultural sector: Can they provide substantial benefits. In K. Easter, M. Rosegrant & A. Dinar (Eds.) *Markets for Water Potential and Performance* (pp. 223-239). Boston: Kluwer Academic Publishers.

Garrido, A. (2000). A mathematical programming model applied to the study of water markets within the Spanish agricultural sector. *Annals of Operations Research*, 94, p. 105-123.

Gonzalez-Romero, A., Rubio, S.J., (1993), El problema de la planificacion hidrologica: Una aplicacion al Caso Espanol, Revista de Economia Aplicadal, 33-66.

Guba, E.G. & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. Denzin & Y. Lincoln (Eds.), *Collecting and Interpreting Qualitative Materials* (pp. 105-117). London: Sage Publications Ltd.

Haddad, B. (2000). *Rivers of gold – Designing markets to allocate water in California.* Washington D.C: Island Press.

Hearne, R., & Easter, W. (1995). Water allocation and water markets: An analysis of gains-from-trade in Chile. (World Bank Technical Paper, No. 315). Washington D.C.: World Bank.

Hoppe, T. (2000). The potential for irrigation expansion in western Canada. Retrieved June 7, 2003 from http://www.egr.ca/pfra/pub/irrexpan.htm#listtab

Horbulyk, T., & Lo, L. (1998). Welfare gains from potential water markets in Alberta, Canada. In K. Easter, M. Rosengrant & A. Dinar (Eds.) *Markets for Water Potential and Performance* (pp. 241-257). Boston: Kluwer Academic Publishers.

Howe, C. (1997). Increasing efficiency in water markets: Examples from the western United States. In T. Andersen & P. Hill (Eds) *Water Marketing – The Next Generation,* (pp. 79 – 97). London: Rowman & Littlefield Publishers.

Howe, C., Boggs, C., & Butler, C. (1990). Transaction costs as determinants of water transfers. *University of Colorado Law Review*, 61 (2), 393-504.

Howe, C., Weber, K. & Lazo, J. (1990). The economic impacts of agricultural to urban water transfers in the area of origin. *American Journal of Agricultural Economics*. December, pp. 1200-1204.

Howitt, R. (1998). Spot prices, option prices, and water markets: an analysis of emerging markets in California. In K. Easter, M. Rosengrant & A. Dinar (Eds.) *Markets for Water Potential and Performance* (pp. 119-140). Boston: Kluwer Academic Publishers

Huberman, A.M. & Miles, M.B. (1994). Data management and analysis methods. In N. Denzin and Y. Lincoln (Eds.) *Handbook of Qualitative Research* (pp. 428-444). London: Sage Publications, Inc.

Hyman, D. & Strick, J. (2001). *Public Finance in Canada.* Toronto: Harcourt Canada,

Jin, L. & Young, W. (2001). Water use in agriculture in China: Importance, challenges, and implications for policy. *Water Policy,* 3, 215-228.

Johansson, R. (2000). Pricing irrigation water: A literature survey. (Policy Research Working Paper, No. 2449). Washington, D.C.: World Bank.

Johansson, R., Tsur, Y., Roe, T., Doukkali, R., & Dinar, A. (2002). Pricing Irrigation Water: A Review of Theory and Practice. *Water Policy*, 4 (2) 173-199.

Laffont, J.J., & Tirole, J. (1993). *The Theory of Incentives in Procurement and Regulation,* Cambridge, MA: MIT Press.

Livingston, M. (1998). Institutional Requisites for Efficient Water Markets. In K. Easter, M. Rosengrant & A. Dinar (Eds.) *Markets for Water Potential and Performance* (pp. 19 – 33). Boston: Kluwer Academic Publishers

McCann, L., & Easter, K. (2004). A framework for estimating the transaction costs of alternative mechanisms for water exchange and allocation. *Water Resources Research*, 40, W09S09, doi:10.1029/2003.

