EDUCATIONAL AND POLICY APPROACHES TO WATER CONSERVATION FOR THE CITY OF LETHBRIDGE

By

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of

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ABSTRACT

Educational and Policy Approaches to Water Conservation for the City of Lethbridge

By Jennifer Reid

Completed in partial fulfillment of the degree of Master of Environmental Design (Planning)

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Excessive applications of water by Lethbridge residents to lawns and gardens have contributed to negative impacts including slope failures and basement flooding. The purpose of this Master's Degree Project is to develop a water conservation strategy to reduce residential outdoor water consumption.

Successful water conservation programs of selected North American municipalities were examined to identify water conservation options that could be incorporated into the water conservation strategy. The identified options that were highly evaluated in water conservation, energy conservation and recycling literature as well as by Lethbridge discussion group participants were incorporated into the strategy. The options included four educational techniques and 3 general techniques. The educational techniques included bill inserts, brochures and booklets, newspaper articles and workshops. The general techniques included home audits, an increasing block rate structure and landscape ordinances. A three-phase approach was devised that arranged the techniques in an implementation sequence intended to obtain long-term decreases in residential consumption while building and maintaining a high level of public support. At the conclusion of the document future research considerations are discussed.

Key Words

Water conservation | water consumption | behaviour modification | water demand management

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Chapter 1

INTRODUCTION

1.1 Introduction

The City of Lethbridge is located in southwestern Alberta on the east and west valley walls (coulees) of the Old Man River (Figure 1.1). Urbanization has contributed to the development of high water tables throughout the City. The exceptionally high water tables have caused many negative impacts including slope failures that have necessitated the removal of homes in some areas (Berg et al., 1996). In 1997, Berg conducted a study in the community of Varsity Village in order to ascertain the source(s) contributing to the high water tables. He concluded that excessive residential irrigation in-puts were contributing significantly to the high ground water levels. In 1997, a Faculty of Environmental Design student team undertook a review of landscape, municipal policy and program alternatives in order to identify outdoor water consumption reduction options (Cerney et al., 1997). One of their municipal policy recommendations called for the development of a water conservation program.

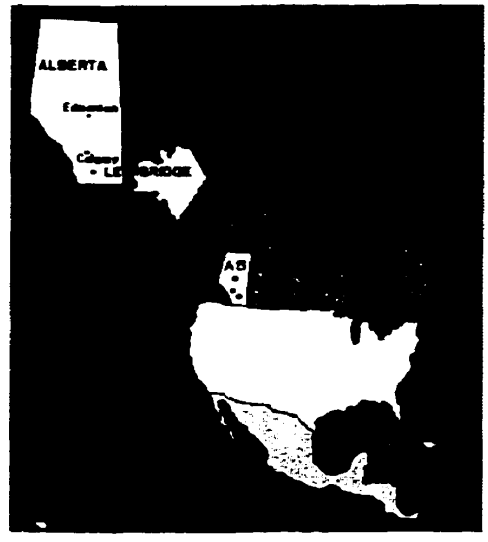


Figure 1.1 Location of Lethbridge within the Province of Alberta
(Modified from www. albertasouth.com)

A water conservation program is defined as the development and implementation of water management options to encourage "the socially beneficial reduction of water use or water loss" (Bauman and Boland, 1980: 4, in Kranzer, 1988). Water management options are the techniques that may be chosen to reduce water consumption. Examples include information campaigns, retrofit programs, water rate structures, water conservation landscaping, and leak detection. The options chosen as part of the program may be completely voluntary, or they may be mandatory, with specific requirements and penalties. They also range from requiring high levels of technology (e.g. a water meter) to requiring little to no technology (e.g. watering less frequently).

The above discussion highlights the fact that municipal water conservation can be handled in many different ways. This flexibility allows a city to develop and implement a water conservation program that is compatible with its needs; however, the flexibility also makes the task of choosing wisely from the range of broad alternatives very challenging. It is evident that the City of Lethbridge would benefit from a study identifying the most appropriate water conservation techniques and how they should be incorporated to create an effective water conservation program tailored to suit its needs.

1.2 Objectives

This Master's Degree Project has several objectives, some are situation specific while others have a potential for broader application. Foremost, this research project is intended to:

- Examine the causes and effects of excessive water consumption experienced by Lethbridge and, in particular, the community of Varsity Village,
- Examine a range of water conservation techniques and other public policy options to ascertain which ones are favored and why,
- Research the literature on public education programs and their potential effect on water conservation, and

- Identify the strengths and weaknesses of public education programs, water conservation techniques and other public policy options and their applicability to the Lethbridge context.

The project also has a more widely applicable objective in that it provides a framework for assessing the effectiveness of water conservation techniques. The research examined, the analysis used and the format of presentation may allow other water conservation planners to establish more formalized procedures to evaluate the water conservation options prior to implementing them as part of a water conservation program.

1.3 Methodology

To achieve the objectives of this Master's Degree Project, the following research methods were utilized: a study of the community of Varsity Village within the context of the City of Lethbridge, a review of water conservation approaches utilized by selected municipalities across North America, an extensive literature review of conservation research, key informant interviews, and feedback from Lethbridge residents who participated in a series of discussion groups.

1.3.1 Study of Varsity Village and Lethbridge

Profiles of the City of Lethbridge and the community of Varsity Village were developed based on their socio-economic, biophysical and physical characteristics. The information was obtained from a variety of sources including: the City of Lethbridge Planning and Development Services Department, the Oldman River Planning Authority, the University of Lethbridge and Statistics Canada.

1.3.2 Water Conservation Approaches Used by Selected Municipalities

Water conservation policies, programs, and techniques adopted by selected mid-sized municipalities were critically evaluated. The four municipalities researched were selected based on many factors including their population size and climate as well as having a universal water metering program and an active water conservation campaign targeting residential customers in place.

1.3.3 Literature Review

A literature review was undertaken on water conservation, energy conservation and recycling research. Most of the information obtained was from reputable research journals, government documents and theses projects; however, information from the internet was also used. The findings were compared with findings obtained from Lethbridge discussion groups regarding preferred and effective water consumption reduction techniques.

1.3.4 Key Informant Interviews

Semi structured key informant interviews were conducted with individuals from several departments at the City of Lethbridge to define the water management issues that face the City of Lethbridge and to frame the subsequent discussion group process. The informant's expertise was sought on a variety of topics including municipal policies, water supply, water consumption, water conservation methods, and the public's receptiveness towards conservation.

1.3.5 Discussion Groups

The water conservation strategy included a limited public consultation process because the residents must ultimately accept, adopt and pay (indirectly or directly) for the water conservation options that are implemented. They are responsible for the consumption reduction the water conservation program achieves. Therefore, their involvement is crucial if an acceptable and effective water conservation program is to be developed.

Discussion groups were chosen to obtain public input towards the development of a water conservation strategy. This approach was chosen because financial resources were limited and feedback from discussion groups has been shown to be an effective way to develop a clearer understanding of individual's perceptions, motives, attitudes and feelings towards a product, experience, situation, program or policy (Anderson, 1998; MacNealy, 1999). They have also been found to be particularly effective in front-end evaluations during strategic planning exercises (Civitarese, 1998).

Four discussion groups were conducted in the City of Lethbridge, two with residents from the community of Varsity Village and two with residents who resided in communities other than Varsity Village. Two discussion groups were conducted in each of the study areas because Krueger (1994: 97) has found that "typically the first two groups provide a considerable amount of new information, but by the third and fourth session, a fair amount may have already been covered". Approximately twelve individuals were invited to each of the two hour discussion groups with the expectation that the ideal number of five to eight participants would attend.

Convenience sampling was used to obtain sample populations of interest. It is not considered a particularly rigorous method; however, it is the method of choice given the fact that it is often difficult to attract participants (MacNealy, 1999). All interested parties were asked to fill out a survey to ensure that they met certain criteria (refer to Appendix B). Individuals who met the criteria were then provided with letters of invitation that included the date, time and location of a particular discussion group (refer to Appendix C) as well as an information booklet that included the topics to be discussed (refer to Appendix D). The meeting places chosen facilitated informal conversation and were located in central locations. Each participant who attended the discussion was informed that he or she could refuse to answer questions and withdraw from the group at any time (refer to Appendix F).

1.3.6 Summary

The information obtained from the aforementioned procedures was integrated into a coherent water conservation management strategy for the City of Lethbridge. The strategy outlines a procedure for integrating effective water conservation techniques into a successful water conservation program given the City's unique situation.

1.4 Research Limitations

This study has a number of limitations:

1. As in most social science research, predicting and understanding behaviour is a difficult and complex task. In an effort to minimize this methodological concern, previous

behaviour research with respect to energy conservation, recycling, and water conservation techniques employed by other municipalities was examined to develop a strong framework. A water conservation strategy that addresses the City of Lethbridge's unique situation was created by incorporating feedback obtained from local residents and key informants into the framework.

2. None of the selected municipalities independently evaluated the effectiveness of their water conservation programs. Due to the lack of applied water conservation studies available, this study primarily explores professed water conservation activity and utilizes information obtained from conservation literature and discussion groups to evaluate the effectiveness of the water conservation techniques. Additional applied studies that document the relationship between water conservation techniques and changes in water consumption behaviour are needed.

3. Some of the information provided in this study was obtained from conversations with administrative personnel. As a result, the accuracy of the data reflects the knowledge of the persons contacted.

4. Data provided by the municipalities in Chapter 3 was presented in diverse formats; therefore, comparison was difficult in some instances.

5. Insufficient water demand data and population growth statistics over a consecutive year timeframe were provided by the selected municipalities. Therefore, in Chapter 3, the effect of each municipality's water conservation programs on water consumption could not be independently determined.

6. Due to time and financial constraints, limited public input was achieved. Broader public involvement would have ensured greater levels of acceptability for the proposed strategy.

1.5 Document Organization

Beginning with an introductory chapter, the body of this study is organized into three main subject areas followed by a concluding chapter. Briefly they proceed as follows:

Chapter 1 – "Introduction" outlines the issue at hand, the purpose of the investigation and the method of inquiry.

Chapter 2 – "Regional, Municipal and Community Profile" is a comparative review of the City of Lethbridge and Varsity Village, the study community. The chapter begins with a description of the characteristic climate, physiography, geology, soil and vegetation of the region. This section is followed by an examination of the impacts resulting from excessive irrigation. Finally, in the community profile section, selected socio-demographic attributes of the community of Varsity Village are compared and contrasted with the City of Lethbridge.

Chapter 3 – "Water Conservation Techniques Employed by Selected North American Municipalities" details the water conservation techniques developed and implemented by selected municipalities to reduce outdoor water consumption.

Chapter 4 – "Evaluation of Water Conservation Techniques" evaluates the effectiveness of various water conservation techniques according to criteria developed from the conservation literature and feedback obtained from the Lethbridge discussion groups.

Chapter 5 "Water Conservation Strategy for the City of Lethbridge" outlines a strategy for integrating effective water conservation techniques into a successful water conservation program.

Chapter 2

REGIONAL, MUNICIPAL AND COMMUNITY PROFILE

2.1 Introduction

The purpose of this chapter is to provide background information that is necessary to understand why high water tables are developing in Lethbridge and their resulting negative effects. The chapter begins with an overview of hydrology and its relationship with the Lethbridge region's natural environment. In the second section the evolution of Lethbridge from a small mining settlement into a modern City is provided. This section is followed with a brief examination on how urbanization, residential landscapes and watering practices have altered the region's hydrology. The chapter concludes with a community profile of Varsity Village. It was chosen as the study community because previous research conducted in this community determined that residential irrigation significantly contributed to the development of abnormally high water tables (Berg, 1997; Berg et al., 1996; Berg and Byrne, 1998). In order to form a better picture of the community, socio-demographic attributes including educational level, gender, home ownership and age are examined. The community's attributes are compared with those from the City of Lethbridge in an effort to gain valuable insight regarding how best to address excessive outdoor water consumption in order to develop an effective and widely accepted water conservation strategy.

2.2 Regional Environment

> *The Origin and vitality of the city of Lethbridge is deeply rooted in its natural environment (Johnston and den Otter, 1985: 9).*

To fully appreciate the unique environmental issues that the City of Lethbridge currently faces, a basic understanding of hydrology is required. Hydrology is the study of the occurrence, distribution and movement of water on earth (Fetter, 1994). The hydrologic

cycle is the central focus of hydrology. The cycle has no beginning or end and its many processes occur continuously (Chow et al., 1988). As shown diagrammatically in Figure 2.1, a portion of water vapor in the atmosphere condenses and gives rise to precipitation. Precipitation either evaporates while falling; is caught by vegetation cover or building structures; flows over the ground surface as runoff or infiltrates into the soil and contributes to soil moisture. The accumulated soil moisture is often removed through evapotranspiration which is the cumulative water loss resulting from land surface evaporation and transpiration from vegetation. Soil moisture may also be removed by the downward percolation of water to depths where it is held for extended periods of time.

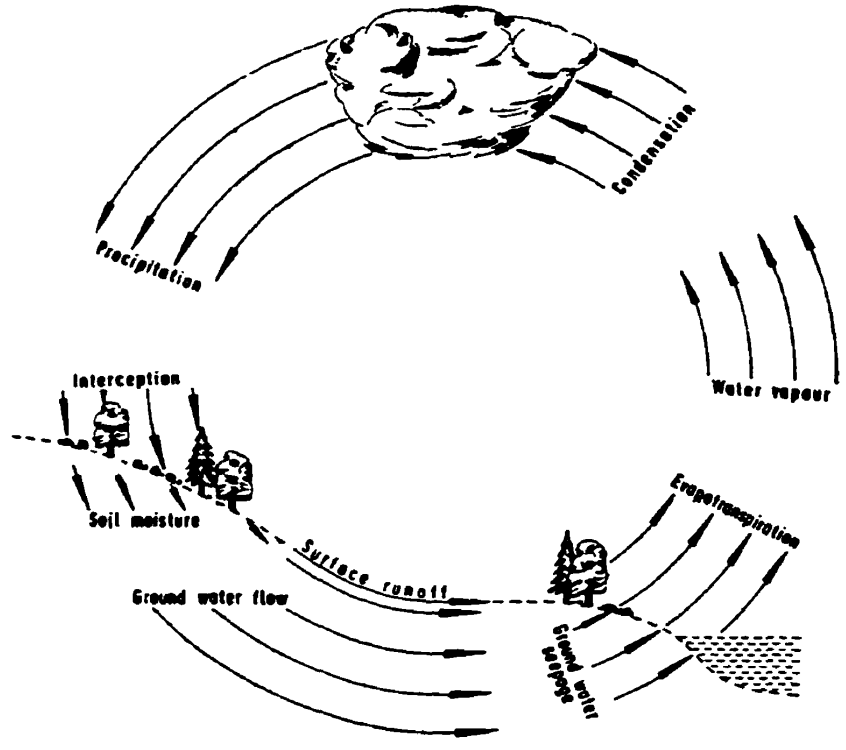


Figure 2.1 Simplified Diagram of the Hydrological Cycle
(Modified from: Ward, 1967)

The aforementioned hydrological processes are very complex and are often examined using a simplified system concept that focuses on an individual catchment area and where an attempt is made to define the inflow and outflow of water. For a delineated catchment

area, over a specified time frame, the relationship between the inflow and outflow can be examined using the water balance equation expressed as:

Inflow = Outflow +/- changes in storage

This approach allows for the investigation of the interaction between specific elements of the hydrologic cycle. For example, in undeveloped areas the inflow generally includes: stream flow and overland flow, precipitation, and ground water inflow from outside the catchment area (Fetter, 1994). The outflow includes evapotranspiration, surface water runoff, and ground water outflow (Fetter, 1994).

It must be emphasized that every catchment area is unique and the components of the water balance equation vary according to what is being studied, the size of study area and the time frame. In addition, the vegetation, climate, physiography, and surface geology influence the relationship between the water inflows and outflows. To better understand this relationship within the Lethbridge context a brief summary of the region's climate, natural vegetation, physiography and geology are discussed below.

2.2.1 Climate

The City of Lethbridge is located within the Southern Canadian Prairies region of Alberta. The climate is characterized as having short warm summers and long cool winters. July is the warmest month with an average daily temperature ranging from 10.9°C to 25.9 °C (Environment Canada, 1993b). January, the coldest month, has an average temperature ranging from –2.6 °C to –14.2 °C (Environment Canada, 1993b). The frost free period is typically above 115 days with a growing season of approximately 185 days (Dzikowski and Heywood, 1990). The characteristics of rainfall in this region are: limited amount, temporal variability, and unpredictability (Chang et al., 1990). The average annual precipitation is 397.6 mm (Environment Canada, 1993b).

Precipitation is the term employed for all forms of atmospheric moisture the falls on the ground including: drizzle, rain, sleet, snow, dew and hail. It results when a body of moist air is lifted causing the water vapor to cool and condense into a cloud of water droplets. The amount of precipitation that an area receives varies in space and time according to the

general pattern of circulation and according to local factors (Rodda et al., 1976). For example, Lethbridge receives less precipitation than coastal locations in part because: (1) it is located at a greater distance from oceans, the main sources of precipitation, and (2) a lot of the moisture present in the westerly winds is extracted on the windward side of the Rocky Mountains causing the development of a rain shadow on the leeward side where Lethbridge is located. The Lethbridge region also experiences seasonal variability of precipitation with over 60% of the precipitation received falling from May to September. "Seasonal variation occurs when annual oscillations in the atmospheric circulation changes the moisture inflow over the region (Chow et al., 1988) and continental interior locations like Lethbridge commonly experience rainfall maximums during the summer months (Ward, 1967).

2.2.2 Vegetation

The native vegetation in Lethbridge is part of the mixed flora sub-region of Alberta. The composition of the vegetation cover in this region is influenced by variations in topography that create differences in exposure, orientation and access to moisture. As a result, areas with distinct vegetation exist including the plains, the coulee slopes, and the river valley.

The characteristic grasses on the plains include June grass, blue grama grass and spear grass. The grasslands also support an abundance of wildflowers. Prairie crocus is a common spring flower, while golden bean, goldenrod, and aster flower into the fall. The common grasses on the plains can be found on the coulee slopes. However, their abundance, location and the prevalence of other species are largely affected by the slope direction and elevation. On the south and west slopes where wind and sun prevail, grasses, prickly pear cactus, sage, yellow locoweed, and milk vetches are common. On the north and east facing slopes, the grasses tend to be higher and form a denser ground cover (City of Lethbridge, 1986). In addition, because soil moisture and shade are greater, isolated patches of shrubs such as Saskatoon, snowberry, buffaloberry, and silverberry occur.

Riparian or riverine woodlands in Lethbridge typically exist on the floodplain zones and creek valleys of the Oldman River. Species that are commonly found within this area include: cotton wood, red-osier dogwood, willow, Saskatoon, wild rose, chokecherry, and

silverberry. These species may also be found further up the coulee slopes near water sources such as seeps, springs or drainage courses. In addition to the woodland vegetation, wetland vegetation is also found in the river valley where pools of standing water occur. The wetland community is comprised of submerged aquatic plants such as cattails, bulrushes, sedges and reeds.

Many of the aforementioned native plants are drought tolerant. They are called xerophytes and they are well equipped to survive Lethbridge's semi-arid environment. Typically, they have far reaching shallow root systems and narrow leaves covered with thick waxy cuticles. Although they are efficient water users, like all plants, they continuously lose water to the atmosphere through stomata primarily located on leaf surfaces. This process is called transpiration. Concurrently, evaporation of water directly from the soil and vegetation surfaces is constantly occurring. Under field conditions it is not possible to separate evaporation from transpiration; therefore, the collective water loss is assessed. It is referred to as evapotranspiration.

When there is an abundant supply of water available in the soil the rate of evapotranspiration is referred to as potential evapotranspiration. Berg (1997) used a modified Jensen Haise equation to estimate potential evapotranspiration occurring in the Southern Alberta Chinook region. The equation is expressed as:

$$PE = 0.00824(RS)(TAVG+7.1)\ 0.00304(W)$$

Where:

RS = daily solar radiation

TAVG = average temperature

W = wind

PE = potential evapotranspiration

The resulting value of potential evapotranspiration must then be multiplied by a coefficient representative of the water usage of a specified plant since water rates differ between plant varieties depending on factors such as rooting depths and stage of growth (Berg, 1997: 18).

In semi-arid locations like Lethbridge, actual evapotranspiration is often much less than potential evapotranspiration because the soil moisture frequently drops below field capacity which is the amount that the soil can hold against gravity by surface tension. As the moisture in the soil diminishes, a plant's ability to extract it is reduced. The reduced uptake causes a reduction in the evapotranspiration rate. The wilting point of a plant can subsequently be reached when moisture becomes so limiting that it is unable to take up water because the tension of the soil-water interface exceeds the osmotic pressure of the roots (Fetter,1994). The amount of water held within the soil between the wilting point and field capacity that is used by plants for growth and transpiration is often termed the available water capacity.

2.2.3 Physiography

The City of Lethbridge is located within the Eastern Alberta Plains Physiographic division of Alberta. The local landscape consists of a gently rolling till plain that slopes down towards the Oldman River approximately 90 m below (Berg, 1997). The Lethbridge area owes its physiography to glaciation events that have taken place over the past three million years (Beaty, 1975). The present natural form of the area is primarily the result of the last major glaciation event that began approximately 15,000 years ago with the advancement of the Laurentide glacier. The glacier began to retreat approximately 12,000 years ago and the runoff initiated the downcutting of the Oldman River which has carved a valley 1500 m to 2000 m wide that encompasses the coulees and the flood plain. (City of Lethbridge, 1986).

2.2.4 Geology

Downcutting by the Oldman River has exposed the geological deposits located below the City of Lethbridge (Fig. 2.2). From the oldest deposits (bottom of the river valley) to the most recent, the typical strata include bedrock (Oldman Formation followed by the Bearpaw

Formation) and surficial deposits consisting of Saskatchewan Sands and Gravels, lower till, upper till, and lacustrine deposits.

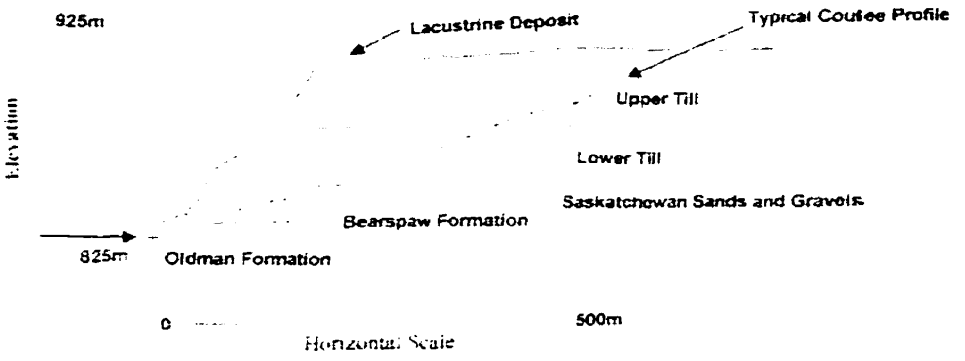


Figure 2.2 Strata Underlying the City of Lethbridge (modified from Berg, 1997)

The Cretaceous bedrock formations, the Oldman and the Bearpaw are visible near the base of the Oldman River valley. The river level bedrock layer is called the Oldman Formation. It is composed of a sequence of non-marine shales and sandstones with the presence of coal seams and carbonaceous shales (City of Lethbridge, 1986). It begins approximately 2 m above the river level and is up to 210 m thick. The Bearpaw bedrock formation is the upper-most bedrock layer composed of silty shale and clayey sandstone (Berg, 1997).

