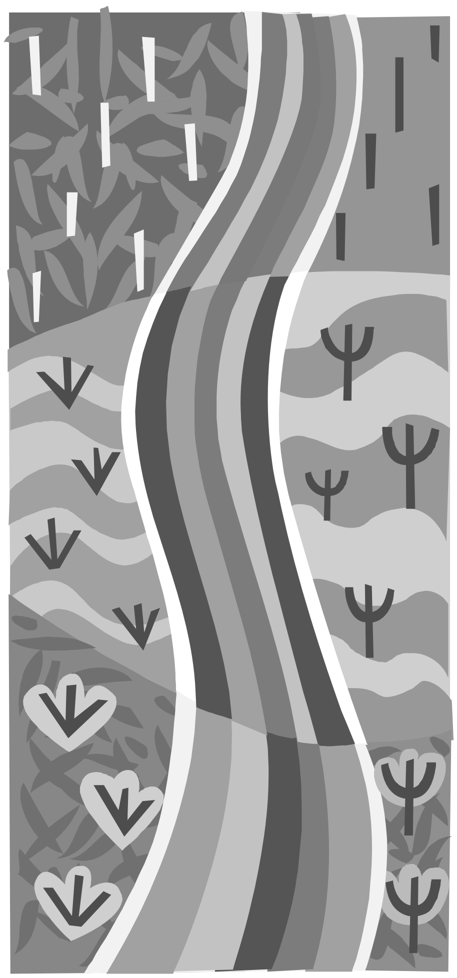
# Water:
# There is No Substitute



A Helen Schuler Nature Centre Research Package

*Prepared by Laura Piersol*

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# I. Introduction

Water flows into all facets (and faucets) of our lives. All living things need it to survive; where there is water there is life. Yet we often take it for granted, forgetting that we use it to put food on our tables, create our clothes and electronics and even build our houses. It also nourishes and shapes the habitats we live in: it is trickling under our feet right now as groundwater, it is being cycled through plants and animals including our own bodies, it is slowly carving out river valleys and seeping into swamps. We are quite literally a blue planet.

## *Importance of Water Conservation*

The need for water conservation stems out of water scarcity. Approximately, 70% of the earth is covered in water, most of which is found in the oceans with the remaining 2.5% being freshwater (Shiklomanov, 1993). Part of this is within permanent snow cover, glaciers or deep groundwater which is too remote for human access which leaves 0.008% of the total water on the planet (Shiklomanov, 1993). If all the earth's water was stored in a 5 litre container, the available fresh water accessible to humans would not quite fill a teaspoon (De Villiers, 1999)! The earth will never "run out" of this freshwater supply (a renewable resource); the amount of water on this planet has been the same for billions of years. However, some uses of water may degrade the quality to the extent that it lowers the amount of water that is actually "available" for consumption or for proper functioning of aquatic ecosystems. As well, on a global scale large human populations are distributed far from accessible freshwater supplies and there is growing concern that global warming will greatly contribute to this uneven distribution/accessibility of water for humans and the rest of the natural world. This lowers this actual percentage of available freshwater even more. So in actuality it is useful to look at water as a finite resource. When we say that the need for water conservation flows out of concerns regarding **water scarcity** we are really talking about issues regarding mismanagement of **water quality** as well as **water consumption/distribution.** Particularly worrying are high rates of degradation and consumption in areas of low supply.

This research package will begin with an overview of scarcity concerns globally, nationally and finally provincially in order to provide a background on the current state of our freshwater resources. Although, the information provided is sobering it is included to emphasize the urgency and necessity for water conservation practices.

“Although two thirds of our planet is water, we face an acute water shortage. The water crisis is the most pervasive, most severe, and most invisible dimension of the ecological devastation of the earth.” ~Vandana Shiva, 2002.

# II. Global Overview of Water Issues

## *A. Water Distribution& Consumption Concerns*

**Water scarcity** is defined by the UN as the point at which the combined impact (by all users) on the supply or quality of water is such that the demand from all sectors (including the environment) cannot be met (UN, 2006). See Figure 1 for areas of water scarcity from a global perspective.