McCann, L., Colby, B., Easter, K., Kasterine, A., Kupervan, K. (in press). Transaction cost measurement for evaluating environmental policies. *Ecological Economics.*

Meinzen-Dick, R.S. (1998). Groundwater markets in Pakistan: Institutional development and productivity impacts. In K. Easter, M. Rosengrant & A. Dinar (Eds.) *Markets for Water Potential and Performance* (pp. 207-222). Boston: Kluwer Academic Publishers.

Milliman, J. (1956), Commonality, the price system, and use of water supplies. *The Southern Economic Journal,* 22 (4) 426-437.

Morse, J. M. (1998). Designing funded qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Strategies of qualitative inquiry* (pp. 56-85). London: Sage Publications, Inc.

National Research Council. (1996). *A new era for irrigation.* Washington, D.C.: National Academy Press.

Nerbas, M. (Berrien Environmental Inc.). (1993). *Impacts of irrigation study, natural resource inventory.* Prepared for AIPA, Lethbridge, Alberta.

Neuendorf, K. (2002). *The content analysis guidebook.* London: Sage Publications.

OECD. (2002), *Transition to full-cost pricing of irrigation water for agriculture in OECD countries* (Report No. JT00121195). Paris: Author.

OECD. (1989). *Water resource management – integrated policies.* Paris: Author.

OECD. (1999). *Agricultural Water Pricing in OECD Countries*. (Working Party on Economic and Environmental Policy Integration, No. 77608). Paris: Author.

Percy, D. (1977). Water rights in Alberta. *Alberta Law Review*, 15 (1), 142-165.

Percy, D. (2000). Who Owns the Water? In D.R. Coote and L.J. Gregorich (Eds.), *The Health of Our Water Toward Sustainable Agriculture in Canada* (pp.10). Publication #2020/E. Retrieved February 5. 2004, from http://res2.agr.gc.ca/publications/hw/PDF/water.pdf.

Postel, S. (1999). *Pillars of sand: Can the irrigation miracle last?* New York: W.W. Norton and Company.

Prairie Farm Rehabilitation Administration (PFRA). (1982). History of irrigation in western Canada. Edmonton: Author.

Randall, A. (1981). Property entitlements and pricing policies for a maturing water economy. *The Australian Journal of Agricultural Economics*. 25 (3) 195-220.

Ring, L. (1988). Alberta's irrigation in a Canadian setting. In S. Rood & F. Jankunis (Eds.), *Economic, Environmental, and Social Aspects of the Oldman River Dam Project*, (pp.9-16). Lethbridge, Alberta: University of Lethbridge.

Rosegrant, M.W. & Binswanger, H.P. (1994). Markets in tradable water rights: potential for efficiency gains in developing country water resource allocation. *World Development,* 22 (11), 1613-1625.

Rosegrant, M.W., & Schleyer, R.G. (1996). Establishing tradable water rights. *Irrigation and Drainage Systems*, 10, 263-279.

Rosegrant, M.W., & Svendsen, M. (1993). Asian food production in the 1990s: Irrigation investment and management scarcity. *Food Policy*, 19 (2), 13-32.

Saleth, R.M. (1998). Water markets in India economic and institutional aspects. In K. Easter, M. Rosengrant & A. Dinar (Eds.) *Markets for Water Potential and Performance* (pp. 187-205). Boston: Kluwer Academic Publishers.

Saleth, M. (2001). Water pricing: Potential and problems, overcoming water scarcity and quality contraints. (Brief No. 10. 2020 Focus 9 - Overcoming Water Scarcity and Quality Constraints). Retrieved January 28, 2004, from http://www.ifpri,org/2020/focus/focus09/focus09_10.html

Saliba, B. C., & Bush, D. B. (1987). *Water marketing in theory and practice: Market transfers, water values and public policy*. Boulder CO.: Westview Press.