The surficial deposits located above the bedrock are the materials that comprise the soil (Plummer and McGeary, 1991). A soil is often described in terms of its horizons. Rodda and others (1976) state that typically three horizons can be recognized:

Horizon A topsoil: zone of cultivation, root growth and organic decay

Horizon B subsoil: weathered bedrock

Horizon C: fragmented bedrock

The texture and the structure of a soil is dependent on the size of the particles. A commonly used size classification is shown below.

Name	Size Range (mm)
Gravel	> 4.76
Sand	4.76 - .074
Silt	.074 - .002
Clay	< .002

The Saskatchewan Sands and Gravels layer is up to 12 m thick and is located 25 m to 40 m above the river valley. The primary water table is located in this layer. Above the Saskatchewan Sands and Gravels, the landscape is a till plain that consists of a heterogeneous mixture of glacier carried rock materials. Generally the till is divided into two sequences, an upper weathered unit and a lower non-weathered unit (Berg, 1997). The lower, non-weathered unit has a high composition of clay and is approximately 3 m thick. The upper segment of till is primarily composed of clays and silts that form a layer that is approximately 40 m thick. Lacustrine deposits composed of silts and sands are observed above the till in the eastern portion of the City of Lethbridge; however, only isolated pockets have been observed in Varsity Village (Berg, 1997).

The texture of the soil influences the storage and movement of water. Figure 2.3 shows how the moisture characteristics of a soil are related to its soil texture.

The moisture level of a soil is also related to its location within the soil profile. Fetter (1994) divided the downward distribution of moisture within the soil into three zones: the soil moisture belt at the surface, the capillary fringe and an intermediate zone located between the soil moisture belt and the capillary fringe. Each of the zones is discussed briefly below.

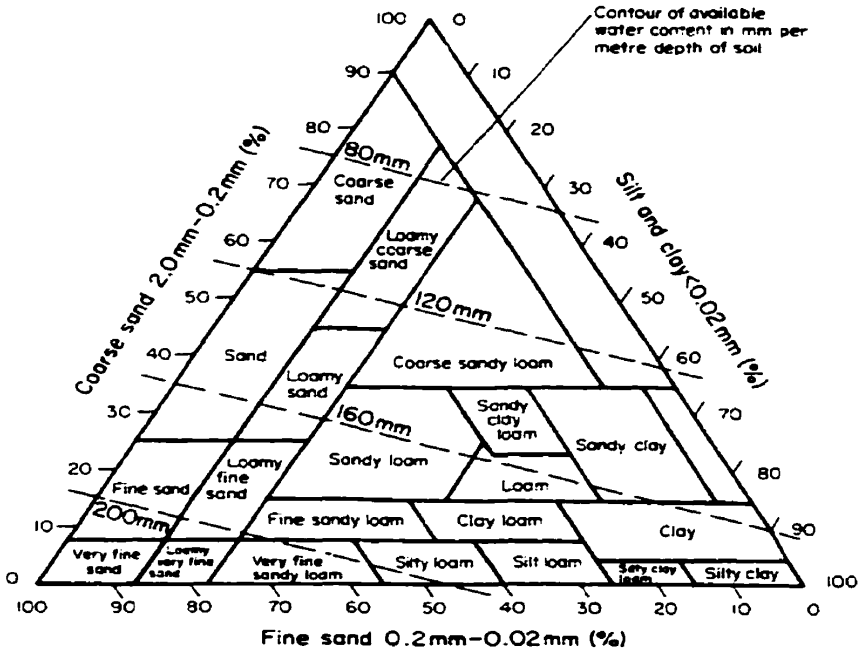


Figure 2.3 Graphical Method for Determining Available Water Capacity
(Modified from: Rodda et al., 1976)

2.2.4.1 Soil Moisture Belt

The soil moisture belt extends from the land surface to a depth of the plant roots (Fetter, 1994). The water in this zone is utilized by plants for growth and transpiration. In Lethbridge, this zone extends to approximately 3 meters. The amount of moisture in this zone is dependant on the amount of precipitation and evapotranspiration that occurs at a given time. As discussed earlier in this chapter, precipitation and evapotranspiration are subject to significant seasonal fluctuations. For example, in the Lethbridge region during the spring, moisture is high within the soil moisture belt due to the infiltration of water from precipitation and snow melt. In the summer, warmer temperatures and decreased precipitation contribute to a decrease in the soil moisture content.

2.2.4.2 Intermediate Zone

The intermediate zone is an unsaturated belt where the soil spaces are partially filled with air and water. Responding to the pull of gravity, water percolates into and through the intermediate zone. The rate that the water is able to travel through the zone is dependent

upon its depth. The rate is also greatly influenced by the soil's permeability which is its capacity to transmit fluids.

The high composition of clay and silt particles in the Lethbridge region's soil cause it to be less permeable than soils with a higher composition of coarser grains. In the fine grained soil, the spaces between particles are very small and often unconnected. The lack of interconnected spaces coupled with the molecular attraction between the particles greatly slows the drainage rate. The vertical movement of water in the upper till is estimated to be 0.1 m per year. The movement of water in the lower till layer is estimated to be 2 m to 6 m per 1000 years (Berg, 1997).

2.2.4.3 Capillary Fringe

The capillary fringe is a transition zone between the water table and the intermediate zone. When the front of the percolating water reaches the capillary fringe, it displaces air in the soil spaces and causes the water table to rise. In Lethbridge, the soil's low permeability combined with frequent moisture deficits in the soil moisture belt contribute to a situation where very little of the moisture that enters the ground surface ever reaches the water table.

2.3 Settlement

The banks of the Oldman River, within the City of Lethbridge, provide evidence of what drew people to initially settle in this area. As mentioned in the previous section, approximately 2 m above the river level, a coal seam up to 1.6 m thick exists. By the late 1860's the presence of the coal seam was known; however, coal mining remained small in scale because local demand was insufficient to warrant greater activity and there was not an economical way to transport it to larger industrial centers. This changed in 1881 when the Canadian Pacific Railway decided to extend the railway across the southern plains. Following this announcement, Sir Alexander T. Galt, with a group of prominent investors, formed the North Western Coal and Navigation Company. The company quickly determined that an extension of the main southern plains railway line at Dunsmore (now Ft. Macleod) to their mine at Coalbanks was required in order to ensure the company's future. Because Federal administrators were anxious to secure a stable fuel supply for their prairie

settlements and western railways, an agreement was made with Sir Alexander T. Galt to construct a narrow gauge railway line linking the main line with the mine located 175 km away. The Federal Government also granted a precedent-setting subsidy of 965 hectares of land per kilometer of railway for a minimal charge and sold the company 10,000 acres of coal lands at $10 an acre (Fooks, 1988). With an efficient means of transportation acquired, the North Western Coal and Navigation Company commenced full production. By October 1885, the Coalbanks settlement boasted over 60 buildings including 6 stores, 5 saloons, 4 billiard rooms, 2 barber shops and a livery stable (Johnston and den Otter, 1985). The mining settlement was subsequently incorporated into the Town of Lethbridge in January of 1891. At the time of incorporation the population was 1, 478.

Although there were high expectations for the growth of Lethbridge based on the demand for coal, the small local market coupled with the long distance to industrial centers minimized the coal industry's growth potential. Beginning in the 1890's greater attention was paid to attracting settlers to farm in the area. Although the land was fertile, the lack of precipitation made farming difficult. In 1898, the Federal Government and the Canadian Pacific Railway funded a large scale irrigation project and by 1900, 153 kilometers of canals had been dug (Johnston and den Otter, 1985). The success of this project led to additional projects and the creation of irrigation districts such as Lethbridge Northern in 1935. Immediately following World War II, the projects were further expanded by government with such innovations as the St. Mary's River Development scheme (University of Lethbridge, 1999 [on-line]). During this time agriculture related activities continued to expand and Lethbridge began to be referred to as an Agricultural Service Centre.

Public health facilities also began to expand following World War II. By the mid 1960's, the City of Lethbridge enjoyed superior health facilities and had well over 100 practicing physicians, dentists, chiropractors, and optometrists (Johnston and den Otter, 1985). In the late 1950s and early 1960s, post secondary education began to influence the development of the City. Post secondary education was supported because it brought "important economic benefits without any detrimental side effects" (Johnston and den Otter, 1985: 198). In 1957 the Lethbridge Junior College opened. A decade later the Alberta Provincial Government decided to locate the Province's third University in the City of Lethbridge. The

selection of the west side of the Oldman River as the location of the University dramatically changed the City's urban form. Before that time the entire city was situated on the east side of the river. Immediately following the decision, the City began negotiating with land owners to obtain land for further developments. The 1969 long term development strategy for the urbanization of the west side envisioned making the University an integral part of the future development of the City (City of Lethbridge, 1979). In keeping with this strategy, residential as well as other developments were planned for which the University has an affinity for attracting. Residential development in West Lethbridge began in 1973 with the construction of Varsity Village. By 1999 the population of West Lethbridge and the City of Lethbridge had grown to 19,764 and 68,712 respectively (City of Lethbridge, 1999b [on-line]).

Its continued prosperity is due in part to its location along major highways. It is located on Highways No. 3 and No. 4. Highway No. 3 is the primary highway running east and west in Southern Alberta. Highway No. 4 links the City with trading partners located in the United States. It is also in close proximity to the Highway No. 2 that runs north towards Calgary, a major population center. Its location near major traffic routes has provided opportunities for the expansion and diversification of the local economy in order to serve approximately 275,000 people within the trading area (Fig. 2.4) (City of Lethbridge,1999 [on-line]). Today, in addition to being an agricultural service center, the City of Lethbridge is a commercial, health and advanced education center for Southern Alberta and Southeastern British Columbia.

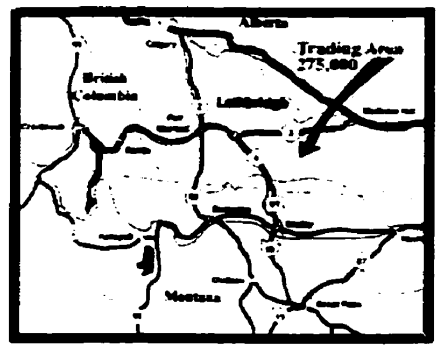


Figure 2.4 Primary Highways located in the Vicinity of Lethbridge
(Modified from: City of Lethbridge, 1999 [on-line])

2.4 Impacts

Although urbanization has significantly contributed to the City of Lethbridge's growth and development, it has altered the dynamic equilibrium of the hydrological cycle. The urban hydrological cycle differs from the hydrological cycle in undeveloped areas largely because of the provision of a piped water supply. As a result, the following modified water balance equation is used in urban settings:

$P + I = r + E + \Delta S$ (Grimmond and Oke, 1986).

The inputs include precipitation (P) and piped-in water (I). The outputs include: runoff (r), evapotranspiration (E), and net change of water storage (ΔS). The piped-in water supply is divided into two components: the external subsystem and the internal subsystem. The internal subsystem consists of water piped throughout the defined urban catchment area. The external subsystem includes the anthropogenic modifications that significantly impact the hydrological cycle throughout the defined catchment area. The modifications include: surface cover changes such as the removal of vegetation and paving; artificial drainage networks; and piped water for outdoor uses such as irrigation. The external subsystem significantly alters the hydrological cycle because it combines the anthropogenic networks with natural processes and environments to form an altered hydroclimatological feedback system (Grimmond and Oke, 1986).

In Lethbridge the external system has lead to an increase in the water inputs and a decrease in the water outputs, resulting in an enhanced ground water recharge rate (Berg, 1997). The enhanced recharge rate has resulted because natural vegetation is removed and the landscape recontoured to build homes, streets and parking lots that are constructed out of highly impermeable materials such as asphalt and concrete. As a result, water that once returned to the atmosphere through evapotranspiration infiltrates into the soil. This water source coupled with excess water from excessive lawn watering contributes to a greater ground water supply. The greater volume of water has contributed to the formation of perched water tables that are commonly situated several meters below the ground surface, far above the regional water table.

An examination of the hydrogeological properties of the underlying strata explains why perched water tables frequently occur in the Lethbridge region. The primary cause is the low vertical permeability of the upper till which is 2.5 x 10^{-9}m/s to 7.0x10^{-7}m/s (Berg, 1997). This drainage rate is far lower than the infiltration rate of the upper top soil which is 4.38x10^{-5} m/s. Whenever the rate of recharge exceeds the natural drainage rate, a perched water table results.

Berg (1997) conducted an urban ground water study in the community of Varsity Village to identify the sources contributing to the elevated water tables. Varsity Village is a 615 acre site delineated on the northwest by Whoop-Up Drive, on the northeast by University Drive, on the south by Macleod Drive and on the southwest by Benton Drive (Fig. 2.5). It is a typical suburban community with residential development accounting for 54 % of the land base (Fig . 2.6). Single family dwellings that have an average lot size of 572m^2 comprise 40% of the housing units (Fig. 2.7) (Berg and Byrne, 1998). Approximately 52% of lots are covered by lawns and gardens under irrigation (Berg and Byrne, 1998). Although landscaping was recognized as an "important component in the overall residential environment" (City of Lethbridge, 1979) in the Area Structure Plan, specific guidelines with respect to appropriate landscaping practices and materials were not included. As a result, the majority of landscapes have drought intolerant lawns composed of non-native species such as Kentucky blue grass.

Because of the limited amount of moisture provided in the semi-arid environment, irrigation is often necessary to maintain the lawns and gardens. The amount of water the lawns require is equivalent to the amount of water that has been drawn from the soil in a specified period through evapotranspiration. An estimation of this value can be obtained using a math formula which calculates the evapotranspiration rate (ET). The amount of water that must be applied through irrigation to make up the water deficit is determined by subtracting the amount of precipitation the area has received from the ET value for the plant species of interest.

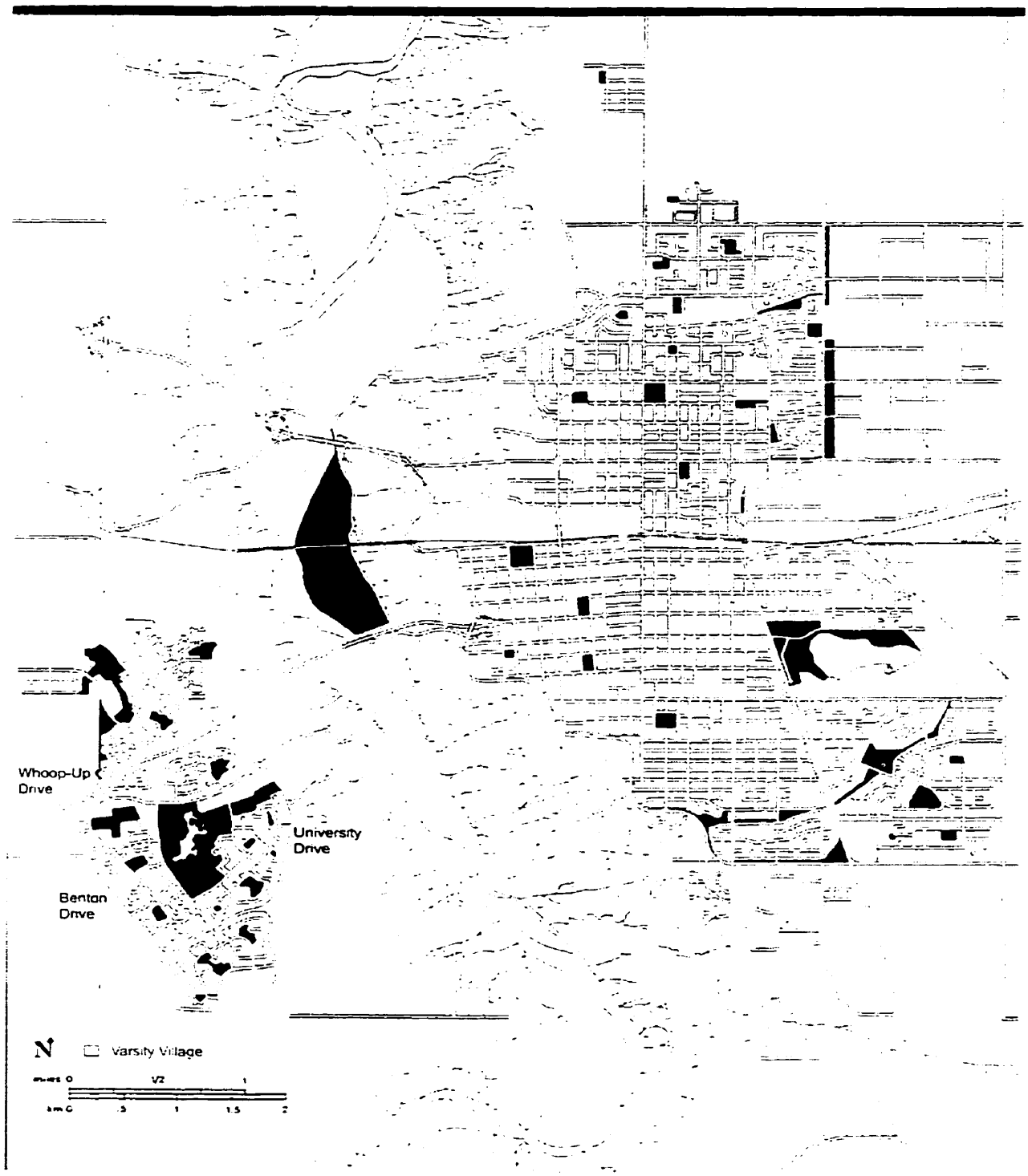


Figure 2.5 Community of Varsity Village

(Modified from: City of Lethbridge, 1996)

Unfortunately, ET data is not readily available to the citizens of Lethbridge[1] and it has been found that unknowing individuals often apply excessive amounts of irrigation to lawns and gardens in climates where irrigation has to be intermittently or continuously practiced (Forester and Morris, 1994). In a study conducted by Berg and others (1996), water table development due to household irrigation in Varsity Village was monitored over a five year period (1990 to 1994). They found that "the application of irrigation was not only in excess of

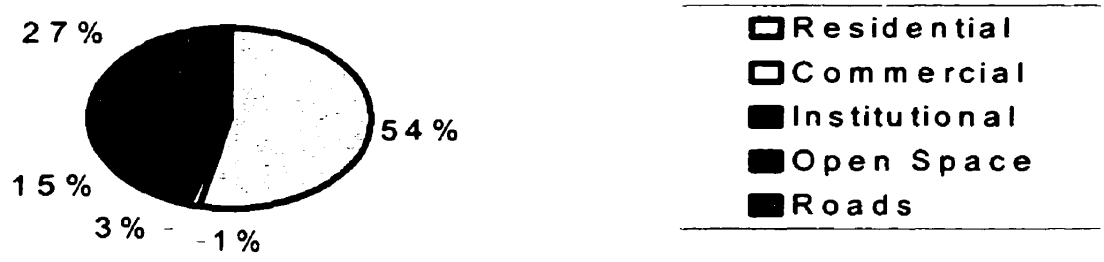


Figure 2.6 Land Use in Varsity Village
(Source: Berg and Byrne, 1998)

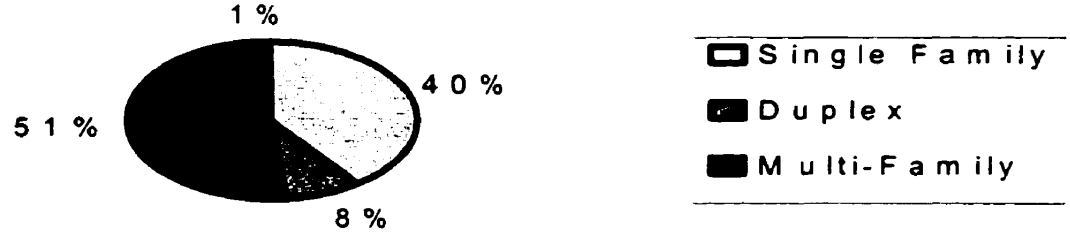


Figure 2.7 Housing Types in Varsity Village
(Source: City of Lethbridge, 1979)

[1] The University is developing a water scheduling program that will be incorporated into a water conservation web site that will provide ET data by the summer of 2000.

the turf grass requirements, but the volumes of water applied did not adjust to the changing weather conditions" (Berg and Byrne, 1998: 71). Figure 2.8 shows that with the exception of July, the combination of irrigation and precipitation in Varsity Village resulted in the application of water that exceeded the turf grass water requirements.

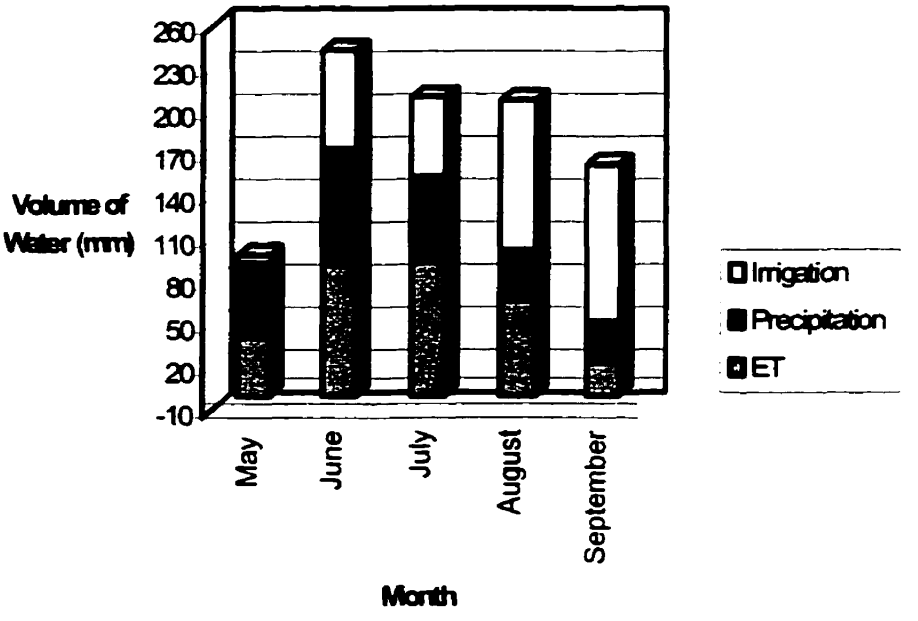


Figure 2.8 Average Water In-Puts in Varsity Village from 1990 to 1994
(Data obtained from: Berg and Byrne,1998)

It is widely accepted that excessive application of irrigation is not unique to Varsity Village; it is a serious problem throughout the City of Lethbridge (Berg, 1997; Berg and Byrne, 1998; Berg et al., 1996; Geiger, 1962; Ruban and Thomson, 1983). The excess water, unutilized by the turf, moves beyond the root zone and contributes to ground water recharge and water logging problems (Chang et al., 1990). Several of the major water logging problems that are occurring within the City of Lethbridge include reduced strength of large paved surfaces such as parking lots, basement and utility corridor flooding, and slumping of coulees.