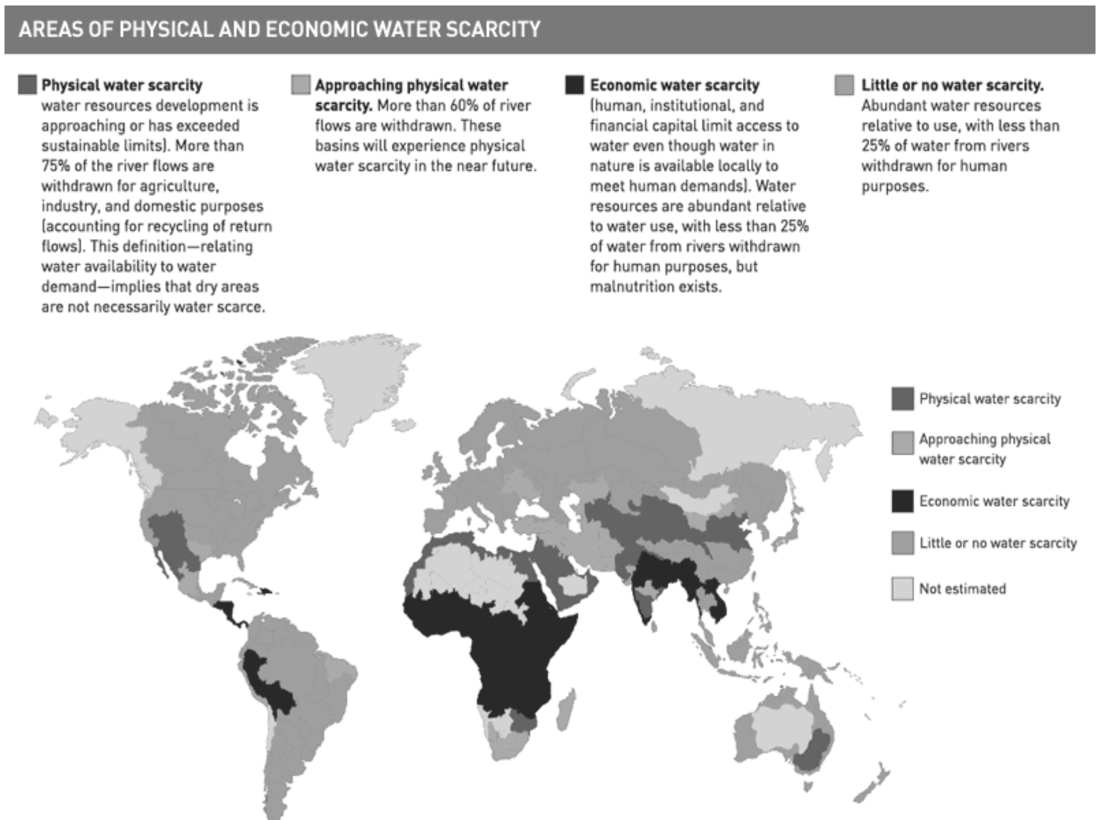



**Figure 1: Global Water Scarcity (Molden, 2007)**

Highly populated regions around the world are often distributed far from freshwater sources. In these areas of **physical water scarcity**, the demand often outstrips the supply, with more than 75 % of the water flow consumed and not replaced (UN, 2006). Currently, approximately 1.2 billion people live in areas of such physical scarcity and 500 million more people are approaching this situation (UN, 2006). Another 1.6 billion people, or almost one quarter of the world’s population, face another type of water scarcity deemed an **economic water shortage**, where countries lack the necessary infrastructure to take clean water from rivers and aquifers (Molden, 2007). In practical

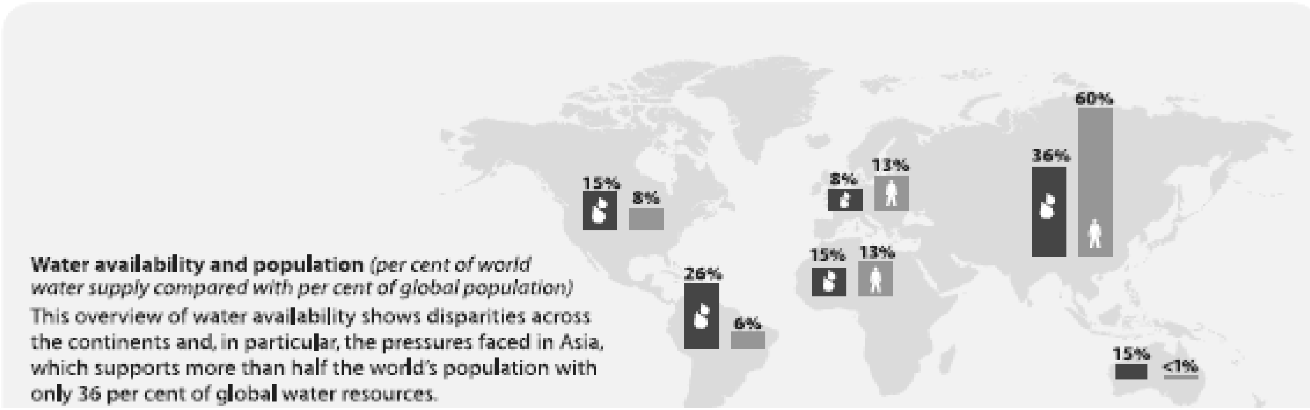



**Figure 2: Global Water Supply compared to Human Population Distribution (UN, Water for Life Booklet, 2005)**

terms this means that one in six people on earth have no regular access to safe drinking water and more than twice that (2.4 billion people) lack access to adequate sanitation facilities (UNEP, 2003). The situation is most dire in Asia which supports 60% of the world's population but only 36% of the global freshwater supply (See Figure 2) (UN, 2005). Depending on future rates of population growth, by 2025, 1.8 billion people will be living in countries or regions with physical water scarcity and two-thirds of the world population could face water stress (water consumption that exceeds 10 percent of available freshwater resources) (UN, 2006). Following current trends over the next 20 years humans will use 40% more water than they do now (UNEP, 2003). This will have dramatic impacts on the earth's finite freshwater sources.