Saunders, R., Warford, J.J., & Mann, P.C. (1977) Alternative concepts of marginal cost of public utility pricing: Problems of application in the water supply sector. (World Bank Staff Working Paper, No. 259). Washington, D.C.: World Bank.

Schleyer, R. (1992, December). Chile's market-oriented water policy: Institutional aspects and achievements. (World Bank Technical Paper No. 249). *Papers and proceedings from the World Bank's Ninth Annual Irrigation and Drainage Seminar*, Annapolis, Maryland.

St. Mary River Irrigation District. (2001a). The Headgate. Vol. 1. pp. 1.

St. Mary River Irrigation District. (2001b). The Headgate. Vol. 3. pp.2.

St. Mary River Irrigation District. (2004). History, The St. Mary Project; General Information. Retrieved March 3, 2004, from http://www.smrid.ab.ca.

Southeast Alberta Regional Planning Commission. (1982). *Irrigation in southeast Alberta*. Lethbridge, Alberta: Author.

Spulber, N., & Sabbaghi, A. (1998). *Economics of water resources*. Boston: Kluwer Academic Publishers.

Stake, R. E. (1994). Case studies. In N. Denzin & Y. Lincoln (Eds.), *Collecting and Interpreting Qualitative Materials* (pp. 236-247). London: Sage Publications Ltd.

Sturgess, G. L. (1997). Transborder water trading among the Australian states. In T. Andersen & P. Hill (Eds) *Water Marketing – The Next Generation,* (pp. 127-145). London: Rowman & Littlefield Publishers.

Swihart, R. (2003, January 25). More irrigated land possible. The Lethbridge Herald, pp. B5.

Thobani, M. (1998). Meeting water needs in developing countries: resolving issues in establishing tradable water rights. In K. Easter, M. Rosengrant & A. Dinar (Eds.) *Markets for Water Potential and Performance* (pp. 35-50). Boston: Kluwer Academic Publishers.

Thompson, B. Jr. (1997). Water markets and the problem of shifting paradigms. In T. Andersen & P. Hill (Eds) *Water Marketing – The Next Generation* (pp. 1-29). London: Rowman & Littlefield Publishers.

Tsur, Y., & Dinar, A. (1997). The relative efficiency and implementation costs of alternative methods for pricing irrigation water. *The World Bank Economic Review*, 2 (2) 243-262.

UMA Engineering Ltd. (1993). *Irrigation impact study. Economic input-output model analysis*. Prepared for Alberta Irrigation Projects Association. Lethbridge, Alberta: Author.

Underwood McLellan Ltd. (1984). *Irrigation development in Alberta 'The economic impact' executive summary*. Prepared for AIPA, Lethbridge, Alberta: Author.

University of Lethbridge. (2003). *Human subject research approval guidelines*. Retrieved September 2, 2003, from http://www.uleth.ca/rch/committees/humansubj.cfm

U.S. Environmental Protection Agency. (1992). Managing nonpoint source pollution. Final Report to Congress on Section 319 of the Clean Water Act, Office of Water. Washington D.C: Author.

Varela-Ortega, C., Sumpsi, J., Garrido, A., Blanco, M., & Iglesias, E. (1998). Water pricing policies, public decisión making and farmers' response: implications for water policy. *Agricultural Economics*, 19 (1-2), 193-202.

Veeman, T. (1985). *Water and economic growth in western Canada*. Ottawa: Economic Council of Canada.

Yeomans, K.A. (1977). *Statistics for the social scientist: Introducing statistics.* Middlesex, England: Western Printing Services Ltd.