2.4.1 Weakening of Paved Surfaces

On the University of Lethbridge campus, it was found that asphalt surfaces used for parking were weakened because the underlying clayey soil was saturated with water. The situation resulted because the asphalt prevented evaporative losses (Stanley and Associates Engineering Ltd., 1993). The paved surfaces were weakened in part because of frost heave and subsistence processes occurring in the soil.

The wet clayey soil is susceptible to frost heave which occurs when water collected in soil cavities begins to expand as it freezes. The ice attracts surrounding water droplets that increase its size. As the mass of ice enlarges, greater quantities of soil are displaced. The end result is the heaving of the ground surface. If the composition of the soil below the paved surfaces surface was uniform structural damage would not result; however, at the University the soil composition is variable because of cut and fill operations used to recontour the land prior to development. Consequently heaving is more severe in some areas than others. The asphalt surfaces crack because they can not withstand the variations in stress. The situation intensifies in the warmer months when the ice melts and potholes replace the heaves. In an attempt to rectify the situation, drains were installed on the University of Lethbridge campus to remove the excess water. Drain installation is a less than ideal solution because subsistence, the downward movement of the wet clayey soil, is likely to occur when it is dried out by artificial draining. Further damage to the paved surfaces may result when differential shrinking of the soil occurs.

Weak paved surfaces is not unique to the University of Lethbridge campus. Berg (1997) expects similar problems to result in other paved locations such as the Nicholas Sheran Leisure Centre and the Varsity Village Shopping Centre.

2.4.2 Flooding of Basements and Utility Corridors

Flooding of basements and utility corridors is a common occurrence in Lethbridge particularly in lower lying moist areas. It results when water collects in the soil around the foundations. The water pressure subsequently builds up on the floor and walls and gradually flows into the basement or corridor through cracks in the concrete. Flooding has prompted the installation of subsurface drains in utility corridors in some instances (Berg,

1997) and the installation of sump pumps in the basements of affected homes. The cost to purchase, maintain, and replace the aforementioned ameliorative measures demonstrates that they are less than ideal solutions.

2.4.3 Slope Failures

The mass movement of materials that occur on the coulees in Lethbridge are referred to as slumps. Slumps involve the movement of materials along a curved surface, the upper part moving downward while the lower part moves outward (Plummer and McGeary, 1991). Both the west and east sides of the Oldman River have been subjected to a decrease in stability due to the development of perched water tables. The decreased stability has resulted in numerous slope failures throughout the City. Two of the larger failures affected the communities of Park Royal Estates and Tudor Estates (Fig. 2.8). In addition, the Stafford coulee slope failure necessitated the removal of eight homes in the area (Fig. 2.8). More failures are expected if ground water recharge rates are not significantly curtailed.

Several factors have been identified that influence mass movement of coulee slopes in Lethbridge. Among them, the grain size of the soil particles, the influence of the saturated soil conditions and the Chinook winds are several of the most significant.

2.4.3.1 Grain Size of the Soil Particles

Clayey soils have the greatest slide potential because they hold water that adds weight to the soil. As the mass on the coulee slope becomes heavier, the likelihood that it will flow downslope because of the added gravitational force increases.

2.4.3.2 Saturated Soil Conditions

Perched water tables create saturated soil conditions within several meters of the earth surface in Lethbridge. In saturated soil, the water between the soil particles reduces the cohesion and acts as a lubricant. It " floats" the particles and makes them more susceptible to gravitational forces.

2.4.3.3 Chinook Winds

The Chinook winds influence the location of the slope failures because they redistribute snow onto the East, Northeast, and North Facing slopes. The additional moisture provided makes these slopes more susceptible to slope failures. South and Southwest facing slopes are the least susceptible due to the drying combination of the Chinook winds and solar rays.

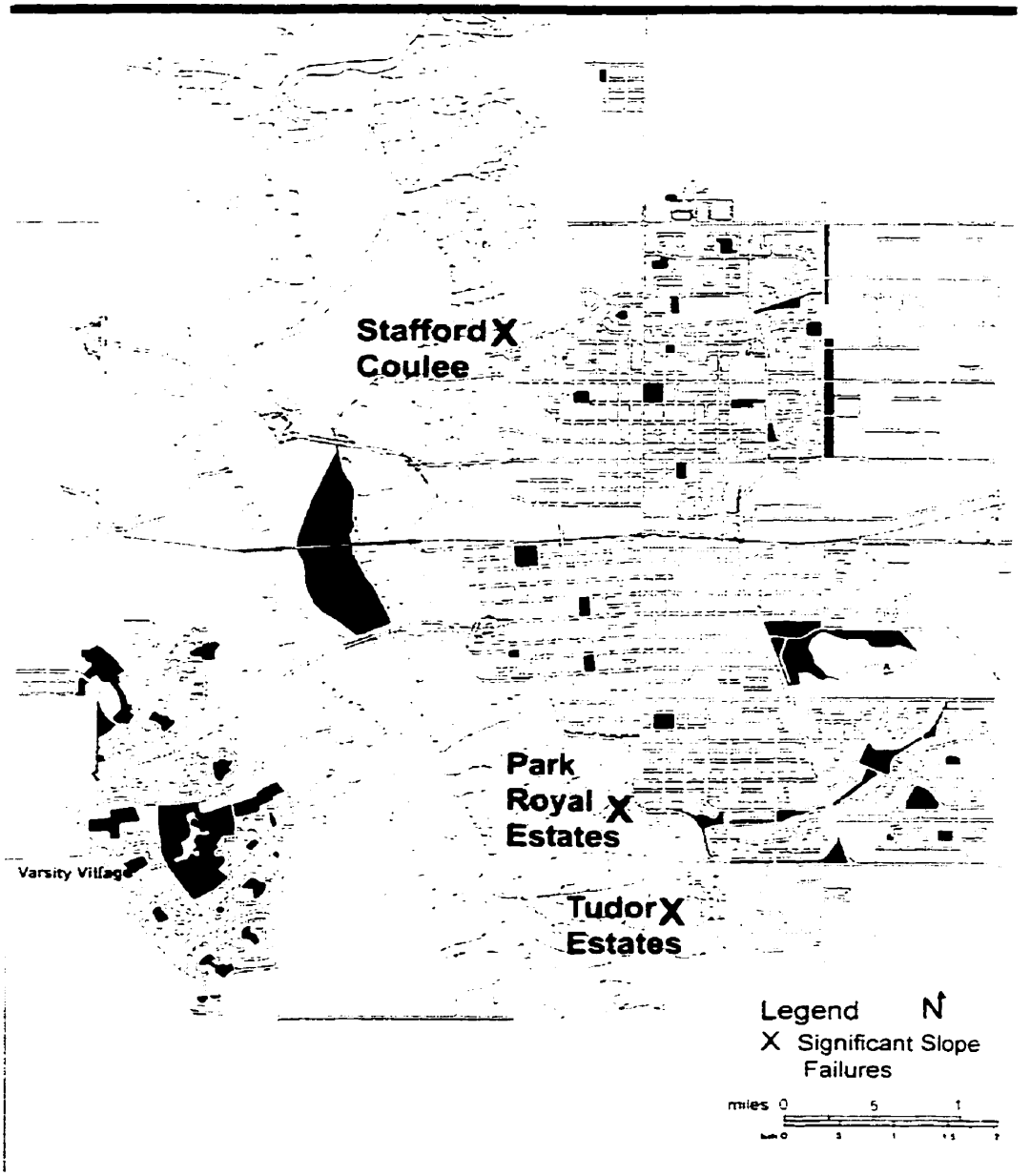


Figure 2.9 Significant Slope Failures within the City of Lethbridge
(Map modified from City of Lethbridge, 1996)

2.4.4 Summary

It is evident that the adoption of appropriate landscaping and irrigation practices by residents could significantly reduce the amount of the input of water thereby reducing the perched water tables and the resulting negative impacts.

2.5 Influence of Socio-demographic Attributes on Water Consumption

In this section the community profile of Varsity Village residents is compared with the profile of Lethbridge residents to gain an understanding of the similarities and differences that exist between the two populations and to obtain information that will provide insight when developing a water conservation strategy. The socio-demographic variables that are examined include: age, education, gender and home ownership.

2.5.1 Age

Figure 2.10 shows an age profile comparison between the City of Lethbridge and the Community of Varsity Village (Statistics Canada, 1996). In 1994, 8185 individuals representing 13% of the population of Lethbridge resided in the community of Varsity Village. When the age cohorts for the community are compared with the general population, three trends are apparent. Firstly, the population of Varsity Village is slightly younger. 45% of the residents in the community are under the age of 25 compared to 39% in the City of Lethbridge. Secondly, Varsity Village and the City have similar population profiles for individuals 25 to 54 years of age; 29% and 32% respectively. Lastly, the population of Lethbridge is older than that of Varsity Village. 20% of the individuals living in Lethbridge are 55 years of age and older compared to 7% in Varsity Village.

2.5.2 Education

Figure 2.11 compares the level of education achieved by residents of Varsity Village with that achieved by City of Lethbridge residents. In general, Varsity Village residents have a higher level of education. There are more individuals with some post secondary education[2] (65% compared to 56%) and more individuals who have obtained at least a university degree (13% compared to 10%)(Statistics Canada, 1996). On the other hand, the City of Lethbridge has a higher percentage of individuals with high school diplomas (87% compared to 75%) as well as more individuals with less than high school education (25% compared to 15%) (Statistics Canada, 1996).

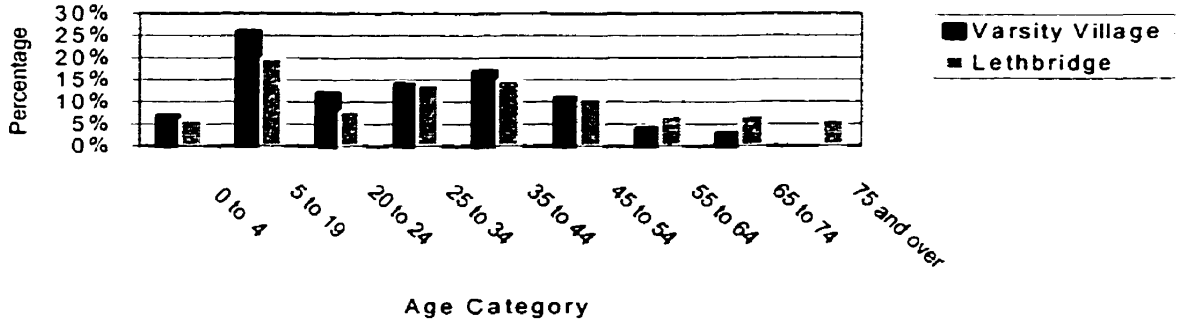


Figure 2.10 Varsity Village Population Age Structure
(Source: Statistics Canada, 1996 – Appendix G)

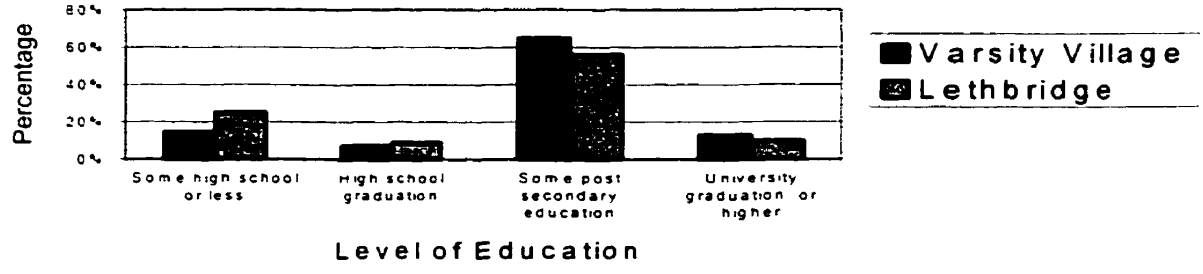


Figure 2.11 Level of Education in Varsity Village
(Source: Statistics Canada, 1996 - Appendix G)

[2] Includes all non-university education and university education without a degree

2.5.3 Gender

The gender ratio between women and men in the study community and the general population is very similar. 51% and 52% of females reside in Varsity Village and the City of Lethbridge respectively (Fig. 2.12).

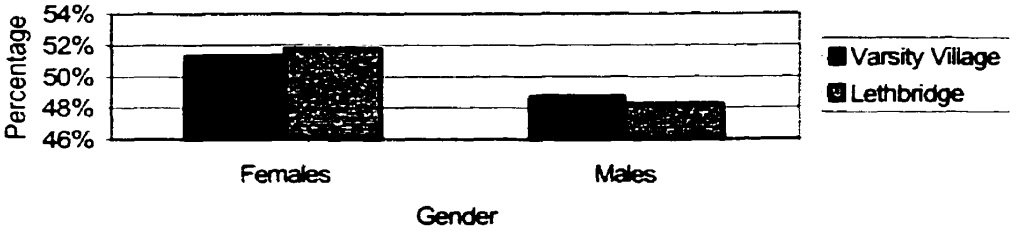


Figure 2.12 Varsity Village Gender Distribution
(Source: Statistics Canada, 1996 - Appendix G)

Figure 2.13 shows the percentage of occupied dwellings that are owned in Varsity Village compared to the City of Lethbridge. Slightly more homes are rented in Varsity Village (36% compared to 31% in the City). This is not surprising given the large number of students that reside in Varsity Village due to its close proximity to the University.

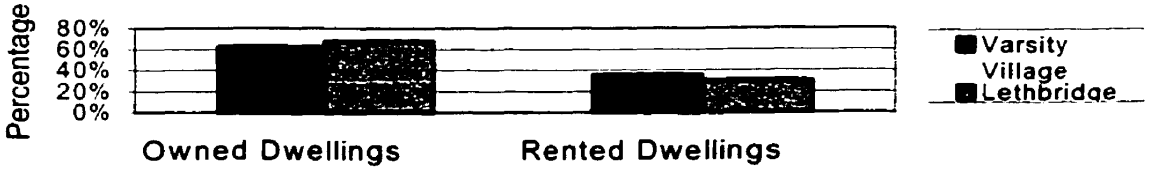


Figure 2.13 Dwelling Ownership in Varsity Village
(Source: Statistics Canada, 1996 - Appendix G)

2.6 Summary

The chapter describes the natural environment in the Lethbridge region and discusses how the City of Lethbridge's development has resulted in the replacement of the well adapted

native vegetation with drought intolerant vegetation that has high water requirements. As a result, residents of the study community of Varsity Village as well as those living throughout the City, apply excessive amounts of water in an attempt to maintain lush landscapes. The excessive irrigation has contributed to the formation of perched water tables that have caused several negative impacts including slope failures, flooding of basements and utility corridors.

These impacts could be greatly reduced through the adoption of appropriate irrigation and landscaping practices. Various attributes of the community population were identified and compared with those of the City of Lethbridge. The influence of these attributes on the development of an effective water conservation strategy will be discussed in subsequent chapters.

The following chapter examines selected municipalities' outdoor water conservation programs. Various water conservation options that could be implemented by the City of Lethbridge are identified.

Chapter 3

WATER CONSERVATION TECHNIQUES EMPLOYED BY SELECTED NORTH AMERICAN CITIES

3.1 Introduction

Although most municipalities in North America have undertaken water conservation programs (Waller et al., 1997), their programs vary considerably due the problems that they address, how they go about addressing them and how effective they are. The objective of this chapter is to identify municipalities with successful water conservation programs that will provide valuable insight towards the development of an effective water conservation strategy for the City of Lethbridge given its unique situation, goals, constraints and opportunities. In the first part of the chapter, the selected municipalities and the criteria used to choose them are discussed. The techniques that comprise the selected municipalities' water conservation programs are then described in detail.

3.2 Criteria Used to Choose the Selected Municipalities

The following criteria were developed to ensure that the municipalities chosen for the study would provide useful information given Lethbridge's unique situation.

1. The municipality must have an active water conservation campaign.

Conservation behaviour will occur more often among those believing in the need for conservation and in the efficacy of conservation practices (Kranzer, 1988). It is assumed that municipalities that actively promote the importance of water conservation are more effective at convincing individuals to reduce their water use. Therefore, only municipalities that actively promote conservation were considered for this study. Municipalities that had particularly effective water conservation campaigns conveying (1) information about the need to conserve, (2) predictions about the negative impacts of excessive water

consumption, and (3) actions that can ameliorate or lessen the negative impacts were given preference.

2. All residents within the municipality must be metered.

Although the success of a water conservation strategy is the result of a combination of techniques, the mandatory installation of water meters is crucial for the long-term reduction of water consumption. This is because meters increase consumers awareness of the value of water and provide a method to monitor the effect water conservation programs have on reducing water consumption (Kranzer, 1988; Sanders and Thurow, 1982; Tate, 1990; Trauth, 1989; Waller et al., 1997). Given the body of research identifying the linkage between mandatory residential metering and the development of effective water conservation campaigns, only municipalities with mandatory metering policies in place were considered.

3. The active water conservation campaign must focus on the reduction of outdoor water consumption.

Water consumption is often divided between two locations: outdoor and indoor use. Indoor water use is primarily related to personal health that includes bathing, flushing toilets, cooking and laundry. Outdoor water use involves car washing and irrigation. Outdoor water consumption has significantly contributed to the increased occurrence of slope failures, flooded basements and weakened parking lots in Lethbridge. In an attempt to identify techniques that have the potential to reduce the excessive outdoor water applications occurring in this City, only municipalities that have implemented programs targeted at reducing their excessive outdoor water use were considered.

4. Municipalities must have normal annual precipitation less than or equal to the City of Lethbridge.

It is well known that municipalities that are located in dry regions and receive small amounts of precipitation consume far greater amounts of water for outdoor uses than municipalities located in more moderate climates (Kranzer, 1988; Sanders and Thurow, 1982; Tate, 1990; Trauth, 1989; Waller et al., 1997). Lethbridge has a semi-arid climate, receiving 398

mm of precipitation annually. The majority of residents supply additional quantities of water to their landscapes to supplement the natural supply. It was believed that residents residing in municipalities that receive precipitation in the amount equal to or lower to that of Lethbridge, also utilize significant quantities of additional water for outdoor purposes. As a result, municipalities that have average annual precipitation levels equal to or lower than that of Lethbridge were chosen for this study.

5. The water conservation campaign must place emphasis on the residential customer category of consumers.

Outdoor water inputs from residential communities have been linked to the development high water tables in Lethbridge (Berg et al., 1996). In addition, it has been found that the residential sector consumes more water than any other group (Environment Canada, 1992). For example, in 1994, the residential sector used over 7 billion liters of water per day in Canadian municipalities, compared to 2.5 billion liters used by the commercial sector and 2.3 billion by the industrial sector (Environment Canada, 1998 [on-line]). For the aforementioned reasons, only municipalities actively targeting their water conservation programs towards the residential sector were chosen for this study.

6. The selected municipalities must have a population under 500,000.

The possibility that the size of a municipality may influence the water conservation budget, the types and combinations of water conservation techniques chosen, and ultimately their level of success was considered. An attempt was made to obtain information about water conservation campaigns initiated by municipalities approximately the size of Lethbridge (e.g. less than 100,000); however, the availability of information was limited. Because the primary purpose of this study was to provide information about various water conservation techniques available to Lethbridge, cities with populations ranging from 50,000 to 500,000 were considered. Other water conservation research (Trauth, 1989) and the Census Bureau have utilized a similar population grouping (i.e. cities with populations greater than 50,000).

7. The climate of at least one of the selected municipalities must be similar to that of Lethbridge.

The possibility that the municipalities' climate may have an impact on the effectiveness of the water conservation program was considered. It is well known that fewer species grow in cooler climates. According to the U.S. Department of Agriculture's climatic zone map, Lethbridge is located in zone three of twelve, with zone one representing the coldest zone a plant will thrive (Bennet, 1998). Because the City of Lethbridge has a cooler climate than many municipalities in North America, residents have a smaller pallet of plant materials that can be successfully incorporated into landscapes and gardens. It was assumed that the reduced plant selection may result in reduced public acceptance and utilization of xeriscaping[3]; one of the most highly used and promising outdoor water conservation techniques (Bennett, 1998; Christopher, 1994; Ellefson et al., 1992; Williams, 1997).

An internet search was subsequently conducted to identify municipalities that complied with the aforementioned criteria and that appeared to have well developed campaigns that would provide useful information. Six potential candidates were found. Contact persons, listed on the web sites visited, were telephoned and a request for additional information about the municipality's water conservation initiatives was made. Municipalities that responded to my request in a timely manner, and provided additional information about their water conservation strategies were selected as examples. The municipalities chosen included: Colorado Springs Colorado, Denver Colorado, Regina Saskatchewan, and Tucson Arizona. Follow up calls were made to obtain additional information as required.

3.3 Selected Municipalities

This section provides brief descriptions of the selected municipalities, their water consumption issues, and their water conservation programs implemented to attain their

[3] Xeriscaping is coined from the Greek word xeros, meaning "dry," and landscape (Ellefson, 1992: 3). "It is a high quality, attractive landscaping that provides beauty, privacy, and protection from the elements while conserving water" (Williams, 1997:2).

water conservation goals. Aspects of the municipalities' climate, current water consumption and water conservation program are listed in Tables 3.1, 3.2 and 3.3.

3.3.1 Colorado Springs

Colorado Springs is the only major Front Range city which is not located on a major river (Colorado Springs Utilities,1996 [on-line]). The climate is predominantly dry and mild. July is the warmest month with an average temperature ranging from 13.9°C to 27.4°C. January, the coldest month, has an average temperature ranging from 5.2 °C to –8.8°C (NCDC, 1997 [on-line]). The average annual precipitation is 391.7 mm, 5.9 mm less than the annual precipitation of Lethbridge (Table 3.1). It is considered by many of its 345,000 residents as a green oasis in an arid climate (Colorado Springs Utilities, 1996, [on-line]). The lushness of the city has not come without a price. Up until the early 1990s, well over 50% of the water supply was used for irrigation. In 1991, the Colorado Springs Water Resources Department determined that its capacity to meet the city's growing needs was insufficient. Since that time, the Department has involved citizens in a water resources planning process to develop a plan that will " provide a safe and reliable water supply to meet the community's needs until at least 2040" (Colorado Springs Utilities, 1996 [on-line]). Citizens involved in the process have advocated the need for a program emphasizing voluntary reductions with a large educational component. They also support water rate modifications and land use policies to reinforce the conservation ethic (Colorado Springs Utilities, 1996 [on-line]).

Because of the public's continued involvement, an effective and publicly acceptable conservation plan has been developed. Although outdoor water consumption has been reduced, summer per capita demand remains approximately three times greater than the winter demand (Table 3.2). Colorado Spring's 1996 Resource Plan addressed the excessive seasonal water consumption. The Plan allocated $14.6 million dollars to fund the development of additional programs including existing system improvements, non-potable irrigation projects, irrigation incentives, and landscape audits. The goal of the plan is for 12% to 25% of the future water supply to result from conservation (Colorado Springs Utilities, 1996 [on-line]) (Table 3.3).