## *B. Water Quality Issues*

Cities in developing countries are growing fast and without adequate infrastructure. As a result of this increased urbanization, there is great strain on existing water and sanitation systems and often large populations who have little access to adequate clean water. In developing countries, roughly 80% of diseases are water-related and more than 2 million people (mostly children) die each year from them (UN, 2006). Unsafe drinking water and inadequate sanitation of human waste can spread disease such as cholera, typhoid, hepatitis and tapeworms. Other water-borne diseases such as malaria affect vast populations globally. This poor water quality on a global level is one of the humanity's most serious concerns.

### *C. Water Scarcity Impacts on Ecosystems*

Within watersheds, a main concern is that high rates of degradation and consumption in areas of low supply will cause serious and irreversible ecological damage. By some estimates, humans already utilize more than half of all renewable and accessible freshwater flows on earth leading to significant ecological disruptions (Postel, Daily, & Ehrlich, 1996). Signs of unsustainable water use are widespread globally: falling water tables, destruction of wetlands, salination of land, shrinking lakes and drying up of rivers and streams. Freshwater ecosystems are in a crisis around the world (De Villiers, 1999). High levels of discharge from heavy metals and hazardous wastes from industry and agriculture also result in groundwater contamination. The permanent removal of water from ecosystems as well as the decline in water quality, both due to human consumption, is leading to extinction of freshwater species and a severe loss of biodiversity (see Figure 3 for one example of this).

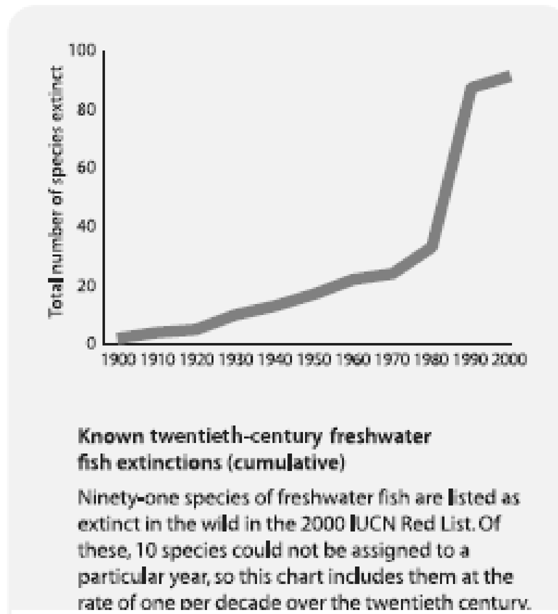



**Figure 3: Global Decline of Freshwater Fish Species (UN, Water for Life Booklet, 2005)**

Given the severity of the situation briefly outlined here, 200 scientists in 50 countries have identified water shortage as one of the two most important crises for the new millennium (the other being climate change) (UNEP, 2003).

# III. National Overview of Water Issues

## *A. Canadian Water Distribution and Consumption Concerns*

While Canada appears to have lots of fresh water (6.5% of the world's renewable freshwater, 25% of its global wetlands), this water is not always available where needed (Sprague, 2007). There is a “myth of water abundance” within the country (Bakker, 2007).  Canada actually ranks third in the world for renewable freshwater supply despite recent quotes from the media, such as: “Canada is blessed with the world’s largest freshwater supply” (Globe and Mail, 2001) or within public policy debates including: “Canada has the world’s largest supply of fresh water…”(David Anderson, 1999, then Minister of the Environment) (Sprague, 2007).