APPENDIX A

SURVEY QUESTIONAIRE: SELLERS

WATER ALLOCATION TRANSFER SURVEY

1. Regarding your sale of water in 2001:

- in what month(s) did you make the deal(s)? _____
- what volume of water was transferred? _____
  (*please indicate in acres, acre feet, acre inches or days*)

2. How important to you were the following in your decision to sell additional water?

	Very Important	Somewhat Important	Neutral	Not Very Important	Not imp at all
Did not need total allocation for my own crops	1	2	3	4	5
Good income opportunity	1	2	3	4	5
Water is worth more transferring it than applying it to my own crops	1	2	3	4	5

3. How did you find a buyer?

1. Word of Mouth
2. Newspaper
3. Bulletin Board (where? _____)
4. Real Estate Agent or Broker
5. Irrigation District Office
6. Other _____

4. How easy or difficult was it to find a buyer?

1 Very Easy 2 Fairly Easy 3 Neutral 4 Somewhat Difficult 5 Very Difficult

5. Did you enter into a written or verbal contract with the buyer?

1 No 2 Yes, a written contract 3 Yes, a verbal contract

6. If you sold water, could you indicate the price ? (*please indicate in acres, acre feet, acre inches or days*)

_____

7. On a scale of 1 to 5, how knowledgeable were you about the market for water and what it was worth? *(1 being very knowledgeable, 5 having no knowledge).*

1 2 3 4 5

8. What was the size of your farming operation in 2001, in total (irrigated and non-irrigated) acreage according to the following categories:

_____ irrigated acres
_____ dry land crops
_____ dry land pasture
_____ owned
_____ rented

9. What crop(s) was the water transferred from:

		Acres	Water Volume (*in acres, acre-feet, acre inches or days*)
1.	Wheat	_____	_____
2.	Barley	_____	_____
3.	Canola	_____	_____
4.	Potatoes	_____	_____
5.	Forage	_____	_____
6.	Other	_____	_____
7.	Other	_____	_____

Which irrigation system(s) was being used for that crop(s) ?

Pivots _____
Wheel Moves _____
Flood _____
Non Irrigated (dry corners) _____

10. Were there any aspects of the transfer process that you found difficult?

1 Yes 2 No

IF YES : Please describe which aspects you found difficult and why.

11. Under what circumstances would you find water transfers potentially useful?

1 Yes 2 No

Please explain

_____

_____

12. What do you think is the main benefit of water transfers?

_____

_____

13. Could you please indicate :

A. Your age _____

B. How many years you have been farming _____

C. Education level (check one)

Grade 12 or under _____
Diploma _____
Undergraduate degree ____
Graduate degree _____

14. Your role in the farming operation is :

_____ owner-operator
_____ manager
_____ other *(please specify)*

APPENDIX B:

SURVEY QUESTIONAIRE: BUYERS

WATER ALLOCATION TRANSFER SURVEY

1. Regarding your purchase of water in 2001 :

- in what month(s) did you make the deal(s)? _____
- what volume of water was transferred? _____

(*please indicate in acres, acre feet, acre inches or days*)

2. How important to you were the following in your decision to purchase additional water?

	Very	Somewhat	Neutral	Not Very Important	Not Imp at all
As insurance against the drought	1	2	3	4	5
Water was inexpensive	1	2	3	4	5
Extra water was easy to find	1	2	3	4	5

3. How did you find a seller?

1. Word of Mouth
2. Newspaper
3. Bulletin Board (where? _____)
4. Real Estate Agent or Broker
5. Irrigation District Office
6. Other _____

4. How easy or difficult was it to find a seller of water?

1 Very Easy 2 Fairly Easy 3 Neutral 4 Somewhat Difficult 5 Very Difficult

5. Did you enter into a written or verbal contract with the seller?

1 No 2 Yes, a written contract 3 Yes, a verbal contract

6. If you paid for water, could you indicate the price (*please indicate in acres, acre feet, acre inches or days*)

_____

7. On a scale of 1 to 5, how knowledgeable were you about the market for water and what it was worth? *(1 being very knowledgeable, 5 having no knowledge)*

1 2 3 4 5

8. What was the size of your farming operation in 2001, in total (irrigated and non-irrigated) acreage according to the following categories:

_____ irrigated acres
_____ dry land crops
_____ dry land pasture
_____ owned
_____ rented

9. What was the transferred water used for?

		Acres	Water Volume (*in acres, acre-feet, acre inches or days*)
1.	Wheat	_____	_____
2.	Barley	_____	_____
3.	Canola	_____	_____
4.	Potatoes	_____	_____
5.	Forage	_____	_____
6.	Other	_____	_____
7.	Other	_____	_____

Which irrigation system(s) was being used for that crop(s) ?