3.3.2 Denver

Denver city has a population of 497,840 and is located in the central part of the state of Colorado, approximately 16 kilometers east of the Rocky Mountains (City of Denver, no date [on-line]). The climate is characterized as mild, sunny, and semi-arid. The average annual precipitation is 391.2 mm, 6.4 mm less than the amount Lethbridge receives annually (Table 3.1). The daily temperature ranges from 14.8°C to 29.9°C in July (the warmest month), to 6.3°C to –8.8°C in January (the coldest month) (NCDC, 1997 [on-line]). In 1982, Denver was ready to begin construction of a dam on the South Platte River to supply an additional 1.45×10^{11} L of water and flood 50 Km of Cheesman Canyon. However, an impact study revealed that "single family homes consumed 65% of the water from all sources in Denver's water system and in the metropolitan area, one half of the water consumed by single family homes was from lawn irrigation" (Christopher, 1994: 14). This information persuaded the Environment Protection Agency to veto the construction of the Two Forks Dam and urge Denver to secure additional water through conservation. Today Denver is a leader in the field of water conservation. Its current Conservation Master Plan lays out strategies to save at least 5.48×10^{10} L of water by 2035 (Table 3.3) (Denver Water, 1997). The Plan has already succeeded in reducing water consumption by 3.65×10^{10} L, enough to meet the needs of an additional 43,000 households (Denver Water, 1999 [on-line]).

3.3.3 Regina

The City of Regina has a population of approximately 180,000. It is located 160 km north of the United States border in the heart of western Canada. The region is characterized as a wide, level, fertile plain with 364.0 mm of annual precipitation. The temperature ranges from 11.9 °C to 26.3°C in July to -11.1°C to –22.5°C in January (Environment Canada, 1993b). In January, the daily minimum temperatures is 8.3°C below the daily minimum temperatures experienced by Lethbridge.

In 1991, the City initiated the enhanced Water Conservation Program to reduce peak water consumption (Table 3.3). The objective of the program was to postpone $80 million dollars in capital expenditures necessary for the expansion of the sewage treatment

facilities that were reaching capacity (City of Regina, no date [on-line]). The program emphasizes reduced use through education and xeriscape demonstrations. Since the program's inception in 1991, water conservation has been reduced by 5.3% (Table 3.3) (City of Regina, no date [on-line]).

3.3.4 Tucson

The City of Tucson is approximately 100 km north of the Country of Mexico and 185 km south of Phoenix. The region is very dry, receiving an average annual precipitation of 304.8mm; 93mm less than the amount received in the Lethbridge region (Table 3.1) (NCDC, 1997 [on-line]). In January, the average annual temperature ranges from 3.7°C to 18.1°C and from 23.1 °C to 37.4°C in July. Although the population of Tucson City is approximately 449,082, Tucson Water serves nearly 600,000 customers within a 483 km^2 area (Tucson Water, 1998 [on-line]). Tucson Water implemented a water conservation program in 1975 when the region was devastated by a series of droughts. The most substantial reduction in water conservation occurred when the program was first initiated (Table 3.3) (Arnold, personal communication, 1999). Over a five year period from 1975 to 1980, the per capita water consumption decreased by approximately 250 L per day (Arnold, personal communication, 1999). The substantial reduction in water consumption is largely attributed to the adoption of an increasing block rate schedule (discussed in greater detail later in the chapter) (Arnold, personal communication, 1999). Today, "Beat the Peak" Water Conservation Program promotes water conservation through a variety of means (Tucson Water, 1998 [on-line]). It is apparent that the water conservation program is having positive effects; many residential landscapes once dominated by turf grass twenty years ago are now covered with vegetation adapted to the dry climate.

Table 3.1 Climate of Selected Municipalities

City	Average Annual Precipitation (ml)	Mean Temperature (°C)			
		January		July	
		Daily Max.	Daily Min.	Daily Max.	Daily Min.
Lethbridge	397.6	-2.6	-14.2	25.9	10.9
Colorado Springs city	391.7	5.2	-8.8	27.4	13.9
Denver city	391.2	6.3	-8.8	29.9	14.8
Regina	364.0	-11.1	-22.5	26.3	11.9
Tucson city	304.8	18.1	3.7	37.4	23.1

(Sources: Environment Canada, 1999b; NCDC, 1997 [on-line], Weather, 1999 [on-line])

Table 3.2 Water Demand of Selected Municipalities

City	Population	Total Population Served	Total Flow (L)	Avg. Per Capita Demand (L/capita/day)	Summer Per Capita Demand (L/capita/day)	Winter Per Capita Demand (L/capita/day)
Lethbridge	63,053	65,000	1.58×10^{10}	664	803	526
Colorado Springs city	345,127	345,127	1.09×10^{11}	850	2200	698
Denver city	497,840	1,000,000	3.46×10^{11}	1743	2399	1086
Regina	180,000	185,000	2.84×10^{10}	394	500	358
Tucson city	449,082	600,000	1.72×10^{11}	630	761	552

(Sources: City of Lethbridge, 1998]; City of Regina, no date [on-line]; Colorado Springs Utilities, 1996 [on-line]; Denver Water, 1999 [on-line], Tucson Water, 1998 [on-line])

3.4 Water Conservation Initiatives Implemented by Selected Municipalities

The outdoor water conservation initiatives used by one or more of the selected municipalities to reduce water consumption are listed under one of the following categories: education, regulations, economic incentives and disincentives, infrastructure improvement, collaborations and sociodemographic techniques (Tables 3.4, 3.5, 3.6, 3.8 3.9 and 3.10 respectively). The left column of the chart matrices lists the conservation techniques implemented. The italicized techniques are discussed in detail in the report. The entries in the cells of the center portion show the techniques that are being used (✓), no longer being used (✂), or are being considered (☐).

Table 3.3 Water Conservation Programs of Selected Municipalities

City	Year Program was Initiated	Current Goal	Actual Reduction Achieved (%)	1999 Water Conservation Program	Funding Source
Colorado Springs city	1990	12% to 25% of supply will result in conservation	Unknown	$14,600,000 in capital costs	Colorado Springs Utilities
Denver city	1980	Reduction of total consumption by 5.48×10^{10} L (15.8%)	10	$1,013,000	Denver Water
Regina	1991	Reduction of per capita consumption and short term peak demand by 15%	5.3	$35,000	Water and Sewer Utility Budget
Tucson city	1975	Not provided	Unknown	$1, 200,000	Tucson Water

(Sources: City of Regina, no date [on-line]; Colorado Springs Utilities, 1996 [on-line]; Denver Water, 1999 [on-line], Tucson Water, 1998 [on-line])

3.4.1 Education

It is widely held that if conservation is to become reality, educational campaigns must be developed that reach a large number of individuals and motivate them to reduce their excessive consumption (Costanzo et al., 1986; Simmons and Widmar, 1990; Vining et al, 1982; Winett and Kagel, 1984). A persuasive water conservation education campaign not only increases public awareness about the importance of water conservation, it sells many otherwise reluctant citizens on the benefits of the program (Sanders and Thurow, 1982). It also increases the effectiveness of techniques by informing the public about them, their effects and the expected results. Various techniques have been developed to educate individuals on how to reduce their outdoor water consumption by instructing them on how to maintain their lawns with minimal water input and how to incorporate drought tolerant vegetation into their landscapes. All of the selected municipalities have incorporated education techniques into their water conservation campaigns and many of the techniques are discussed below (Table 3.4).

3.4.1.1 Conservation Brochures and Booklets

Brochures and booklets are commonly produced to provide information about the importance of water conservation and methods to reduce water consumption. Government agencies and utilities from all of the selected municipalities produce water conservation pamphlets. Regina has created brochures on a variety of topics including the cost benefits of xeriscaping, how to create xeriscapes, general water conservation information, and water conservation as a cost effective alternative to enlarging the treatment plant facilities. Tucson Water has produced a number of pamphlets to demonstrate how customers can reduce water consumption. Some of the pamphlets can now be obtained over the internet.

3.4.1.2 Demonstrations by Specialists

Denver's and Tucson's water conservation campaigns include the use of lectures and demonstrations by specialists. Denver offers slide shows and lectures on xeriscape and water conservation to interested groups such as neighbourhood associations and garden clubs (Denver Water, 1998). Since 1997, Tucson Water has been offering a free conservation lecture series every Tuesday evening during the summer. Issues on a wide

variety of topics are covered including: design, installation and maintenance of desert adapted landscapes; finding new and attractive low-water use plants; and rain water harvesting (Tucson Water, 1998 [on-line]).

3.4.1.3 Evapotranspiration Programs

A major challenge many municipalities face is how to educate residents on how to determine what the necessary amount of water required by their garden is. Techniques that are gaining popularity are called evapotranspiration (ET) programs. ET is the amount of water drawn up from the soil by the plant and lost through evaporation. The amount of moisture lost by the plant must be reapplied to the soil in the form of irrigation or precipitation to maintain the health of the garden. If there is insufficient precipitation, the consumer must make up the difference by watering his/her garden. Although every plant species has a specific ET, most municipalities only provide the ET of turf grass. Turf ET does not correspond exactly to the water lost from other plants, but it does provide an objective reading of one species' water needs, and that is a benchmark that can be used to assess the needs of other plantings (Christopher, 1994).

Colorado Springs and Denver have ongoing ET Programs. Colorado Springs provides watering guidelines in the local newspaper, on radio and television to direct appropriate water use (Colorado Springs Utilities,1996 [on-line]). Denver has had an ET program since 1981. It currently has a web site where the consumer enters the amount of precipitation and irrigation the garden has received and the computer calculates the amount of additional irrigation the garden requires (Denver Water, 1999, [on-line]).

3.4.1.4 Municipal Xeriscaping

The perceived credibility of the local government and water authorities as an important factor in the success of a municipally initiated water conservation program has been documented (Jones, 1993). Colorado Springs, Denver and Tucson have committed to converting aspects of municipal landscapes to xeriscapes.

Colorado Springs Utilities is examining the possibility of converting landscapes surrounding municipal buildings to xeriscapes as well as upgrading the irrigation systems. Although

Colorado Springs Utilities expects that the water savings will be low relative to the cost of redesigning the landscapes, it acknowledges potential benefits including showing the City's commitment to conservation and providing a model for customers (Colorado Springs Utilities, 1996 [on-line]). Denver Water has committed to, and substantially completed the conversion of, the landscape surrounding its own properties, specifically the Administration Complex and the Moffat Treatment Plant to xeriscape (Denver Water,1999 [on-line]). The vegetation surrounding Tucson Water's facilities has been converted to drought tolerant species. Tom Arnold, an employee at Tucson Water, states that the cost of water coupled with the increasing block rate makes conventional landscaping too expensive to maintain (Arnold, personal communication, 1999). In addition, the water conservation program would not be as convincing to the consumers if the water utility did not practice what it is promoting.

3.4.1.5 Newspaper Articles

All of the case study municipalities use newspaper articles to educate their residents. In Colorado Springs, evapotranspiration information (also referred to as water scheduling information) is provided in the local newspapers (Colorado Springs Utilities, 1996 [on-line]).

3.4.1.6 Radio Commercials or Programs

Colorado Springs, Denver, Regina and Tucson provide radio program and/or public service announcements regarding the importance of outdoor water conservation.

3.4.1.7 Self Awareness

Self awareness occurs when citizens learn to actively monitor and control their behaviour. The only selected municipality that actively promotes self awareness is Tucson. As part of its Water Zanjero, or water manager program, consumers are taught how to accurately read their water meters by trained staff (Tucson Water,1998 [on-line]). Tucson and Denver also provide consumers with residential conservation kits; however, it appears that the conservation devices provided in the kits are primarily for inside of the home (e.g. the provision of faucet aerators and toilet tank dams). They are also intended to improve water efficiency, rather than educate the consumer through a self monitoring process.

3.4.1.8 Television Commercials or Programs and Video Tapes

All of the case study municipalities indicate that they have created water conservation videotapes, commercials and programs. Denver Water first began to use television to increase public awareness of conservation in 1990. They have continued to inform the public by presenting a series of water conservation programs on the local television network (Denver Water, 1999 [on-line]).

3.4.1.9 Water Conscious Citizen's Awards

Tucson is the only municipality that has introduced a program that recognizes individual efforts to reduce the City's overall water use. Tucson's Water Corps Campaign recognizes "individuals who have made a personal commitment to reduce their water use by eliminating water wasting habits and adopting water saving strategies" (Tucson Water, 1998 [on-line]).

3.4.1.10 Xeriscape Demonstration Gardens

Demonstration gardens are used by many municipalities as teaching tools to alter citizens' negative perception about xeriscapes, demonstrate how xeriscaping can be introduced to individual's yards and the range of materials that can be used to create a unique, beautiful and drought tolerant garden.

Colorado Springs, Denver and Regina have developed xeriscape demonstration gardens as part of their water conservation programs. In Colorado Springs the xeriscape garden was developed next to the visitor center located at the Water Operations Control Office (Colorado Springs Utilities, 1996 [on-line]). Placing the garden next to the Center provides an opportunity to visitors, who are impressed with the garden, to obtain additional educational materials about water conservation. The City of Regina has actively pursued demonstration gardens as a method to reduce citizens' outdoor water consumption. In collaboration with SaskTel, the City created a xeriscape garden in a residential area that incorporated 40 species of plants (Regina Works and Utilities, 1999). The designers incorporated plants with a range of colors and textures hoping to appeal to a range of consumers' tastes. The garden was so well received that another xeriscape garden is

being planned in collaboration with Dr. A.E. Perry School. It is scheduled for completion in the fall of 1999. The variety of plant materials that are showcased in the demonstration garden and the positive feedback the garden has received indicate that demonstration gardens can be effective in cooler climates like Lethbridge's.

3.4.1.11 Xeriscape and Irrigation Workshops

At workshops, individuals receive "real life " demonstrations and have the opportunity to try out behaviours and receive instruction and feedback (Winett and Kagel, 1984). The City of Regina held two xeriscape workshops in 1998 (one in the spring and one in the fall), and each was attended by approximately 225 participants. The City feels that the workshops were a success and will offer them in 1999 (Regina Works and Utilities, 1999). Colorado Springs, Denver and Tucson also run workshops (Colorado Springs Utilities, 1996 [on-line]; Denver Water, 1999 [on-line]; and Tucson Water, 1998 [on-line]); however, they did not provide information about the level of participation or public acceptance.

3.4.2 Regulations and Guidelines

Regulations are public laws often contained within a zoning ordinance or land development code. They establish minimum standards through the use of rules, regulations, controls and procedures to ensure that particular actions do not jeopardize the health, safety and beauty of a municipality. The type of ordinance considered, whether it is implemented, and the direction it takes depends on several factors including: the issue the municipality is attempting to address, public opinion towards the use of ordinances, citizen needs, current laws, and political limitations. Commonly used water conservation regulations include: landscape ordinances and water ordinances (Table 3.5). Voluntary limits establish standards that should be followed, but they are not enforceable.

Table 3.4 Education Techniques

Education Techniques	Colorado Springs	Denver	Regina	Tucson
Billboards			✂	
Conservation Brochures and Booklets,	✓	✓	✓	✓
Conservation Bill Inserts	✓	✓	✓	✓
Conservation Helpline	✓	✓	✓	✓
Demonstrations by Specialists		✓		✓
Evapotranspiration Program	✓	✓		
Municipal Xeriscaping	☐	✓		✓
Newspapers	✓	✓	✓	✓
Radio	✓	✓	✓	✓
Refrigerator Magnets			✓	
Residential Conservation Kits	☐	✓		✓
School Programs		✂	✓	
Self Awareness Program				✓
Television Information Programs, Commercials or Videotapes	✓	✓	✓	✓
Water Conscious Citizen Awards				✓
Water Conservation Information Van				✓
Web Site Information	✓	✓	✓	✓
Xeriscaping and Irrigation Workshops	✓		✓	✓
Xeriscape Demonstration Gardens	✓	✓	✓	

Legend
✓ Techniques that are being used
✂ Techniques that are no longer being used
☐ Techniques that are being considered

3.4.2.1 Landscape Ordinances

Landscape ordinances are used to guide site development and landscape appearance through the regulation of landscape design, landscaping, landscape installation and maintenance. They have the potential to reduce slope instability and basement flooding by promoting the incorporation of appropriate vegetation, non-living landscape materials and other site materials intended to reduce irrigation requirements. The objective is to promote the incorporation of landscape alternatives that not only reduce the problems associated with excessive irrigation, but harmonize and enhance residences and communities. Currently, Colorado Springs is considering a new law requiring commercial and

government customers to incorporate xeriscape landscaping practices (Colorado Springs Utilities, 1996 [on-line]).

3.4.2.2 Water Ordinances

Water ordinances promote the conservation of water by establishing a set of standards with respect to the operation of irrigation systems and/or the maintenance of irrigation systems. The intent of water ordinances is to ensure that irrigation is as efficient as possible by regulating water use times, and the efficiency of irrigation systems (i.e. monitoring for leaks, improperly adjusted sprinkler heads). The chosen municipalities tend to implement restrictions only when there is a risk that the water utility may be unable to meet the demand. All of the cities examined have implemented restrictions during periods of drought when high volumes of water consumed were accompanied by reductions in the volume of water available. The restriction most commonly implemented is a limit placed on the number of days outdoor irrigation is permitted. During the drought from 1977 to 1980, Denver's water restriction limiting customer's outside water use to once every three days resulted in a 21% seasonal savings (Wiley, 1983).

3.4.2.3 Voluntary Limits

All of the case study municipalities support and promote voluntary reductions in residential water consumption.

Table 3.5 Regulations

Regulations	Colorado Springs	Denver	Regina	Tucson
Landscape ordinances	❑			
Mandatory water restrictions	✓	✓	✓	✓
Voluntary limits	✓	✓	✓	✓

Legend ✓ Techniques that are being used
❑ Techniques that are being considered

3.4.3 Economic Incentives and Disincentives

Incentives and disincentives motivate individuals to reduce consumption by providing them with the ability to reduce their water costs by controlling their consumption. Examples of economic incentives and disincentives include: water rate structures, price of water, and xeriscape and irrigation rebates (Table 3.7).

3.4.3.1 Rate Structures

Volume based and flat rate structures are the predominant rate structures used in North America. Flat rates are fixed payments imposed in each billing period unrelated to the volume of water used while volume rates relate to the amount paid by the customer to the amount used (Figure 3.1) (Tate and Lacelle, 1995). All of the selected municipalities use volume based rate structures that require water meters; however, the rate structures vary considerably because each municipality is free to establish its own structural characteristics. Colorado Springs, Lethbridge, and Regina have constant rate structures while Denver and Tucson use increasing block rates.

- Constant Rate

Under a constant rate structure, the same amount is charged for each unit of water. The cost of the water is directly proportional to the amount used.

- Increasing Block Rate

Under an increasing block rate structure, consumers are charged one rate for a certain quantity of water and higher rates for quantities beyond this amount. Often municipalities have several blocks comprising their block rate structure. Denver and Tucson have both implemented an increasing block rate structure with three and four blocks respectively Denver Water, 1999 [on-line]; Tucson Water, 1998 [on-line]. Table 3.6 compares the amount of money consumers in each of the municipalities pay relative to a specific volume of water. The amount consumed by an average winter residential water account in Denver and Tucson is approximately 32,580 L and 16,560 L per month respectively (Table 3.2[4]). The cost of water is very reasonable. The impact of the block rate is only felt by the majority

[4] Winter per capita demand multiplied by 30

of the consumers during the summer months when consumption increases substantially. This is because the rates are designed to provide an incentive to irrigate as efficiently as possible.

- Peak Demand

Under a peak demand rate schedule, higher rates are charged for water consumed above a pre-established amount during peak consumption periods. Typically the higher rates are applied during the summer months when outdoor consumption is the greatest. Although this rate schedule appears to be a useful technique for reducing outdoor water consumption, none of the selected municipalities have implemented it. Colorado Springs is currently testing a program that charges largest water users more for water during the high-use summer months to encourage water savings (Colorado Springs Utilities, 1996 [on-line]).

3.4.3.2 Price

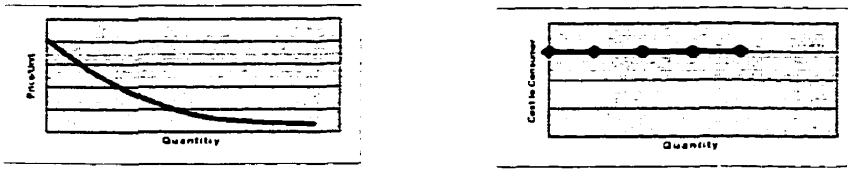
"The periodic water bill paid by customers is based on the unit charges (e.g cents per liter) built into the water rates" (Tate and Lacelle, 1989: 9). The unit charges of the selected municipalities is shown in Table 3.6. The overall observation from the chart is that unit water rates are very low. Unfortunately, low prices of water sends the message that water is a cheap commodity that need not be conserved.

3.4.3.3 Xeriscape and Irrigation Incentive Programs

Colorado Springs and Denver are the only selected municipalities developing xeriscape and/or irrigation incentive programs (Table 3.7). Colorado Springs is considering implementing a new home xeriscape incentive initiative as part of its water conservation program (Colorado Springs Utilities, 1996 [on-line]). This initiative would offer rebates to developers and builders of new homes who use xeriscaping rather than traditional landscaping techniques. Colorado Springs Utilities anticipates that the water savings would be moderate and the cost of implementing the program would be high.

In Denver, over 54% of water consumed is used for irrigation practices (Denver Water, 1999 [on-line]). As a result, Denver Water has implemented an irrigation efficiency program that includes the provision of incentives to reduce over watering of landscapes and promotes the conversion of landscapes to xeriscapes. Unfortunately, details about the types of incentives that are being used were not provided.

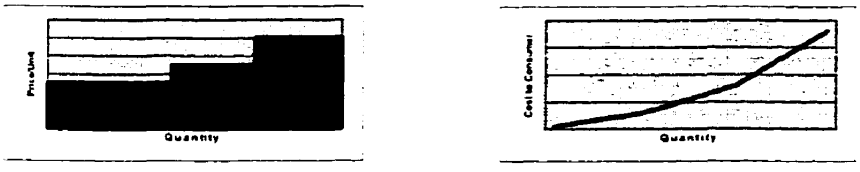
A. Flat Rate - Charge each consumer the same amount regardless of how much they consume.



B. Decreasing Block Rate - Charge one rate for a certain quantity of water and lower rates for units beyond this amount.

C. Constant Rate - Charge a constant rate for each unit of water consumed.

D. Increasing Block Rate - Charge one rate for a certain quantity of water and higher rates for units beyond this amount.



E. Peak Demand Rate - Charge a higher rate for water used in excess of a pre-established level during peak consumption periods (e.g. during the summer).

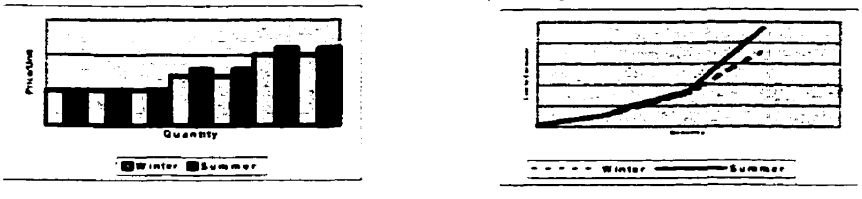


Figure 3.1 Water Rate Structures
(Modified from: Saunders and Thurow, 1982)

Table 3.6 Water Prices

Cost per 1000 Liters of Water ($)					
Volume of Water (L)	Colorado Springs	Denver	Lethbridge	Regina[5]	Tucson
0 to 10, 201	.45	.30	.41	Minimum Bill[6]	Minimum Bill[6]
10,202 to 51,006	.45	.30	.41	.375	.36
51,007 to 102, 012	.45	.30	.41	.375	
102,013 to 272,762	.45		.41	.375	
Above 272,762	.45		.41	.375	

Note: Because of the municipalities' diverse range of rate structures and prices comparison is difficult. In order to facilitate comparison, water volume ranges were selected and included on the left side of Table 3.6. The price of each municipality's water is listed in the remaining cells of the table. The degradation of shading in the chart reveals the blocks in Denver and Tucson's block rate water structure

(Sources: City of Lethbridge, 1998 [on-line]; City of Regina, no date [on-line]; Colorado Springs Utilities, 1996 [on-line]; Denver Water, 1999 [on-line], Tucson Water, 1998 [on-line])

Table 3.7 Economic Incentives and Disincentives

Economic Incentives and Disincentives	**Colorado Springs**	**Denver**	**Regina**	**Tucson**
Water rate structures				
• *Constant rate*	✓		✓	
• *Increasing block rate*		✓		✓
• *Peak demand*	❑			
Price	✓	✓	✓	✓
Xeriscape incentive programs	❑	❑		

Legend ✓ Techniques that are being used
❑ Techniques that are being considered

3.4.4 Infrastructure Techniques

Home audits, metering and retrofitting are examples of infrastructure techniques (Table 3.8).

[5] Billing is by-monthly
[6] A given volume of water is associated with the payment of a fixed fee

3.4.4.1 Home Audits

Environment Canada (1993: I-1) states that the objective of a water audit is to "identify each facet of the water distribution system and thus define the system as a whole such that (i) areas of the facility with water supplies are identified, (ii) measured and unmeasured water supplies are accounted for, (iii) all points in the system where water can be extracted are identified (e.g. outdoor and indoor taps, sinks, and toilets). Audits concentrate on physical changes such as system optimization (leak detection and repair), water saving systems (retrofitting and repair) and pressure reductions. Colorado Springs, Denver and Tucson all have active audit programs. Colorado Springs provides self administered water use audits to help homeowners reduce their water bills by suggesting more efficient water use both outside and inside the home (Colorado Springs Utilities, 1996 [on-line]). In 1997, Tucson implemented the Tucson Water Zanjero Program to help customers manage their water use. "The free service offers customers an individualized survey of the water use in their home, and provides them with the tools and information they need to lower their water use and their water bills" (Tucson Water, 1998:5 [on-line]).

3.4.4.2 Retrofit

"Retrofit means adapting or replacing an older water-using fixture or appliance with one of the many water efficient devices now on the market" (Environment Canada, 1992: 1). In the United States, Federal and State legislation make it difficult to install anything but water efficient plumbing fixtures; therefore, municipalities do not emphasize retrofit initiatives in their water conservation programs. They assume that older, inefficient fixtures will be replaced over the years. Unfortunately, the Federal and State legislation is primarily targeted towards the replacement of inefficient toilets and shower heads. As a result inefficient sprinklers are still commonly used. This is unfortunate because inefficient sprinklers such as oscillators lose as much as 50% of the water dispersed through

evaporation (Environment Canada, 1992). Another retrofit technique that was used by the municipality of Denver involved installing pressure regulators in service mains serving selected subdivisions to reduce water flow. In the communities receiving reduced water flow, water consumption was reduced by 8% (Maddaus, 1987).

Table 3.8 Infrastructure Improvements

Infrastructure	Colorado Springs	Denver	Regina	Tucson
Infrastructure Projects				
Metering	✓	✓	✓	✓
Home Audits	✓	✓		✓
Retrofit programs		✓		

Legend ✓ Techniques that are being used

3.4.5 Collaborations

Collaborations involve the coming together of groups for the common purpose of reducing water consumption. Examples of collaborations include: school-city water conservation education partnerships, city-landscape firm relationships and city-newspaper relationships. All of the selected municipalities acknowledge the value of partnerships and strive to develop water conservation partnerships with various parties. Several unique and effective partnerships between the municipalities and public or private agencies are discussed below.

3.4.5.1 Public Agencies

In 1998, Denver Water began an innovative partnership with Denver Parks to update irrigation controls and convert a large number of parks and golf courses currently being irrigated with potable water with non-potable water (Denver Water, 1998). The same year, the City of Regina, in cooperation with Dr. A.E. Perry School, landscape architects, the Regina Public School Board and the school community finalized plans for the development of a xeriscape demonstration project at Dr. A.E. Perry School (Regina Works and Utilities, 1999).

3.4.5.2 Private Organizations

In 1998, Denver Water introduced two new initiatives to obtain greater involvement from the business sector: pilot projects and performance zoning. Pilot projects involve the testing of innovative, but unproven water conservation methods and technology (Denver Water,

1998). Innovations that substantially reduce water consumption may then be implemented on a larger scale. Performance contracting encourages contractors awarded municipal contracts to document water conservation initiatives and where applicable, additional money is provided when work is completed.

Table 3.9 Collaborations

	Colorado Springs	Denver	Regina	Tucson
Collaborations	✓	✓	✓	✓

Legend ✓ Techniques that are being used

3.4.6 Socio-Demographic Techniques

All four of the case study municipalities do very little to implement techniques targeted at specific groups. Colorado Springs, Denver and Tucson have implemented programs targeted at low income earners; however, Colorado Springs is the only city that is examining the impact of techniques on different socio-economic groups. Colorado Springs has established a partnership program with the Bureau of Reclamation called YARDX (Yield and Reliability Demonstrated through Xeriscape) (Seymour, personal communication, 1999). The program offers incentives, design and education to two different socio-economic groups: $40,000 to $50,000 income earners and earners of over $100,000. The program is designed to determine if higher income earners are less likely to conserve than the lower income earners.

The municipalities may invest little effort in developing water conservation techniques targeted at specific population segments because previous research has found little evidence demonstrating that demographic variables are predictive of individuals' responses to conservation measures (Ebreo et al., 1999; Griffin, 1987; Martinez and Scicchitano, 1998; and Heslop et al., 1981.).

Table 3.10 Techniques Used to Target Specific User Groups

City	User Groups Targeted
Colorado Springs city	YARDX – A program that offers incentives, design and education to two different socio-economic groups: higher income earners (over $100,000/year) and lower income earners ($40,000 to $50, 000/year)
Denver city	Low income residential water conservation program
Regina	Programs primarily targeted towards residential consumers in general
Tucson city	Low income residential rebate program

(Sources: Denver Water, 1998 [on-line]; Regina Works and Utilities, 1999; Seymour, personal communication, 1999; Tucson Water, 1998 [on-line])

3.5 Summary

Colorado Springs, Denver, Regina and Tucson have water conservation programs that provide valuable information about the types of techniques that could be implemented in the City of Lethbridge. The criteria used to choose the selected municipalities included: annual amount of precipitation equal or lower than the amount received in Lethbridge, metering of all residential water systems, an active water conservation program, excessive outdoor irrigation necessitating the development of the water conservation programs and a residential target audience. Following the selection of the municipalities, many of the water conservation techniques that comprised their programs were identified and described. Although the numbers and types of techniques implemented by the municipalities varied, the programs had several common characteristics. The common characteristics included incorporating a large number of educational components, advocating voluntary reductions in water conservation, promoting the use of xeriscapes as an attractive and water efficient alternative to traditional lawn covered landscapes, and rarely relying upon regulations to curb consumption.

In the following chapter the effectiveness of many of the water conservation techniques identified in this chapter will be assessed and compared with the evaluations from four small discussion groups of Lethbridge residents.

Chapter 4

EVALUATION OF WATER CONSERVATION TECHNIQUES

4.1 Introduction

> *Every water resource problem offers a number of possible solutions, with effective management being the art of choosing wisely from among the possibilities (Tate, 1990:4)*

One of the greatest challenges when developing a water conservation program is determining which initiatives, out of the many options, will serve to promote water conservation given a city's unique situation. The objective of this chapter is to assess the effectiveness of the water conservation techniques identified in chapter three. The assessment is based on previous recycling, energy conservation, and water conservation research with respect to accessibility, behaviour modification, economic feasibility, and public preference level. The criteria used to assess the effectiveness of the techniques are discussed below.

4.1.1 Accessibility

The accessibility of a technique is evaluated by examining the proportion of individuals who can easily obtain it. Accessible techniques are widely distributed and are offered for a minimal fee or free of charge.

4.1.2 Behaviour Modification

A technique's ability to persuade individuals to modify their behaviour is termed behaviour modification. Effective behaviour modifying techniques promote positive behaviour changes that persist over extended periods of time.

4.1.3 Economic Feasibility

The economic feasibility of a technique is determined by examining whether it is cost effective. Cost effective techniques generate sufficient revenue to pay for their operating costs or they reduce expenses attributed to excessive water consumption sufficiently to justify their cost.

4.1.4 Public Preference Level

The public preference level for a technique is evaluated according to the degree the public endorses it as a conservation method or a source of information. The central assumption is that "conservation policies that have the support of citizens are more likely to get enacted and once enacted, more likely to have their intended effect" (Bennet and Moore, 1981: 313).

4.1.5 Approaches to Evaluation

The techniques that are considered effective, based on the aforementioned criteria, are discussed in detail. The information obtained from previous findings is compared with feedback provided by participants from the Lethbridge discussion groups. Techniques that are endorsed by the discussion groups, but have not been evaluated in previous conservation literature or have received poor evaluations are also discussed. Before discussing the effectiveness of the water conservation techniques described in chapter three, it is useful to develop a framework for their assessment. The following section presents such a framework in terms of the water conservation techniques and the criteria used to assess their effectiveness.

The water conservation techniques that were identified in chapter three and have been highly evaluated in conservation literature are listed in the left-hand column of Table 4.1. The criteria used to assess their effectiveness are listed in the column headings: accessibility, behaviour modification, economic feasibility and public preference level. The entries in the various cells of the matrix provide an indication of the effectiveness of each technique with respect to the column heading. They are rated according to a five term scale: excellent, very good, average, below average and poor. In cases where there are

contradictory findings, the symbol (X) is used. The right hand column of Table 4.1 summarizes the overall effectiveness of the water conservation techniques. The rank of the techniques was determined by examining their performance with respect to the four assessment categories.

Water conservation techniques, including the ones listed in Table 4.1, were also evaluated by four Lethbridge discussion groups that were held in May 1999. Residents used two criteria to evaluate the effectiveness of techniques, their preferences and their beliefs that the technique could reduce their outdoor water consumption. The techniques that were highly evaluated by residents from the City of Lethbridge and Varsity Village discussion groups also appear in Table 4.1. The techniques in bold font were highly evaluated by the residents and researchers. Techniques that were evaluated as being potentially effective by the discussion group participants, but were not highly favored by researchers, are italicized. In addition, the placement of the techniques in Table 4.1 was influenced by the discussion groups responses. For example, if two or more techniques received the same rating with respect to the overall evaluation derived from previous research, the technique that received a higher evaluation by the discussion groups was listed above the other(s).

In the following section the techniques listed in Table 4.1 are discussed in detail.

4.2 Evaluation of Water Conservation Techniques

4.2.1 Education Techniques

4.2.1.1 Newspapers

Newspapers received the highest overall effectiveness ranking for educational techniques. They received ratings of very good or greater in all categories. The have an excellent rating with respect to public preference level.

"Today's newspapers use design elements, story placement, type face and graphics to make information easily accessible to the reader" (Cheyney, 1991: 4).

Table 4.1 Evaluation of Water Conservation Techniques

	Accessibility	Behaviour Modification	Economic Feasibility	Preference Level	Overall Ranking
A. Education Techniques					
Newspapers	**Very Good**	**Very Good**	**Very Good**	**Excellent**	1
Conservation Brochures	**Very Good**	**Average**	**Very Good**	**Very Good**	2
Xeriscape Demonstration	**Very Good**	**Very Good**	**Average**	**Very Good**	2
Conservation Bill Inserts	**Excellent**	**Below Average**	**Very Good**	———	3
Television Commercials	Very Good	Below Average	Average	Excellent	3
Xeriscaping and Irrigation Workshops	**Below Average**	**Excellent**	**Very Good**	X	4
Conservation Helpline	*Average*	*Very Good*	*Average*	*Below Average*	5
Self Awareness	*Below Average*	*Average*	*Below Average*	*Very Good*	6
Television Programs	Below Average	Very Good	Poor	Excellent	7
B. General Techniques					
Increasing Block Rate	**Excellent**	**Excellent**	**Excellent**	**Below Average**	1
Landscape Ordinances	**Good**	**Excellent**	**Excellent**	**Average**	2
Collaborations	**Very Good**	**Very Good**	**Very Good**	**Very Good**	3
Home Audits	**Average**	**Excellent**	**Average**	**Average**	4
Landscape Ordinances (General)	Excellent	Average	Very Good	Poor	5

Legend		
	Bold Font	Techniques are favored by researchers and discussion group participants
	Italicized Font	Techniques are favored by discussion group participants
	Normal Font	Techniques are favored by researchers
	X	Contradictory Findings

They are commonly used information sources[7] that many individuals prefer as a means of acquiring information about conservation. In a study conducted in San Antonio Texas, newspaper articles were found to be the second leading media source used by respondents to learn about water conservation initiatives as well as the second most preferred information source (Olsen and Highstreet, 1987). Feedback from the Lethbridge discussion groups support Olsen and Highstreet's findings that newspapers are very popular information sources. The discussion groups evaluated newspapers as the third most popular education technique. In addition, the city-wide participants rated newspapers as their second choice with respect to behaviour modification while they were rated fourth by the Varsity Village participants. The slight discrepancy between the two discussion groups may be a result of the larger number of senior citizens in the citywide groups. Phillips and Sternthal (1977 in Griffin, 1987) found that newspapers play a particularly

important function for the elderly, because reading is self paced and learning difficulties that are exacerbated by externally paced presentations are avoided.

The majority of Lethbridge participants had a common vision of the type of newspaper article they felt would be most effective. They thought that newspaper articles that focus on drought tolerant landscapes within the Lethbridge region would be particularly effective. Many envisioned showcasing either a privately or publicly owned demonstration garden each week in the Lethbridge Herald. The information that they indicated would be particularly helpful included: tips regarding how to begin creating a drought tolerant landscape, the benefits (in terms of time, money saved, and convenience), details about the plants depicted in the photographs, as well as resource persons who could be contacted for additional details. They also indicated that photographs of the garden's evolution would also be valuable.

4.2.1.2 Conservation Brochures and Booklets

Conservation brochures and booklets, received the second highest overall effectiveness ranking. They received favorable evaluations in all categories: a rating of very good for accessibility, economic feasibility and public preference level, and an average rating for behaviour modification .

Simmons and Widmar (1990) have found that perceived lack of information interferes with participation in conservation activities. This suggests that techniques that educate the public about action strategies will increase participation. Brochures and booklets are commonly used methods that provide information. They are relatively inexpensive to produce and they can be disseminated to a large portion of the population. Olsen (1981) states that information about the nature of the crisis and the importance of conservation is necessary and should be distributed as widely as possible. Several other researchers have found that general information that is commonly provided in brochures and booklets is insufficient to promote conservation (Costanzo et al., 1986; Olsen, 1981; Vining et al., 1992). They maintain that clear, specific information that convinces individuals of the validity of

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On an average weekday, 62% of Americans read newspapers and on Sundays, newspapers are read by 67%.

conservation as well as the means for accomplishing it is more effective at promoting consumption reduction (Costanzo et al., 1986; Vining et al., 1992).

In a study examining the effectiveness of brochures as a waste reduction medium, DeYoung and Duncan (1993) reported that individuals' solid waste production was significantly reduced after receiving carefully worded pamphlets that provided reasons for adopting behaviours as well as how to adopt them. They also found that "economic and environmental [information] combined in an additive fashion, having significantly greater influence on behaviour than either treatment alone" (DeYoung and Duncan, 1993: 78).

Although this method of information dissemination is relatively inexpensive, easy to deliver, and has the potential to alter excessive water consumption behaviours, the public's support for the technique should also be considered before resources are devoted. In a study conducted by Olsen and Highstreet (1987), San Antonio residents' preferences towards information sources were examined. They found that 51% of respondents highly preferred reading about water conservation techniques in brochures. The Lethbridge discussion group participants also strongly favored conservation brochures and booklets as sources of information. The technique was rated as the second and fourth most popular by the citywide and Varsity Village participants respectively and the combined evaluation ranked brochures and booklets as the third most effective education technique (refer to Appendix H).

The positive evaluations from the researchers and discussion group participants about these relatively inexpensive interventions provide support for utilizing them as part of a water conservation strategy for the City of Lethbridge.

4.2.1.3 Xeriscape Demonstration Gardens

Along with conservation brochures and booklets, xeriscape demonstration gardens received the second highest overall effectiveness ranking. They received a very good rating in the accessibility, behaviour modification and public preference level categories. They received an average rating in the economic feasibility category.

Demonstration gardens are used by many municipalities as teaching tools to show citizen's that drought tolerant landscapes have far more to offer than just rock and cacti. They provide examples of how xeriscaping can be introduced and the range of materials available to create unique, beautiful and drought tolerant yards. Some water utility officials have argued against promoting water conserving landscaping based on the assumption that people want and prefer landscapes dominated by turf. Jones (1992) found that this assumption is faise. In a pilot study to determine aesthetic preferences for residential landscaping treatments, she found that "landscapes featuring substantial turf areas were..."less preferred than those featuring a variety of plant species and little lawn area" (Jones, 1992). In addition, Flack and Greenberg (1987: 50) state that "education of the water consumer on the types of native drought resistant vegetation available and a public display as a part of an innovative landscape design may convince the water user that a more natural design can be as pleasing as the green look".

The participants at the Lethbridge discussion groups agreed with Flack and Greenberg. In terms of behaviour modification, demonstration gardens were considered the most effective education techniques (refer to Appendix H). They were also singled out as the most popular techniques by the Varsity Village discussion groups' combined feedback and the fourth most popular by the combined feedback of the city-wide discussion groups. However, the participants had two distinct ideas about what demonstration gardens are and how they could enhance a local water conservation campaign. The more traditional idea involved creating a demonstration garden on public property for others to look at. The other involved using local residential landscapes as demonstration gardens. The following discussion explores each concept separately.

- Residential Demonstration Gardens

All of the discussion groups preferred residential garden demonstrations over public ones; however only two of the discussion groups (one from each area) felt that they would be more effective at changing their behaviour (refer to Appendix H). The participants who favored this technique had several suggestions regarding how the gardens could be used. One participant suggested that each week, over the course of the summer, a local resident's drought tolerant garden could be showcased in the newspaper. Utilizing local

gardens in this fashion would not only broadcast the xeriscape message to a greater number of citizens, it would reveal the various landscaping options that exist. Several other participants suggested that a xeriscape garden tour of local residences be organized. Individuals on the tour would get a first hand look at attractive water efficient landscapes and have the opportunity to speak with the owners about how to incorporate particular features into their own yards. Although this technique does not reach as many individuals, those who come on the tour may be particularly motivated to change their behaviour. Rogers and Shoemaker (1971) determined that people are most likely to accept an innovation when they have come into contact with others who have successfully adopted it.

- Public Demonstration Gardens

The participants who thought that a public demonstration gardens would be an effective education technique, provided several locations in Lethbridge where they felt that it would have the most impact: the City Hall, by the community gardens and at the Galt Gardens. They also had several suggestions on how to improve its effectiveness. One participant stressed the importance of providing images (either real or in photographs) of the development of the garden. He stated that alone, a well established, beautiful garden discourages people from attempting to create their own; however, a garden coupled with images of the process that led up to the final product would be beneficial. Another participant stated that the demonstration garden should be split into two halves. One half should have a conventional landscape, the other should have a xeriscape. At the site information should be provided explaining the savings the xeriscape provides in terms of cost and labor. Several others stated that it should be located by an interpretive centre for residents who are impressed with the garden to obtain additional information.

4.2.1.4 Conservation Bill Inserts

Conservation bill inserts are tied with television commercials and public service announcements for the third highest overall effectiveness ranking. In terms of accessibility, they received an excellent evaluation; however, they received a below average rating for their behaviour modifying capabilities. Although they received the same ranking as

television commercials and public service announcements, they were placed ahead because of the greater positive response from Lethbridge discussion group participants.

According to Michel (1968), a person is best able to alter his or her behaviour when he or she has specific knowledge of the consequences of his or her behaviour. A bill insert is an impersonal water conservation technique that has the potential to inform consumers about the economic consequences of their actions. Although its traditional format is ineffective at reducing consumption, researchers have found that when the information is modified or supplemented with social incentives, desired conservation behaviours do result (Seaver and Patterson, 1976; Winett and Kagel, 1984).

Winett and Kagel (1984) discussed several reasons why information commonly presented in utility bills is ineffective. They also identified the modifications required to obtain reductions in consumption. They found that the bills provide consumers with feedback infrequently (monthly or bimonthly) and as a result the consumers are unable to determine the impact of their conservation practices on consumption. In addition, bills do not "correct for exogenous factors such as the weather, nor do they make comparisons with previous use patterns" (Winett and Kagel,1984: 659). However, Winett et al. (1979) found that when individualized feedback about energy consumption and changes in energy use due to temperature fluctuations was provided to residents several times a week, energy consumption was reduced by 30%.

A study conducted by Seaver and Patterson (1976), revealed that residents who received utility bills supplemented with an information sheet and a decal stating "We Conserve Oil" conserved significantly more fuel than residents who only received the utility bills and the information sheet. In the study, consumers received their utility bills with specially prepared information slips that contained an explanation of their consumption rate during a delineated period, the rate of use during the same period the previous year, and the dollar savings or loss compared to energy expenditures the previous year. Some of the households who had reduced consumption from the previous year were also provided with a small decal stating "We are saving oil". It was found that over the following two months the households that received stickers consumed 10% less oil than households that did not. Cook and

Berrenberg (1981: 88) state that social incentives like the decal "promote conservation in instances where most members of the community value the activity for which recognition was bestowed".

Specific information with respect to individuals' preferences towards bill inserts was not found in the literature reviewed. Although the majority of the participants from the Lethbridge discussion groups evaluated bill inserts as an effective water conservation technique, several participants disagreed. Those who did not favorably evaluate bill inserts indicated that they considered the information that often accompanied them as junk mail that they rarely read. They failed to read the information messages because they seemed irrelevant to them; however, most stated that they would be more likely to read and utilize the information if it specifically related to their water consumption behaviour. One gentleman suggested that the amount owing should be circled in red with an arrow pointing to how much the bill could be reduced if specific conservation techniques were implemented. He also stated that a contact name and phone number should accompany the information for individuals who wanted to obtain more information.