Pivots	_____
Wheel Moves	_____
Flood	_____
Non-Irrigated (dry corners)	_____

10. Were there any aspects of the transfer process that you found difficult?

1 Yes 2 No

IF YES : Please describe which aspects you found difficult and why.

11. Under what circumstances would you find water transfers useful?

_____

12. **What do you think is the main benefit of water transfers?**

_____

_____

13. **Could you please indicate :**

A. Your age _____

B. How many years you have been farming _____

C. Education level (check one)

Grade 12 or under _____

Diploma _____

Undergraduate degree _____

Graduate degree _____

14. **Your role in the farming operation is :** _____ owner-operator

_____ manager

_____ other *(please specify_____)*

APPENDIX C:

SURVEY QUESTIONAIRE: NON-SELLERS AND NON-BUYERS

WATER ALLOCATION TRANSFER SURVEY

1. Were you aware of the ability to transfer irrigation water from one user to another in the year 2001?

1 Yes
2 No

2. Did you try to purchase additional water in 2001?

1 Yes
2 No

IF you tried, but could not buy water, what was the PRIMARY reason ?

1. You were unable to find water to buy.
2. Water was too expensive.
3. The process of buying water was too difficult.
4. Other (please specify) _____

2. Did you try to sell some of your water?

1 Yes
2 No

IF you tried, but could not sell water, what was the PRIMARY reason ?

1. You were unable to find a party wanting it.
2. The process of selling water was too difficult.
3. Other (please specify) _____

4. Do you feel there are benefits to being able to transfer water?

1 Yes
2 No

Please explain _____

5. Do you think farmers should have the opportunity to buy and sell water in drought years?

1 Yes

2 No

6. Under what other circumstances would you find water transfers potentially useful?

_____

_____

7. If a drought reoccurred, do you anticipate you would :

A. Sell water? Yes No

B. Buy water? Yes No

Please explain _____

8. Could you please indicate :

A. Your age _____

B. How many years you have been farming _____

C. Education level (check one)

Grade 12 or under _____

Diploma _____

Undergraduate degree _____

Graduate degree _____

9. Your role in the farming operation is :

_____ owner-operator

_____ manager

_____ other *(please specify*_____*)*

APPENDIX D:

COVERING LETTER

Dear Sir/Madam:

You may be aware the Universities of Lethbridge, Calgary and Alberta have established a Water Research Centre. Much of the research will focus on optimal use and conservation of water. Since this is very important to the SMRID we are partnering with the Water Research Centre. The water allocation transfer, or buying and selling of water between Irrigators during the drought of 2001 is currently being studied. You may recall that SMRID sent a questionnaire to all Irrigators at the end of the 2001 season and as a follow-up I ask that you complete and return the enclosed survey. The Water Research Centre is paying all costs for mailing and analysis of this survey.

The results from this survey will be used to gain a better understanding of how the buying and selling of water during 2001 affected the irrigation farmer and the people of Southern Alberta. Some of these results will enable SMRID to improve policies for water allocation transfer.

All information will remain confidential and participation in the survey is voluntary, so your name and/or address is not required. If you have any questions, you can contact Lorraine Nicol at the University of Lethbridge office (329-2512) or home (320-7332) or by email (lorraine.nicol@uleth.ca). Thank you for your cooperation.

Yours truly,

Ron L. Renwick, P. Eng.
General Manager

RLR/dc