Overall, bill inserts are inexpensive widespread information dissemination mediums that have the potential, when modified, to reduce consumption. Researchers have shown that they are less effective than more personalized techniques such as workshops or home audits though (Seaver and Patterson, 1976; Winett and Kagel, 1984) and it appears that they do not have universal appeal.

4.2.1.5 Television Commercials, Programs, Public Service Announcements and Video Tapes

Researchers have determined that lengthy television programs and short television advertisements vary in terms of their attributes and their overall effectiveness.

- Television Programs and Video Tapes

Of the educational conservation techniques listed in Table 4.1, television programs and video tapes received the lowest overall ranking. They are highly preferred by the public and

are very good at changing their behaviour. However, they do not reach a large segment of the population and are very costly to produce.

An evaluation conducted by Olsen and Hightstreet (1987) regarding the level of acceptance of the water conservation techniques by residents of San Antonio Texas revealed that 72% of respondents preferred television as a means of acquiring information about conservation techniques. Target behaviours that are explicitly demonstrated utilizing media such as television or videos are referred to as symbolic modeling. Research indicates that symbolic modeling is effective at reducing energy consumption (Syme et al., 1987; Winett and Kagel, 1984). For example, Winett and Kagel (1982) found that after consumers viewed specific conservation strategies depicted in a twenty minute video program, consumers tended to follow practices that were not followed prior to viewing the program, their home energy consumption was reduced by 10%, and energy used for heating and cooling (the targets of the program) were reduced by approximately 22%. It has been found that the effectiveness of modeling is enhanced by incorporating the following principles of communication into the messages: setting an agenda, presenting two sides of an argument and refuting one side, presenting simple rules and messages several times and in different contexts, using print captions and theme songs to tie messages together, and using a story line, rapid pacing, zooms and fadeouts to maintain attention (Winett and Kagel, 1984).

Although it is apparent that videos and television programs in particular, are accepted by the public and have the potential to reduce individuals' water consumptive behaviours, there are several drawbacks to using these techniques to convey water conservation messages. Syme et al (1987) state that the practical problems of developing, distributing and paying for films that are approximately twenty minutes in length are enormous. In addition, finding large audiences to watch these types of programs is often difficult. Finally, and most importantly, Lethbridge residents that provided feedback did not list television or videos within their top five preferred education sources, nor did they indicate that television programs would substantially change their behaviour (refer to Appendix H).

- Television Commercials and Public Service Announcements

Television commercials and public service announcements were ranked third, along with bill inserts for their overall effectiveness. Researches have found that they are highly preferred information sources that reach a large segment of the population. Because of their short duration, they are more economically feasible than television programs; however, they have a less than average rating with respect to their ability to modify behaviour.

The role that brief, televised public service announcements could play in an overall gasoline conservation strategy was examined by Syme et al. in 1987. They found that in contrast to television programs and video tapes, television commercials and public service announcements are cost-effective and, therefore, have a greater potential for wide spread distribution. They are also relatively successful at increasing awareness and promoting simple conservation behaviours such as using rain gauges (Winett, 1987). Awareness gained from media sources, such as television, enhances the perceived importance of conservation and energy conservation attitudes (Griffin, 1990).

Researchers have found that television commercials have limited effectiveness inducing more complex behaviour changes such as installing drip irrigation or xeriscapes (Costanzo et al., 1986, Syme et al., 1987; Winett et al., 1987). The research shows that the aforementioned conservation behaviours require significant inputs of time, effort and money and the behaviour changes are more complex than brand switching behaviours that are the aim of most media advertisements.

Lethbridge discussion group participants did not consider television commercials or public service announcements as a highly preferred information source nor particularly effective at changing their behaviors (refer to Appendix H). Given the fact that the participants likely have a greater understanding and interest in the issues addressed at the discussion group than those who chose not to attend (City of Austin, 1999), their lack of receptivity towards this technique may indicate that it should not be used as a medium directed at individuals with knowledge or understanding of the issues who are interested in learning more about complicated techniques. However, public service announcements, in particular, may be an

economical and effective part of a more integrated information program. The role of public service announcements should be restricted to informing the public about existing concerns resulting from excessive water consumption, the existence of a conservation program and the minor behaviour modifications that may reduce outdoor water consumption.

4.2.1.6 Xeriscape and Irrigation Workshops

Xeriscape and irrigation workshops received an overall effectiveness ranking of fourth. They are very good at changing the behaviour of those who attend; however, only small numbers of residents generally partake in them and there is often a fee for attending. As a result, workshops only influence a small percentage of the population and because there is a fee, access is reduced. In addition, there are conflicting reports about the public's preference level.

Workshops are an example of participant modeling. It occurs when "individuals receive real life demonstrations and have the opportunity to try out behaviours and receive instruction and feedback" (Winett and Kagel, 1984: 658). Workshops are a costly technique, but it appears that they are very effective at changing participants' behaviour. It has been found that attitudes from direct experiences exert a greater influence on subsequent behaviour than attitudes obtained by indirect experience such as watching programs or from reading information booklets (Vining et al., 1992).

The workshops are particularly effective when the following approaches are included: (1) models that viewers can identify with, (2) coping models who gradually demonstrate mastery over a problem, (3) multiple demonstrations of the desired behaviour, (4) showing models being rewarded for their behaviour and, (5) giving rules and chains of behaviour to follow to guide behaviour change (Winett and Kagel 1984: 658). It has also been found that exposure to several conservation workshops run in a reasonable time frame, tends to result in cumulative and reinforcing behaviour modification (Olsen, 1981).

Although workshops change participants' behaviour, determining the number of participants willing to partake in workshops is another important consideration. A study conducted by Montana State University-Bozeman on preferred learning methods regarding

urban pest management practices (Johnson and Jacobson, 1997), found that learning in a group setting was the least preferred method of learning. In contrast, the City of Regina has high attendance at its xeriscape workshops. It views the high numbers of participants as an indicator of the technique's popularity (Regina Works and Utilities, 1999). The latter finding is in agreement with the feedback obtained from the discussion group participants. All of the discussion groups thought that workshops could be effective at changing their behavior; and out of approximately 20 techniques[8], workshops were rated as the fifth and sixth most preferred technique by the city-wide and Varsity Village residents respectively. Overall, the discussion group participants evaluated workshops as the fifth most effective educational water conservation technique.

4.2.1.7 Conservation Helpline

A helpline is an information dissemination technique that provides individualized feedback to consumers or offers a series of pre-recorded messages that can be selected using a touch-tone phone. The conservation helpline received the fifth highest overall effectiveness ranking. It is a reasonably accessible and very good at changing individuals' behaviours provided that the callers have an opportunity to speak with a knowledgeable staff person. Having staff on hand to answer telephone calls is expensive though. The cost of running the hotline is significantly reduced by using pre-recorded messages; however, the effectiveness of the technique is significantly reduced.

The relationship between obtaining customized information that can be applied to one's own circumstances and the adoption of conserving behaviours is well established (Costanzo et al., 1986; Vining et al., 1992; Winett and Kagel, 1984). This indicates that helplines that have trained operators to answer specific conservation questions would be more effective than a pre-recorded answering system. Although helplines are less expensive to administer and potentially serve more customers than inter-personal techniques, the information provided is less vivid and as a result, individuals will be less motivated to modify their behaviour (Yates and Aronson, 1983).

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[8] The list presented to the participant contained twenty techniques; however, the participants were invited to expand the list thereby increasing the number of alternatives in some cases.

In addition, consumers appear to only moderately prefer this technique as a source of conservation information. A study conducted in San Antonio revealed that out of 303 respondents 50% stated that they did not prefer a helpline as an information source, 30% stated that they moderately preferred it and 19% stated that they highly preferred it (Olsen and Highstreet,1987). Although participants from the Varsity Village and Lethbridge discussion groups stated that a hotline was a preferred information source and that it may modify their behaviour, when compared with their evaluation of other options, it received a relatively low rating (refer to Appendix H). It was evaluated as the seventh and last technique that was commonly identified by the discussion groups.

Overall, a water conservation telephone line does not appear to be an overly effective water conservation technique; however, the effectiveness of the technique may improve if it combined with a home audit program. The services are complimentary and together they could provide a service that may be preferred by more consumers, more cost effective than running each program separately, and motivate more individuals to change their behaviours.

4.2.1.8 Self Awareness

Self awareness options such as rain gauges or soil moisture monitors received the second lowest overall effectiveness ranking, placing above television programs and video tapes. They are effective at modifying the behaviour of individuals who use them correctly; however, they are often not widely distributed nor are they as economically feasible as many other options.

Because of the low cost of water and the way it is purchased and used, it is difficult for consumers to monitor the consequences of their lawn watering habits. Self-monitoring devices are options that can assist consumers by helping them ensure that their water applications are adequate, not excessive. Researchers have found that the benefits of self monitoring programs are dependant on the level of participation which is strongly influenced by advertisements, education materials, subsidies and incentives (Costanzo et al., 1986; Waller et al., 1997). They have also found that the long term commitment of consumers to use fixture modifications, the performance of fixture modifications and the consumers'

knowledge of how to properly utilize the devices influence the effectiveness of this technique (Costanzo et al., 1986; Waller et al., 1997).

Winett et al (1979) conducted an energy conservation study to determine the effect of self-monitored feedback on electricity consumption. They found that consumers who accurately measured their electricity consumption reduced it by 7.5% over the one-month study period. In order to ensure that the participants properly recorded the readings, Winett's group gave them a ten-minute training session. Previous research with respect to the effectiveness of personalized instruction (Simmons and Widmar, 1990; DeYoung and Duncan, 1993) provides a strong basis for hypothesizing that the reduced consumption was influenced by the training session. The hypothesis is supported by Archer et al (1985, in Costanzo, 1986) who found that in the absence of training, a significant proportion of consumers do not understand how to implement water conserving measures properly, thereby limiting the measures' ability to reduce water consumption. Their conclusion was based on the results of a survey conducted on public awareness and understanding of four conservation techniques ranging in complexity with the simplest being "peak load usage and efforts to encourage use of electric appliances in nonpeak hours" (Costanzo, 1986: 522). Although 78.1% of respondents claimed to understand the aforementioned technique, accurate understanding was only demonstrated by 41.3% of respondents.

In terms of water conservation, one of the most inexpensive and simple self-monitoring devices that consumers could utilize to monitor their irrigation application would be small plastic measuring containers. Saunders and Thurow (1983: 20) state that "putting the conservation kits together and getting them distributed has many opportunities for headaches and consequently has less favorable reviews than other water conservation options" . In addition, although all of the Lethbridge discussion groups indicated that self-awareness had the potential to be an effective water conservation measure, the participants did not highly evaluate it (refer to Appendix H). With respect to the technique's preference level and behaviour modifying ability, the city-wide discussion groups evaluated it as the seventh and fourth most effective, while the city wide discussion groups ranked it seventh in both categories. Overall it was evaluated as the sixth most effective technique, the second least favored technique.

4.2.2 General Techniques

The general techniques listed in Table 4.1 are discussed below.

4.2.2.1 Increasing Block Rate Structure

The increasing block rate structure is a consumption based price structure where consumers are charged one rate for a certain quantity of water and higher rates beyond this amount. It was evaluated as the most effective general water conservation technique. It affects a large segment of the population, is economically feasible and effectively modifies water consumption behaviour; however, it has a below average rating with respect to public preference level.

Waller and others (1997: vii) found that ,"A consumption based price structure...if based on realistic prices and appropriately selected to address local circumstances can result in significant reductions in water consumption" . Several researchers have found that the adoption of this structure has resulted in reduced residential water consumption (Sanders and Thurow, 1982; Waller et al., 1997).

The Washington Suburban Sanitary Commission carefully monitored the influence the rate structure had on water consumption in Maryland over a three-year period from 1978 to 1982 (Saunders and Thurow, 1982). The new rate schedule had 100 different increments of use, set at 45.5 liter intervals from 45.5 liters to 4550 liters. Under the increasing block rate schedule, consumers who used an average of 2727.6 liters of water per day, experienced an increase in the amount of their sewer and water bill from $98.76 to $124.88 per quarter. The water bill of individuals who used an average of 454.6 liters of water per day was reduced from $17.70 per quarter to $10.26. The total demand for water for the third quarter of 1978 was down 13% and the reduced consumption remained for the duration of the study (Saunders and Thurow, 1982).

The rate structure's success at achieving reductions in residential water consumption is likely a result of several factors including: being implemented in conjunction with an active water conservation program, involving the public in the rate setting process, implementing a realistic unit charge for the water and combining the sewer charges with the water charge.

Researchers have found that the increasing block rate is generally acceptable to residents, if they are informed and included in the decision making process (Olsen and Highstreet, 1987; Saunders and Thurow, 1982). They found that individuals particularly liked the idea that they had some control over the size of their water bills; they could save money if they were prudent; and they were not paying for those who squandered it. Individuals who participated in the Lethbridge discussion groups shared similar sentiments.

All of the discussion groups evaluated the increasing block rate structure as the fourth most effective general water conservation technique with respect to preference level and behaviour modification. Although the rate structure determines how efficiently, economically and equitably consumer water use is influenced, it does not in itself, create the incentive to conserve. If the cost of water is too low, consumption will remain high or gradually return to higher levels once people became accustomed to the higher costs resulting from the increasing block rate structure (Sanders and Thurow, 1982; Waller et al., 1997). This is because it is the price in the block in which water use occurs which creates the incentive to conserve (Kranzer, 1988). Tate (1990: 40), states that insufficient data is available to conclude definitively that water prices in Canada are "too low"; however, he makes the important observation that water prices are low relative to the prices of other central services such as energy. This suggests that in order to reduce water consumption in Lethbridge by implementing a water rate structure, the unit price of water may have to be increased. Unfortunately, Lethbridge discussion group participants did not endorse increasing the price of water. However, acceptance of a price increase may improve in conjunction with an extensive education program.

4.2.2.2 Landscape Ordinances

Landscape ordinances are used to guide site development and landscape appearance through the regulation of landscape design, installation and maintenance. Researchers have found that landscape ordinances that are applied to specific situations are far more effective than ordinances that affect the entire population. Landscape ordinances that are applied to subdivision developers and buyers of new homes are ranked as the second most effective general water conservation technique. They received excellent ratings with

respect to behaviour modification and economic feasibility, a good rating for accessibility and an average rating for public preference level. Of the general water conservation techniques listed in Table 4.1, general landscape ordinances received the lowest overall effectiveness ranking. Although they reach the target population, are economically feasible and are good at changing the public's behaviour, they are not preferred. In fact, out of the fourteen techniques highlighted in Table 4.1, they received the lowest public preference level evaluation.

In most instances, ordinances regulate the aesthetic character of landscapes as opposed to their water requirements. One notable exception is in Kings County Washington, where owners of new homes who choose to install irrigation systems must adhere to a water efficiency minded landscape ordinance. The ordinance includes design standards that prescribe a maximum water budget tied to a combination of plantings (Sakrison, 1997). Home owners must submit a landscape plan that demonstrates that the proposed landscape's water requirements comply with the water efficient landscape design standards. The water budget for the water efficient landscape is 67% of the amount required to maintain a typical landscape on a low density residential dwelling (Sakrison, 1997).

For municipalities in which it is important to reduce outdoor water consumption, landscape ordinances are a cost effective means of reaching the target population. They can direct individuals to reduce water consumption by incorporating standards with respect to proper soil preparation and vegetation selection. Preparations that are properly suited to the local environment facilitate water consumption reductions and thereby contribute to a reduction in problems that are caused by excessive watering such as slope instability and basement flooding. The significant drawback to this technique is the public's negative perception of being forced to comply with a set of regulations.

Lethbridge residents who participated in the discussion groups were strongly opposed to being required to use water conserving site designs or having restrictions placed on specific water uses, the quantity of water used, or the time within which it can be used for certain functions. This negative reaction may be thought of in terms of reactance theory (Brehm,

1966 in Cook and Berrenberg, 1983: 86) which states that "people react against compulsory changes that involve them without their consent. It states that disincentives such as ordinances are often ineffective at changing behaviour unless there is a high level of surveillance". In addition, residents' negative feelings towards the ordinance may form a lasting negative impression about the entire water conservation campaign. As a result, they will be less likely to modify their attitude or behaviour towards water conservation.

Kranzer (1988) has found that individuals respond more favorably to restrictions placed on others than on themselves. This finding is consistent with the feedback obtained from the participants who took part in the Lethbridge discussion groups. In fact, nineteen out of the twenty two participants were in favor of regulations imposed on new home buyers or developers of proposed subdivisions. The participants from three out of the four discussion groups strongly preferred landscape ordinances as a behaviour modification technique while participants from one city wide discussion group moderately preferred them (refer to Appendix H). "They are clearly within the public purpose of subdivision or landscaping regulations since they not only protect the important common resource, they also are a means by which municipalities can avoid unnecessary future expenses" (Saunders and Thurow, 1982: 12). They are also effective at reducing water consumption (Sakrison, 1997) and generally have public support (Saunders and Thurow, 1982). They can gain support from developers if the materials that are mandated are in the same price range as standard landscaping supplies.

4.2.2.3 Collaborations

Collaborations are one of the most consistently evaluated general water conservation techniques. They received very good ratings in all four of the assessment categories. It is widely held that well planned and implemented collaborations create innovative, cost effective initiatives that rapidly gain recognition and acceptance by the public (Gray, 1985; Lacey, 1985; Scheff and Kotler, 1996; and Waller et al., 1997).

In the Canadian Municipal Water Conservation Initiatives Report (1997: 62), Waller and others stated that "collaborations with other agencies, businesses, service clubs, community organizations, and media can enhance municipal [water conservation]

programs by making available human, financial and other resources including the experience and contacts that collaborations provide". They also provide opportunities for the partners to learn from one another, explore innovative opportunities to grow, and to involve other parties. As more parties become involved, the credibility of the collaborative initiative increases, as does information dissemination to various segments of the population. It has also been shown that individual interest and acceptance of the initiatives increases when individuals are informally told about them by a network of peers (Lacey, 1983). According to Festinger's cognitive dissonance theory (1957 in Yates and Aronson, 1983), once individuals have bought into or become involved in the collaborative initiative, they are more likely to accept other water management practices. This is because they experience discomfort when their beliefs are inconsistent. They will strive to reduce the inconsistency by changing one or more beliefs to make them more compatible.

The Lethbridge discussion groups provided a considerable amount of feedback with respect to their usefulness and the kind of collaborative initiatives that would have the greatest value. All of the participants responded favorably towards the promotion of collaborative efforts across various sectors of society, e.g., among local businesses, the city, the University and communities. Overall, collaborations were evaluated as the second most effective general education technique, behind landscape ordinances (Refer to Appendix H). Two collaborative projects were identified as being particularly useful: a workshop and a demonstration garden. The following discussion explores these two options separately.

- Demonstration Gardens

The participants were strongly in favor of the development of a demonstration garden; however, they felt that a jointly planned and orchestrated garden would have a greater impact. It would reach more residents and be more convincing. They also thought that a garden that generated enthusiastic involvement of many groups would be more likely to be maintained and have a lasting impact.

- Workshops

The participants thought that a collaborative effort between local businesses and the University or College was important to develop a workshop series on drought tolerant landscaping techniques. They indicated that workshops are already being provided by local businesses; however, residents feel pressured to purchase products and are often skeptical about the accuracy of the information they are provided. A collaborative effort between the local learning institutions and businesses would increase the credibility of the workshops. Residents would feel confident about the quality of the information received and where appropriate materials could be purchased.

4.2.2.4 Home Audits

Home audits are ranked as the fourth most effective general water conservation technique, above general landscape ordinances. They are particularly effective at changing individual's behaviours. They are also economically feasible and preferred by many citizens; however, they are not as accessible as the other general water conservation techniques listed in Table 4.1.

One of the primary goals of water conservation audits is to provide information and training with respect to water conservation options that are uniquely tailored to meet the needs of individual households. Because individuals receive personalized instruction and feedback, audits are considered to be an extremely effective, but somewhat costly behaviour changing strategy (Winett and Kagel, 1983). A study conducted to determine the relationships between information sources and the adoption of conservation behaviours found that audits promoted pro-conservation attitudes and behaviour more consistently than any other information source examined (Griffin 1987). Griffin (1987) also concluded that audits would be particularly effective in instances where adoption required expert advice in order to identify actions that were appropriate to individual's dwellings and lifestyle. The aforementioned comment is particularly relevant with respect to the adoption of drought tolerant landscaping features.

One potential drawback of this technique is its inability to disseminate information to large numbers of individuals quickly. Unlike other information sources such as brochures that can

be distributed to large numbers of consumers, auditors can only provide feedback to a limited number. Yates and Aronson (1983) state that auditors can increase the diffusion process by encouraging residents to teach their friends, neighbours and relatives what they have learned. In addition, the trained residents serve as models and when neighbours see the results of new practices and plant materials, their use will spread rapidly.

When residents of San Antonio were surveyed about their preference level towards audits, individuals stated that they moderately preferred them (Olsen and Highstreet ,1987). In contrast, participants from the Lethbridge discussion groups stated that they highly preferred audits (Refer to Appendix H). They also thought that a visit from an auditor would result in reduced water consumption. One concern that several participants raised was the name "home audit". They felt that it did not accurately reflect the services that are provided nor did it place them in a positive light. One participant stated that the word "audit" sounds like a punishment that individuals would try to avoid rather than pursue.

4.3 Conclusion

There are four educational water conservation techniques and three general water conservation techniques that were highly evaluated by researchers and the Lethbridge discussion groups. The education techniques are: conservation bill inserts, conservation brochures and booklets, newspapers, and workshops. The three general techniques are home audits, increasing block rate structure, and landscape ordinances for buyers of new homes and proposed subdivisions. Two additional techniques that were highly evaluated by Lethbridge discussion group participants and the research findings to date are collaborations and demonstration gardens.

Although the aforementioned techniques have been evaluated as effectively promoting the reduction of water consumption, their effectiveness in the Lethbridge context is dependent on being strategically integrated into a comprehensive water conservation program. In chapter five, the strategy to build an effective water conservation program by incorporating these techniques is discussed.

Chapter 5

STRATEGY FOR THE CITY OF LETHBRIDGE

> *Successful strategies that reduce water consumption, "invariably include some combination of water saving technologies, economic incentives, regulations and consumption reduction. These measures are mutually reinforcing, and they are most effective when implemented jointly" (Postel, 1985 in Tate, 1990: 42).*

In chapter 4 critical aspects of water conservation techniques were examined in order to evaluate their effectiveness. The techniques were evaluated using criteria derived from previous conservation research as well as feedback obtained from four Lethbridge discussion groups. The findings from both evaluations were compared and a list of techniques that were highly evaluated by researchers and Lethbridge discussion group participants was created. The list of effective techniques included: collaborations, conservation bill inserts, conservation brochures and booklets, increasing block rate structure, home audits, landscape ordinances for new subdivisions and newspaper articles, xeriscape demonstration gardens, and workshops.

In this chapter a coherent water conservation management strategy is formulated. The process involves developing a goal and then grouping the techniques that will be used to achieve the goal into three levels of implementation based on the degree of direct municipal involvement. The techniques in phase I take an educational and informational approach, relying on residents' initiative to achieve savings rather than provide actions. In phase II the municipality is more directly involved, offering residents on-site audits and technical assistance. In phase III program providers and the municipality are directly involved in the development and implementation of mandatory measures such as landscape ordinances and modifications to the water rate structure. In Table 5.1 the effective water conservation techniques discussed in chapter 4 are grouped into the three increasing phases. In the following sections, the strategy for implementing the successive phases is discussed in detail.

Table 5.1 Incorporation of Techniques into Integration Phases

Goal: The reduction in demand required to alleviate problems resulting from excessive irrigation	
Phases	**Lethbridge Residential Outdoor Water Consumption Techniques**
Phase I - Education	Conservation Bill Inserts Conservation Brochures and Booklets Newspapers Xeriscape Demonstration Gardens
Assess Effectiveness of Program	
Phase II – Elective Involvement	Collaborations Home Audits Xeriscape and Irrigation Workshops
Assess Effectiveness of Program	
Phase III – Mandatory Measures	Increasing Block Rate Structure Landscape Ordinances (applied to new subdivisions and owners of new homes)
Assess Effectiveness of Program	

5.1 Goal

Establishing a water conservation goal that specifies the reduction in demand required to alleviate problems resulting from excessive irrigation is important because it influences the character of the water conservation program. It will determine how stringent the program must be and serve as a benchmark for evaluating the effectiveness of the program.

5.2 Education Phase

Many researchers have concluded that individuals' awareness and accurate understanding of issues facing a municipality is a necessary precondition for conservation behaviours (Costanzo et al., 1986; Seaver and Patterson, 1976; Simons and Widmar, 1990; Yates and Aronson, 1983). Several have also found that residents must be convinced that their own behaviour, no matter how small, has a direct effect on the situation.

Although 18 out of the 22 discussion group participants stated that they were aware of the basement flooding and slope instability problems occurring in Lethbridge (refer to Appendix G), many of their comments revealed a lack of understanding about the issue. For

example, very few understood that excessive residential irrigation significantly contributed towards the aforementioned problems and even fewer understood that excessive outdoor irrigation, that was not directly applied on or beside the impacted areas, also contributed.

Water conservation brochures, booklets, bill inserts and newspaper articles are relatively inexpensive, highly effective sources of information that the City of Lethbridge could utilize to inform residents about the water issues. In addition to using the education techniques that have been found to be particularly effective at informing the public, other techniques that have already been implemented (e.g. water conservation web page and television public service announcements) will enhance the information dissemination process because people frequently prefer and utilize several information sources (Olsen and Highstreet, 1987).

In addition to educating the public about the water issues that face their community, the public's negative perceptions towards conservation must also be addressed. For some, the term xeriscape and drought tolerant landscaping, bring to mind images of cacti, rocks, and little to no landscaping. Demonstration gardens can be used to change their negative views and increase the acceptability of these measures in the community (Kranzer, 1988: 103). For others, the term conservation has become synonymous with "going without". To prevent people from making this negative association, the term water efficiency may be used in the conservation literature. Numerous researchers have also stated, the information presented should be vivid, highly imaginable, contain information about the adverse impacts of excessive irrigation, and state why conservation at the household level is important. It should also include conservation approaches that residents can implement, particularly ones that are simple, inexpensive, and easy to understand. For example, demonstrating how to monitor water applications by using small containers would be an appropriate option. Clear, concise directions regarding how to implement the option as well as the benefits it provides should also be outlined. The benefits should build on several motivating factors such as the economic benefits, time savings, and sense of responsible action towards the environment because each of these motivations may appeal to different people.

Informing residents about the importance of conservation and the methods for achieving savings leads to better informed consumers and to more favorable attitudes towards conservation (Seaver and Patterson, 1976). However, the reduction in consumption residents are likely to achieve are small relative to the reductions that are likely to be achieved during phases II and III of the water conservation program. It must be emphasized that promoting awareness and changing attitudes in favor of conservation is a necessary precursor to successfully implementing a water conservation program. In order to ensure the success of the water conservation program, education must be established as an integral and on-going part of the water conservation program.

There is not a set period time when the program should advance to stage two of the process. When the education phase is established and it is apparent (through surveys or otherwise) that most residents have a solid understanding of the water related issues their city faces, techniques from the second phase can begin to be incorporated into the program.

5.3 Elective Involvement Phase

The elective involvement phase involves the promotion of techniques that residents have the option of deciding whether and to what extent they would like to participate. Once the majority of residents have been made aware of the water related issues facing the City of Lethbridge, the elective involvement phase may be successfully initiated. Conservation efforts in this phase are designed to circumvent barriers that impede residents from implementing water conservation options. Typical barriers include lack of knowledge with respect to implementation, lack of motivation and cost. Two of the primary methods that should be used to address these impediments are home audits and workshops. A strategy for implementing each of these techniques is discussed below.

5.3.1 Home Audits

Costanzo and others (1986) state that interaction between information and its application results in the adoption of conservation behaviour. Home audits provide an ideal opportunity for trained personnel to demonstrate how various water conservation options can be

implemented in the residential setting. In this environment the resident has the opportunity to evaluate the techniques and determine which are more appropriated given his or her lifestyle, financial situation and degree of commitment. Together the auditor and the resident can then develop a water conservation approach that is uniquely tailored to meet the needs of the household.

Auditors will also find that residents vary in terms of receptivity towards implementing water conservation techniques especially options (e.g. xeriscaping) which can be costly in terms of time, effort and money. Some residents may be uncertain about changing their water consumption behaviour, others may be motivated and a few may have already implemented significant water conserving practices. In order to promote conservation behaviour by residents who are skeptical about changing their behaviour, the auditor should ask them to make very small conservation commitments such as monitoring the amount of water they apply to their lawns. Katzev and Purdini (1987) have found that encouraging individuals to begin conserving by making a small commitment to recycle can act as a catalyst for initiating and sustaining further conserving acts. The more reluctant water conservers who have agreed to make a small commitment along with those who are more motivated to change their behaviours should then be asked to consent to having their names listed in local media sources with those who have also committed to conserve water. In an energy conservation study conducted by Wang and Katzev (1990), individuals who consented to having their names listed among those who had committed to conserve energy not only used significantly less fuel, but they sustained the reductions throughout the twelve month follow up period even when they were aware that their names were no longer listed and the possibility of public recognition had ceased.

Auditors should also seek residents who have drought tolerant landscapes or have been practicing water efficient gardening. Those residents should be approached and actively encouraged to "show off" their gardens. Yates and Aronson (1983) found that the diffusion of conservation techniques can be accelerated by cultivating visible and credible models, the most effective being "the person next door". Interested individuals should be asked if they would be willing to have their gardens showcased in local newspaper articles, meet

with others who are interested in creating a garden with similar features, and/or teach their friend and neighbours about the water conservation practices they have implemented.

The involvement of local residents as credible models is not only effective at accelerating the adoption of water conservation throughout communities, but also many of the Lethbridge discussion group participants stated that it is a highly preferred information dissemination method.

5.3.2 Workshops

Simmons and Widmar (1990:14) state that "environmentally responsible behaviour has been linked with skill level necessary to carry out the desired behaviours". Workshops are an ideal setting for residents who are motivated to make modifications to their landscape and irrigation systems, but feel that they lack the skills. Collaborative efforts among educational institutions, the City of Lethbridge and local businesses should be formed to develop highly effective workshops that provide benefits to all parties involved. Reputable companies would benefit from the exposure and contact with potential customers. The educational institutions would ensure that the information presented is accurate and suitable. The City would benefit from the decreased water consumption of those in attendance. The participants would learn the skills required to modify their landscape, feel more secure that the information received is accurate and feel less pressure to purchase unwanted items.

Home auditors could be instrumental in recruiting individuals interested in participating in the workshops. Since word of mouth is one of the most effective modes of communication (Olsen and Highstreet, 1987) a well run workshop with the involvement of multiple parties would likely have a larger number of residents interested in participating the following year. Subsidies could also be provided for those who are interested in attending the workshops, but are not in the financial position to do so.

Once the home audits and workshop portions of the program have been implemented, the effectiveness of the water conservation program should be assessed. The assessment could be based on an estimation of the portion of homes that have adopted water

conserving measures and the volume of water that has been conserved since the implementation of the program. If the reduction achieved by the education and elective involvement phases meet the water conservation goal, further techniques may not be required. However, if the goal has not been met then mandatory measures may need to be implemented.

5.4 Mandatory Measures Phase

Mandatory techniques are the most difficult to successfully implement. "It is essential that the public perceive the need for water conservation in order to obtain public support" (Kranzer, 1988:105). The necessary support is obtained using an intensive education campaign that explains why the mandatory measures are required and what consumers can expect once the changes are in place. Two effective techniques that were highly evaluated by Lethbridge residents are landscape ordinances for new subdivisions and the increasing block rate structure.

5.4.1 Landscape Ordinances for New Subdivisions

As mentioned in chapter three, a landscape ordinance is a public law that is often contained within by-laws or subdivision standards that can regulate landscape design, installation and maintenance. If the City of Lethbridge intends to establish a landscape ordinance that requires the use of water conserving site design, it should begin by extending its water conservation principles that are outlined in the Municipal Development Plan. Currently the planning goal (Chapter 3, point 12,) is to reduce water and maintenance requirements in parks and open spaces (City of Lethbridge, 1996). The goal should be broadened to include all land uses. The City should then make water conserving site design and landscaping a condition of subdivision approval. According to the Municipal Government Act (Section 640, subsection 4), the City can establish development controls that include subdivision standards (a), and landscaping (d) (Cerney et al., 1997). The subdivision design standards should be established to encourage the conservation of water resources by specifying the appropriate soil preparation, suitable irrigation systems, and vegetation that is suited to the natural climate of the area. The developers should then be provided with lists

that specify the vegetation that will satisfy the requirements. Finally, the City should amend the landscaping By-law (Section IX, subsection 56, City of Lethbridge, 1989) and clearly state that individuals who purchase homes in water-efficient subdivisions must enter into a contract agreeing to maintain the landscape in the state purchased.

5.4.2 Increasing Block Rate Structure

The increasing block rate structure promotes water conservation behaviour changing higher rates for units of water consumed beyond a predetermined amount. Currently, the City of Lethbridge's residential customer class is charged a constant rate for water consumed (City of Lethbridge, 1998 [on-line]). If the City elects to change the method that it employs to charge its customers for water use in favor of a more conservation oriented approach (e.g. increasing block rate), public education efforts should be used to gain the approval of the citizens. They should also be involved in the decisions and development processes.

In order to develop an effective increasing block rate structure, the City should be consider the following recommendations. In order to be equitable to the residents, the City should divide the single family residential class of water consumers into several smaller customer categories that include single family residential, small multi-family residential (including duplexes and tri-plexes) and large multi-family residential (including four-plexes and five plexes). Fixed service charges should be applied to consumers in each customer category. In addition, a base consumption level should be established according to the amount of water used during the six month winter season (Berg et al., 1996). A rate for smaller consumers of water should be set lower than the base rate to provide for the needs of low income and elderly persons. A rate that is slightly higher than the base rate, but is reasonably priced should also be established. This rate would be established for water use that exceeds the base consumption but is within a boundary required to adequately water efficient landscapes. Water efficient landscaping moisture requirements could be determined through evapotranspiration calculations (Berg and Byrne, 1998). The next step is to carefully consider the number of additional blocks required, the volume of water

allocated to each block and the corresponding price in order to develop a structure that will meet the City's water conservation goals and is accepted by the public.

If, after implementing the mandatory measures, the water conservation program is still unsuccessful at meeting the City's water conservation goals, an in-depth review of the program should be conducted and additional techniques, particularly those that fit into the mandatory measures phase , should be considered.

5.5 Future Research Considerations

This research has examined water conservation techniques that could be implemented by the City of Lethbridge. The research has identified the techniques that are effective at promoting conservation behaviour. It also enhanced our understanding of why these techniques are effective. This research, however, had several methodological limitations which may have affected the final conclusions. The following three points indicate the areas where further research is required.

1. Additional Water Conservation Studies

Although there has been a significant amount of research conducted on a variety of recycling and energy conservation topics, information on water conservation is far less prevalent. Additional information on which conservation measures are adopted, why they are adopted, and how they are adopted will enable the design and implementation of more effective and efficient water conservation programs.

2. In-Depth Studies of Municipal Water Conservation Programs

The selected municipalities did not provide sufficient evidence that clearly demonstrated linkages between specific water conservation options and greater conservation activity. Future research that employs an experimental design of pre and post treatment studies will provide additional support.

3. Greater Public Involvement

Due to time and financial constraints, a small public consultation process was conducted. In order to ensure the wide spread acceptance of this strategy a larger, more representative, public consultation process is required.

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APPENDICES

Appendix A - Discussion Group Process

I. Objective

To obtain individuals' preferences towards various outdoor water conservation management options and educational approaches

II. Focus Group Process Overview

Up to four focus groups will be organized and facilitated; ideally, two with the residents from the case study community of Varsity Village and two with residents from other communities in Lethbridge. The ideal number of participants for a focus group is five to eight; however, several individuals who have agreed to participate often do not attend. Therefore, I would like to recruit approximately twelve individuals for each focus group with the hope that eight will attend.

A. Sessions

Each focus group participant will be asked to participate in one session. The session (held in May or June) will be held for information sharing purposes. The participants will be asked to provide feedback on a variety of outdoor water conservation management and public education options. Selection and Recruitment of Participants

i. Population of Interest

Individuals that represent the population of interest include:

3 Residents of Lethbridge that live in single unit residential dwellings

4 Approximately equal number of males and females

5 Range of age group

6 Range of income and educational levels

ii. Convenience Sampling Method

The convenience sampling method is commonly used to obtain sample populations of interest for focus groups and it appears to be the most effective method for my study. It is not the most rigorous approach; however, it is the method of choice given the difficulty of obtaining participants (MacNealy, 1999:2), and limited resources.

B. Approach to Obtain Focus Group Participation

i. Home and Garden Show

At the Home and Garden Show there was a draw for dinner for two at Fire 911 and brunch for two at the Lethbridge Lodge. At the bottom of the entry forms the respondents were asked if they would be interested in participating in a discussion about various water conservation techniques. Thirty-nine respondents indicated that they would be interested in participating. Of the thirty-nine, thirty-one were from communities outside of the case study community of Varsity Village. They currently make up the list of potential participants for the general focus groups.

ii. **Other Strategies**

Eight of the respondent are residents of Varsity Village. The number is insufficient to conduct focus groups with; therefore, two additional strategies will be used to obtain more participants. One method is to contact the interested participants and ask if he/she has neighbours that may be interested in participating. Other strategies include placing posters at selected locations and canvassing residents throughout the community a to obtain additional participation.

C. Focus Group Preliminary Process

The preliminary process involves two steps that each participant will be involved with:

Step 1: Administering a questionnaire to the potential participants (see Appendix B)

Every potential participant will be contacted and asked to respond to questions in a questionnaire. The questionnaire contains socio-demographic questions that will be used to obtain additional information about the potential participants including: his/her age, the community he or she lives in, length of time he or she has lived there, whether he or she is a home owner, his/her occupation and income etc. The information obtained will:

7 Facilitate the systematic stratification of the sample by being able to select and stratify the potential participants into categories based on the socio-demographic characteristics listed above.

Step 2: Providing an information booklet to the participants prior to the focus group session

The information packages are intended to:

- Provide the participants with background about the issues, key concepts definitions etc. This will level the knowledge base before discussion begins and allow the participants to "develop a commitment to a position before the discussion begins" (Anderson, 1998).

8 Ensure that the focus group runs smoothly and the desired information is obtained.

Appendix B - Discussion Group Screening and Invitation

Participant Code # _____
Participant Name _____
Participant Phone Number _____

Hello, my name is Jennifer Reid and I am a Masters student at the University of Calgary. I am working on a study examining various water conservation techniques that could be used to reduce outdoor water consumption in Lethbridge. At the Home and Garden Show you indicated that you would be willing to participate in the project by attending a discussion group. Are you still interested in participating?

Yes _____ No _____
IF YES:
There are a few questions I would like to ask you:

In the last six months, have you attended a focus group or group discussions?
Yes _____ No _____

Are you aware of the slope instability and basement flooding problems that have resulted from
Yes _____ No _____

Have you or someone you know been affected by the aforementioned problems?
Yes _____ No _____

Less than 1 year _____ 1 to 5 years _____ 6 to 10 years _____ More than

Are you living in a single unit house?
Yes _____ No _____

Do you own the house or are you renting?
Own _____ Rent _____

Session 1: Tuesday May 11th 7:00pm to 9:00pm Yes _____ No _____

Session 2: Wednesday May 19th 7:00pm to 9:00pm Yes _____ No _____

Which of the following age groups are you in?
Under 19 years _____ 20 to 24 years _____ 25 to 34 years _____ 35 to 54 years _____
55 to 64 years _____ 65 to 74 years _____ 75 years and over _____

At the present time are you

_____ A homemaker
_____ Employed full time outside of the home
_____ Employed part time
_____ Not employed/ retired
_____ Other (please specify _____

What is the highest level of formal education you achieved:

_____ Some high school or less
_____ High school graduation
_____ Some post-secondary education (college, university of technical)
_____ University graduation
_____ Post-graduate education

Which of the following income groups describe your approximate annual gross family

_____ Under $10,000
_____ $10,000 to $19,999
_____ $20,000 to $29,999
_____ $30,000 to $39,999
_____ $40,000 to $49,999
_____ $50,000 to $59,999
_____ Over $60,000

Thank you for this information. See you on *day, time and place*. Should you have questions, concerns or have to cancel your participation, please call Jennifer Reid at 320-7591.

Appendix C - Discussion Group Letter of Invitation (Sample)

April 13, 2000

Dear (name),

Thank you for accepting my invitation to attend the discussion at the **University of Lethbridge** on **Thursday, May 27th** in the **University Hall** building. The meeting will begin at 7:00 p.m. and will conclude by approximately 9:00 p.m. in **room B772** (please refer to the attached maps for directions).

Since I am talking to a limited number of people, the success and quality of our discussion is based on the cooperation of the people who attend. Because you have accepted my invitation, your attendance at the session is anticipated and will aid in making the research project a success.

The purpose of discussion you will be attending is to discover residents' preferences towards various water conservation techniques that could be used to reduce outdoor water consumption and to provide insights into workable conservation opportunities. I have attached a booklet that includes many of the water conservation techniques that could be used. Please review it prior to attending the discussion and bring it, along with some comments to the discussion. If for some reason you find you are not able to attend, please call me to let me know as soon as possible. My phone number is 320-7591.

I look forward to seeing you on May 27th.

Sincerely,

Jennifer Reid

Appendix D - Discussion Group Handout

I. Purpose of the Discussion Groups

In the City of Lethbridge, excessive irrigation of residential lawns has contributed to several negative impacts including slope failures and basement flooding in some areas. Discussion groups will be conducted with residents to discover their preferences towards various water conservation techniques that could be used to reduce outdoor water consumption and to provide insights into workable conservation opportunities. The techniques that could be used to reduce water consumption are grouped into the following categories: (A) Laws (Ordinances), (B) Economic Incentives, (C) Infrastructure Improvements, (D) Collaborations and (E) education. A brief description of the categories and examples of accompanying techniques are provided below.

Please review the techniques provided in this booklet and carefully consider the following questions:

Are there any techniques that are not included and should be?

Which techniques do you prefer and why?

Which techniques do you think would be the most effective? Why?

Which techniques do you think are the least effective? Why?

I. Categories

A. Laws (Ordinances)

Public laws that are often contained within a zoning ordinance or land development codes that establish minimum standards to ensure that particular actions do not jeopardize the health, safety and beauty of a municipality.

i. Techniques

Water Ordinances - They regulate water use times, and the efficiency of irrigation systems (i.e. monitoring for leaks, improperly adjusted sprinkler heads).

Landscape Ordinances - They are used to guide site development and landscape appearance through the regulation of landscape design, landscaping, and landscape installation and maintenance.

B. Economic Incentives

They motivate individuals to implement water conservation techniques and/or reduce water consumption through the use of financial rewards. Examples of economic incentives include: landscape rebates, water rebates, water rate structures and the cost of water.

ii. **Techniques**

Landscape Rebates - They encourage homeowners to use water more efficiently in their yards by offering price reductions on specific landscaping products and approved plant materials (i.e. native and adaptive water conserving species).

Irrigation Rebates – Individuals who install specific irrigation systems may qualify for a rebate of a specified amount if they agree to have a professional audit conducted on their system[1]. The intent of the audit is to ensure that the system is running efficiently (i.e. there are no leaks, improperly programmed controllers are fixed, and improperly adjusted heads are adjusted).

Water Rate Structures - Municipal water users in Canada pay for their water through rates set by the individual municipalities (Tate, 1990:13). Some of the most common rate structures include: flat rate, decreasing block rate, constant rate, increasing block rate, and peak demand rate (refer to figure 1 for additional information).

Price of Water- The periodic water bill paid by customers is based on the price of water (e.g. cents per m^3) that is built into the water rates. The unit charge of water in Lethbridge is 41¢ per m^3. The price is similar to prices of water throughout the Country (e.g. the median price of water is 54 ¢ per m^3 and 37 ¢ per m^3 in Alberta and Ontario respectively). When compared to the price of other liquids[9], the price of water is very low [2]. Many believe that the low cost of water sends a message that it is a cheap commodity that need not be conserved.

Voluntary Water Reductions – Municipalities promote voluntary reductions in residential water consumption.

iii. **Points to Ponder**

The rebates provided are just a sampling of a wide variety of rebates that could be implemented. Can you think of a rebate example that you would like implemented in Lethbridge?

Do you think increasing the price of water would reduce water consumption?

Do you think the price of water should be increased in Lethbridge? If so, by how much?

---

[1] In many instances the audits are funded using general tax money. There are no user fees charged directly to the consumer.

[2] Consider that the consumable liquid priced closest to water, cola, is 1675 times as expensive (Tate, 1990:14)

C. Infrastructure Improvements

i. Techniques

Home audits – Provide residents with a survey of their outdoor water use and provides them with the necessary tools and information to lower their outdoor water use. Audits primarily concentrate on leak detection and repair, water saving systems (retrofitting and repair, and pressure reduction).

Retrofits – Adapting or replacing water inefficient irrigation equipment with one of the many efficient devices on the market today.

D. Collaborations

They occur when various groups come together and invest time and/or money towards a project. The groups that become involved are commonly city departments, communities, public agencies and private companies. Examples of water conservation collaborative projects that have been used successfully elsewhere include landscape and irrigation workshops, xeriscape[3] demonstration gardens, lecture and demonstrations presented by experts, and school programs.

i. Techniques

Landscape and Irrigation Workshops - Landscaping companies and the City of Lethbridge could organize workshop(s) to teach interested residents how to transform their traditional landscapes into more water efficient ones.

Xeriscape Demonstration Gardens – The Lethbridge School Board could work with the City of Lethbridge and garden centers to create a demonstration garden. The designers could use the garden as a teaching tool to reveal to the residents how attractive and unique xeriscaped yards can be.

Lectures and Demonstrations by Specialists – The City of Lethbridge in collaboration with various groups could offer a water conservation lecture series over the summer. Each week a specialist would be invited to present a lecture on a relevant topic. Some of the topics could include: landscape design, maintenance of xeriscapes, and finding new and attractive drought tolerant plants.

School Programs – Private corporations and the City of Lethbridge could develop an educational program designed to teach students about the local environment and appropriate stewardship that starts in their own backyard.

ii. Points to Ponder

Can you think of other collaborative projects that you would like to see occur?

What would be a suitable location to have a demonstration garden?

---

[3] Xeriscape – naturalization using sound gardening practices, and native and drought tolerant plant materials.

What would be a suitable location for lectures and workshops?

E. Education

There are many techniques that could be used to educate residents about the importance of reducing the amount of water consumed outdoors. A list of examples is provided below. Brief descriptions are only provided for the techniques that appear to require further explanation. However, if you have any questions about specific techniques listed below please do not hesitate to ask at the discussion group session.

i. Techniques

Bill inserts, brochures, booklets and pamphlets

Conservation "hotlines" - *A phone number to obtain additional information.*

Information van

Internet information – *A web site that would provide local water conservation, landscape information, and a water scheduling program (i.e. tell you how much you should water your lawn based on recent precipitation and irrigation inputs).*

Landscaping workshops

Landscape demonstration gardens

Lectures and demonstrations presented by experts

Municipal and utility landscaping programs – *A property surrounding municipal and/or utility buildings is xeriscaped.*

Newspaper articles

Radio information programs and commercials

Refrigerator magnets

Residential garden and yard contests

School programs

Television information programs, commercials and videotapes

Water conscious citizen's awards

Water scheduling program - *Informs the resident how much irrigation his/her yard required based on recent precipitation and irrigation in-puts.*

Xeriscape demonstration gardens

ii. Points to Ponder

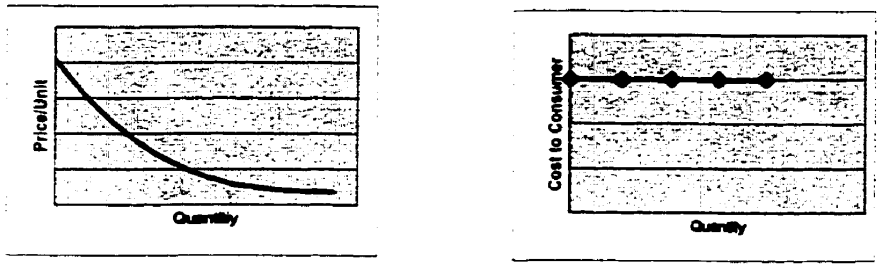
Are there any education techniques that you would like added to the list?

Which techniques do you prefer the most?

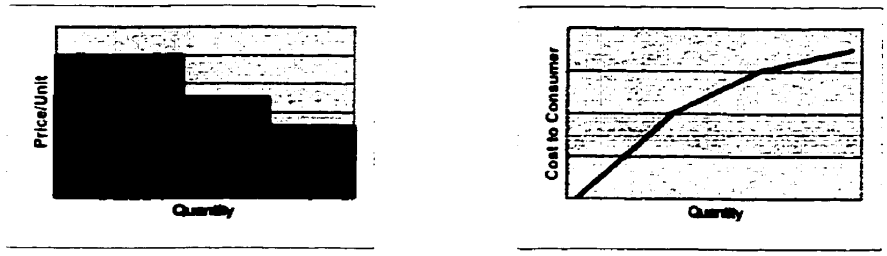
Which techniques do you prefer the least?

Figure 1. Rate Structures

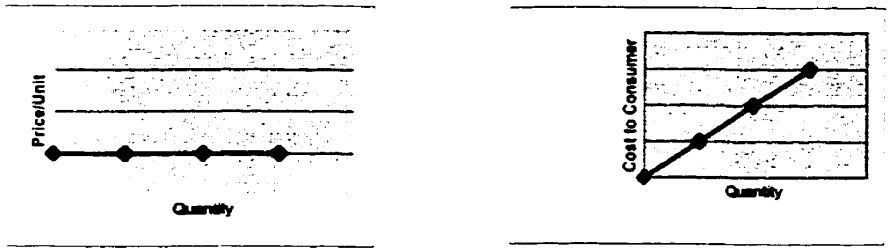
A. Flat Rate - Charge each consumer the same amount regardless of how much they consume.



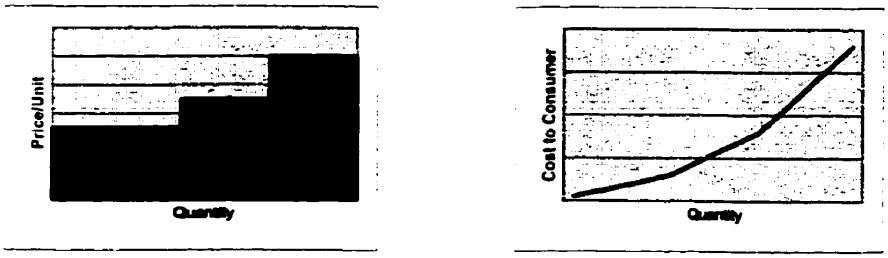
B. Decreasing Block Rate - Charge one rate for a certain quantity of water and lower rates for units beyond this amount.



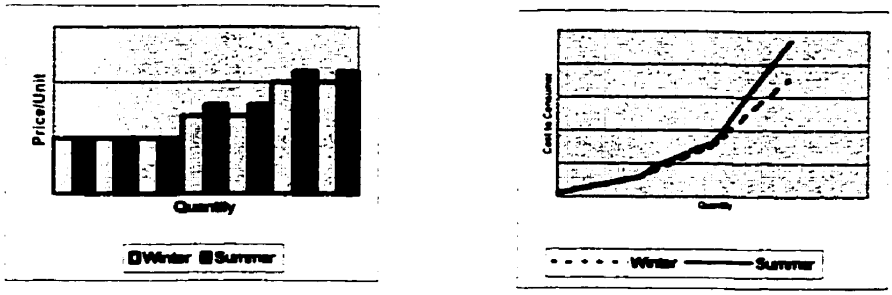
C. Constant Rate - Charge a constant rate for each unit of water consumed.



D. Increasing Block Rate - Charge one rate for a certain quantity of water and higher rates for units beyond this amount.



E. Peak Demand Rate - Charge a higher rate for water used in excess of a pre-established level during peak consumption periods (e.g. during the summer).



Appendix E - Discussion Group Guide

Date: _____ Time: _____
Location: _____
Number of males: _____ Number of females: _____

I. Purpose of the Discussion Groups

In the City of Lethbridge, excessive irrigation of residential lawns has contributed to several negative impacts including slope failures and basement flooding in some areas. Discussion groups will be conducted with residents to discover their preferences towards various water conservation techniques that could be used to reduce outdoor water consumption and to provide insights into workable conservation opportunities.

A. Introduction

1. Thank participants for attending
2. Provide the opportunity for individuals to introduce themselves and briefly state why they chose to attend the discussion group
3. Provide assurance of confidentiality
4. Answer any questions

B. General Introduction to the Water Management Techniques that will be Discussed

Many of the outdoor water management techniques used by municipalities to reduce outdoor water consumption are listed under on of the following categories: (1) education, (2) laws, (3) economic incentives, (4) infrastructure and (5) collaborations[10].

Are there any categories or specific techniques that you do not understand and would like me to go through?

Are there any additional categories or techniques that you would like to add to the ones listed?

[10] The techniques will be listed and dispiayed on flip chart paper in front of the participants

Appendix F - Participant Consent Form and Discussion Questions

University of Calgary
Faculty of Environmental Design
Consent Form

Educational and Policy Approaches to Water Conservation

This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please ask. Please take the time to read this form carefully and to understand any accompanying information.

Project Information

Exceptionally high water tables on the west side of the city of Lethbridge have caused many negative impacts including slope failures that have necessitated the removal of homes in some areas. These problems have been exacerbated by the application of excess water to lawns and gardens within the areas (Berg et al., 1996). The purpose of this research project is to design a water conservation strategy for the City of Lethbridge. As part of the research process, semi structured interviews will be conducted to help define the issues and to obtain feedback about various public educational programs, water conservation techniques and public policy options that may be included in the water conservation strategy.

I, _____(please print), agree to participate in a semi structured interview as part of a research project on the development of a water conservation strategy for the City of Lethbridge.

I understand that:

1. The time required for the interview is approximately two hours.

2. There are no foreseeable risks with this research.

3. The information given by myself will be audiotaped or written down. Following the interview, it will be kept in a confidential, secure place, where no one will gain access to it except the researcher.

4. My name will not be included in the project unless I provide authorization to do so.
5. Three years after completion of the project, the raw data will be disposed of permanently.

6. The information obtained from the interviews will be used to inform the development of the water conservation strategy.

On the basis of the above conditions I agree to participate.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive you legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw form the study at any time. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout you participation. If you have further questions concerning matters related to this research, please contact Jennifer Reid @ (403) 590-7207.

If you have any questions concerning your participation in this project you may also contact the Environmental Design Research Ethics Committee, Prof. Richard Revel @ (403) 220-3622

Participant	Date
Investigator/Witness (optional)	Date

I authorize the use of my name in the project

Participant	Date
Investigator/Witness (optional)	Date

A copy of this consent form has been given to you to keep for your records and reference.

Discussion Group Questions

I. Education Questions

1. One technique that is often considered important when promoting conservation is education. If you think that education is an important component of a water conservation program for the City of Lethbridge, please rank, from most preferred to least preferred, the three educational techniques that you prefer the most. Please provide explanations for your choices.
2. Of the three education techniques that you prefer, which ones (if any) would be the most effective at altering you behaviour? Please rank your choices from most effective to least effective and provide explanations for your choices.
3. State the three education techniques that you prefer the least. Please rank your choices from least preferred to most preferred and provide explanations for your choices.

II. General Questions

4. Aside from education, there are many other techniques that could be used to reduce outdoor water consumption. Please rank the three techniques that you prefer the most and state why you prefer each one.
5. Of the three techniques that you prefer, which ones (if any) would be the most effective at altering your behaviour? Please provide explanations for your choices.
6. List the three techniques that you find the least acceptable and provide explanations for your choices.
7. Would any of the techniques that you find least acceptable reduce your outdoor water consumption behaviour? Why or why not?

III. Consensus Building Questions

1. Water conservation programs often include a combination of techniques. What techniques would you include?
2. Suppose that only one of the aforementioned techniques could be implemented over the next few years. The other techniques would have to wait until more funds became available in the future. Which one of the techniques would you want to implement first? What would be your second and third choices?

Appendix G - Census and Participant Survey Information

Varsity Village Population Total 2n=8185

Lethbridge Population Total 2n=63055

A. Females

			Discussion Groups			
	Varsity Village (V.V.)	Lethbridge (G)	V.V (#3&#4)	G (#1&#2)	V.V (#3&#4)	G (#1&#2)
Total Population	n=4200	n=32630	n=5	n=6	%	
0 to 4 years	4%	3%			0%	0%
5 to 9 years	4%	3%			0%	0%
10 to 14 years	5%	3%			0%	0%
15 to 19 years	5%	4%			0%	0%
20 to 24 years	7%	4%			0%	0%
25 to 34 years	7%	7%			0%	0%
35 to 44 years	9%	8%	1	1	20%	17%
45 to 54 years	6%	6%	1	1	20%	17%
55 to 64 years	2%	4%	2	2	40%	33%
65 to 74 years	2%	4%	1	2	20%	33%
75 years and over	0%	4%			0%	0%

B. Males

			Discussion Groups			
Males	Varsity Village	Lethbridge	V.V (#3&#4)	G (#1&#2)	V.V (#3&#4)	G (#1&#2)
By age:	n=3990	n=30425	n=6	n=5	%	
0 to 4 years	3%	3%			0%	0
5 to 9 years	4%	3%			0%	0%
10 to 14 years	5%	3%			0%	0%
15 to 19 years	5%	4%			0%	0%
20 to 24 years	6%	4%			0%	0%
25 to 34 years	7%	7%		1	0%	20%
35 to 44 years	8%	8%	1	1	17%	20%
45 to 54 years	6%	6%	3	2	50%	40%
55 to 64 years	3%	4%	1		17%	0%
65 to 74 years	1%	3%	1	1	17%	20%
75 years and over	0%	3%			0%	0%

C. Owned Dwellings

	Varsity Village	Lethbridge	V.V (#3&#4)	G (#1&#2)
Owned Dwellings	64%	69%	100%	100%

D. Level of Schooling

Level of Schooling	Varsity Village	Lethbridge	V.V (#3&#4)	G (#1&#2)	V.V (%)	G (%)
Some high school or less	15%	25%	2		18%	0%
High school graduation	7%	9%	1		9%	0%
Some post secondary education	65%	56%		4	0%	36%
University graduation or higher	13%	10%	8	7	73%	64%

E. Labour Force Activities

By labour force activity	Varsity Village	Lethbridge	V.V (#3&#4)	G (#1&#2)	V.V (%)	G (%)
In the labour force	40%	25%			0%	0%
Employed (of th 40% in the labour force)	95%	93%	8	5	73%	45%
Unemployed (of th 40% in the labour force)	4%	7%			0%	0%
Not in the labour force	13%	16%	3	6	27%	55%

F. Number of Discussion Group Participants Aware of the Problem

Awareness of Problem	V.V (#3&#4)	G (#1&#2)	V.V (%)	G (%)
	8	10	73%	91%

G. Number of Discussion Group Participants Affected by the Problem

Affected by Problem	V.V (#3&#4)	G (#1&#2)	V.V (%)	G (%)
	8	7	73%	64%

H. Number of Discussion Group Participants that have Internet Access

Internet Access	V.V (#3&#4)	G (#1&#2)	V.V (%)	G (%)
	6	7	55%	64%

G. Discussion Group Participants Length of Residency at Current Address

Length of Residence	V.V (#3&#4)	G (#1&#2)	V.V (%)	G (%)
Less than 1 year				
1 to 5 years	1	1	9%	9%
6 to 10 years	3	2	27%	18%
More than 10 years	7	8	64%	73%

Appendix H - Discussion Group Evaluations of Water Conservation Techniques

Four water conservation discussion groups were held in Lethbridge in May 1999. The first two were held with residents from the community of Varsity Village and the last two were held with residents who live throughout the City with the exception of Varsity Village. The Varsity Village and city-wide discussion groups were attended by six, five, seven and four participants respectively.

The residents were asked to evaluate the effectiveness of water conservation techniques that had been utilized by selected municipalities throughout North America. The techniques evaluated by the residents were divided into two general categories: educational techniques and general techniques. This was done on the premise that techniques from both categories are necessary to develop an effective water conservation strategy. The residents were asked to evaluate them using two criteria: the techniques they preferred the most and the techniques that they felt would change their behaviour.

Every participant was asked to rank, from most preferred to least preferred, the three techniques that he or she felt were most effective with respect to the aforementioned criteria. The three choices were allocated points: first choice received fifteen points, second choice received ten points and third choice received five points. The points from all of the participants were subsequently tallied up and presented in the following Tables.

Table H1 General Techniques – Individual Preferences

General Techniques	Discussion Groups					
	City Wide			Varsity Village		
	Group 1	Group 2	Sum	Group 3	Group 4	Sum
	n=6	n=5	n=11	n=7	n=4	n=11
Regulations						
Guidelines			0	15		15
Landscape Ordinances	75	10	85	55	40	95
Mandatory Water			0	30		30
Voluntary Limits		15	15			0
Incentives and Disincentives						
Constant Rate			0	5		5
Decreasing Block Rate			0			0
Flat Rate			0			0
Increasing Block Rate		30	30	40		40
Peak Demand			0	10		10
Incentive Programs	30	25	55	10	25	35
Price of Water			0			0
Collaborations	15	60	75	10	45	55
Infrastructure						
Home Audits	60	10	70	35	10	45
Metering			0			0
Retrofit programs			0			0
Total	180	150	330	210	120	330

Table H2 General Techniques –Individual Responses with Respect to Behaviour Modification

General Techniques	Discussion Groups					
	City Wide			Varsity Village		
	#1	#2	Sum	#1	#2	Sum
Regulations						
Guidelines			0	15		15
Landscape Ordinances	75		75	45	40	85
Mandatory Water Restrictions			0	30		30
Voluntary Limits			0			0
Incentives and Disincentives						
Constant Rate			0	5		5
Decreasing Block Rate			0			0
Flat Rate			0			0
Increasing Block Rate		45	45	40		40
Peak Demand			0			0
Incentive Programs	30	75	105	10	25	35
Price			0			0
Collaborations	15	30	45	10	45	55
Infrastructure						
Home Audits	60		60	40	10	50
Metering			0			0
Retrofit Programs			0	15		15
Total	180	150	330	210	120	330

Table H3 Education Techniques - Individual Preferences

Education Techniques	Discussion Groups					
	City Wide			Varsity Village		
	#1	#2	Sum	#1	#2	Sum
Billboards			0		5	5
Conservation Brochures	15	30	45	25	10	35
Conservation Bill Inserts	15	15	30	20	25	45
Conservation Hotline	15	5	20	15		15
Contests and/or Awards	10	20	30	10		10
Evapotranspiration Program			0			0
Lectures		15	15			0
Municipal Xeriscaping Program			0	10		10
Newspapers	15	25	40	10	30	40
Radio	10		10			0
Refrigerator Magnets			0			0
School Programs	50		50	15		15
Self Awareness	15	5	20	5	5	10
Television Commercials and PSA's	5		5	10	10	20
Television Programs and Videos			0	15		15
Water Conservation Information Van			0			0
Web Site Information			0	10		10
Xeriscaping and Irrigation Workshops	15	10	25	15	15	30
Xeriscape Demonstration Gardens (public)		10	10	20		20
Xeriscape Demonstration Gardens	10	15	25	20	20	40
Additional Ideas						
Home Audits	5		5	10		10
Total	180	150	330	210	120	330

Table H4 Education Techniques– Individual Behaviour Modification Responses

Education Techniques	Discussion Groups					
	City Wide			Varsity Village		
	Group 1	Group 2	Sum	Group 3	Group 4	Sum
Billboards			0			0
Conservation Brochures and Booklets	10	20	30	40		40
Conservation Bill Inserts	10	5	15	25		25
Conservation Hotline	15		15	5	10	15
Contests and Awards			0			0
Evapotranspiration Program	10	10	20			0
Municipal Xeriscaping programs			0	5		5
Newspapers	10	40	50		25	25
Radio	5		5		35	35
Refrigerator Magnets			0			0
School Programs	5		5	25		25
Self Awareness	35		35	5		5
Television Commercials and PSA's			0	10	5	15
Television Programs and Videos			0	10		10
Water Conservation Information Van			0			0
Web site information	10		10	5		5
Xeriscaping and Irrigation Workshops	20	25	45	15		15
Xeriscape Demonstration Gardens	35	5	40	50	5	55
Xeriscape Demonstration Gardens (private)		35	35	5	40	45
Additional Ideas						
Home Audits	15		15	10		10
Landscaping Co-op		10	10			0
Total	180	150	330	210	120	330

In Tables H5 and H6, the ranking of the education and general techniques are provided. The techniques are ranked according to the number of points the combined Varsity Village discussion groups and the combined citywide discussion groups awarded them with respect to the aforementioned criteria. The discussion groups responses were combined because it has been found that findings from at least two discussion groups are required in order to obtain the majority of pertinent information (Krueger, 1994). The criteria used to evaluate the techniques are shown in the column headings, and the entries in the cell matrix indicate the perceived level of effectiveness of the techniques with respect to the criteria. A number 1 indicates that the technique is favored the most by the individuals who participated in the particular discussion group, a number two indicates that is the technique is second most popular and so forth. The right hand column of the table summarizes the overall effectiveness of the water conservation techniques. The overall effectiveness was determined by averaging ratings.

Table H5 Ranking of Education Techniques

Education Techniques	Criteria				Overall Evaluation
	Behaviour		Preference Level		
	City	Varsity	City	Varsity	
Billboards				9	
Conservation Brochures and	5	2	2	4	3
Conservation Bill Inserts	7	4	5	2	4
Conservation Hotline	7	5	7	8	7
Contests and/or Awards			5	7	
Evapotranspiration Program	6				
Lectures			8		
Municipal Xeriscaping Program		7		8	
Newspapers	2	4	3	3	2
Radio		3	9		
Refrigerator Magnets					
School Programs		4	1	7	
Self Awareness	4	7	7	7	6
Television Commercials and		5	10	6	
Television Programs and Videos		6			
Water Conservation Information					
Web Site Information	8	7		8	
Xeriscaping and Irrigation	3	5	6	5	5
Xeriscape Demonstration	1	1	4	1	1
Additional Ideas					
Landscaping Co-op	8				

Table H6 Ranking of General Techniques

	Criteria				Overall Evaluation
	Behaviour Modification		Preference Level		
	City Wide	Varsity Village	City Wide	Varsity Village	
Regulations					
Guidelines		7		6	
Landscape Ordinances	2	1	1	1	1
Mandatory Water Restrictions		6		5	
Voluntary Limits			5		
Incentives and Disincentives					
Constant Rate				8	
Decreasing Block Rate					
Flat Rate					
Increasing Block Rate	4	4	4	4	4
Peak Demand				7	
Incentive Programs	1	5	4		
Price					
Collaborations	4	2	2	2	2
Infrastructure					
Home Audits	3	3	3	3	3
Retrofit Programs		7			

Table H7 illustrates the eleven water conservation techniques that both the Varsity Village and city-wide discussion groups evaluated as being potentially effective with respect to the aforementioned criteria. The techniques that the residents evaluated as having the potential to be effective are listed on the left-hand column of Table H5. The criteria used to evaluate the techniques are shown in the column headings, and the entries in the cell matrix indicate the perceived level of effectiveness of the techniques with respect to the criteria. A number 1 indicates that the technique is favored the most by the individuals who participated in the particular discussion group, a number two indicates that is the technique is second most popular and so forth. The right hand column of the table summarizes the overall effectiveness of he water conservation techniques. The overall effectiveness was determined by averaging ratings.

Table H7 Lethbridge Residents' Evaluation of Selected Water Conservation Techniques

Water Conservation Techniques	Evaluation Criteria				Overall Evaluation
	Behaviour Modification		Preference Level		
	City Wide	Varsity Village	City Wide	Varsity Village	
A. Education Techniques					
Conservation Bill Inserts	7	4	5	2	4
Conservation Brochures and Booklets	5	2	2	4	3
Conservation Hotline	7	5	7	8	7
Newspapers	2	4	3	3	2
Self Awareness	4	7	7	7	6
Xeriscaping and Irrigation Workshops	3	5	6	5	5
Xeriscape Demonstration Gardens	1	1	4	1	1
B. General Techniques					
Collaborations	4	2	2	2	2
Home Audits	3	3	3	3	3
Increasing Block Rate	4	4	4	4	4
Landscape Ordinances	2	1	1	1	1