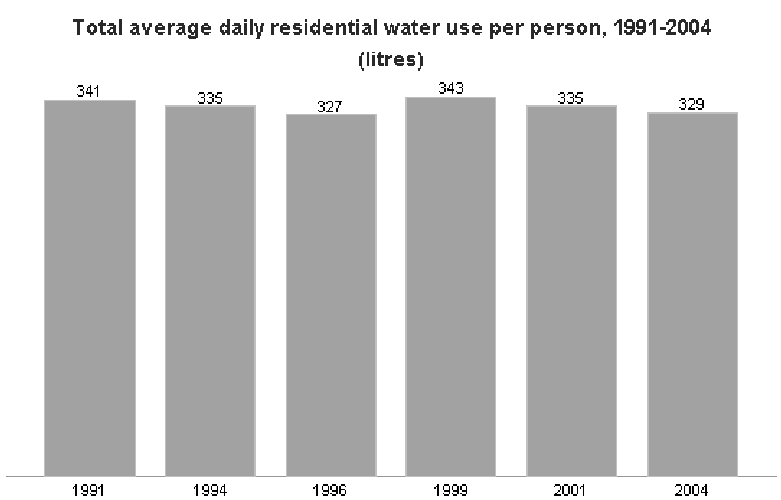


**Figure 4: Residential Water Use in Canada (Environment Canada, 2007)**

In reality, 60% of Canada’s freshwater supply drains to the north while 85% of the population lives in the south, so it is not surprising that those drainage basins with higher freshwater consumption to available supply ratios are also located in southern Canada (Environment Canada, 2008d). As Sprague suggests, this means the supply in southern Canada is only about 2.6% of the world supply and this is the number that should spring into the mind of Canadians when they contemplate the country's water resources (Sprague, 2007).

Despite this, Canadian water use per capita remains the second highest in the developed world (Statistics Canada, 2003). Countries such as Australia and Denmark which have implemented strong water conservation strategies have Each Canadian uses 329 litres per capita per day compared to 250 litres in Italy, 150 litres in France and an average of 10 litres in developing countries (Bakker, p.39, 2007; UNEP, 2003). Even though the number is very high it has dropped: in 1999, Canadians were consuming 343 litres per day. Some of the main things we use it for include: power generation, transportation, recreation, irrigation, manufacturing, agriculture and drinking water. We have only been systematically recording water use since 1975 (Shrubsole & Draper, 2007).

Thermal power production is largest withdrawal use in Canada then manufacturing,

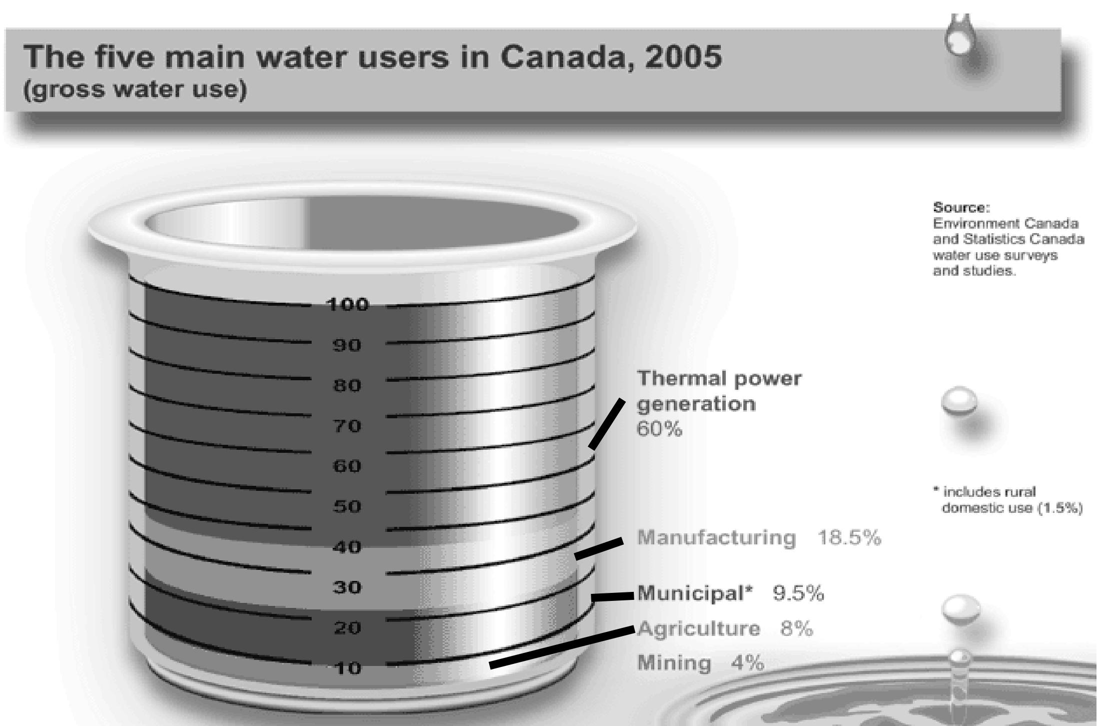



**Figure 5: Gross Water Use by Sector in Canada (Environment Canada, 2008b)**

municipal, agricultural and mining, see Figure 5. However, most of the water withdrawn for thermal power and manufacturing use is returned to the source, unlike within agriculture which is the highest **consumer** of water with only 25-40% returning to the source, see Figure 6 (Shrubsole & Draper, 2007).

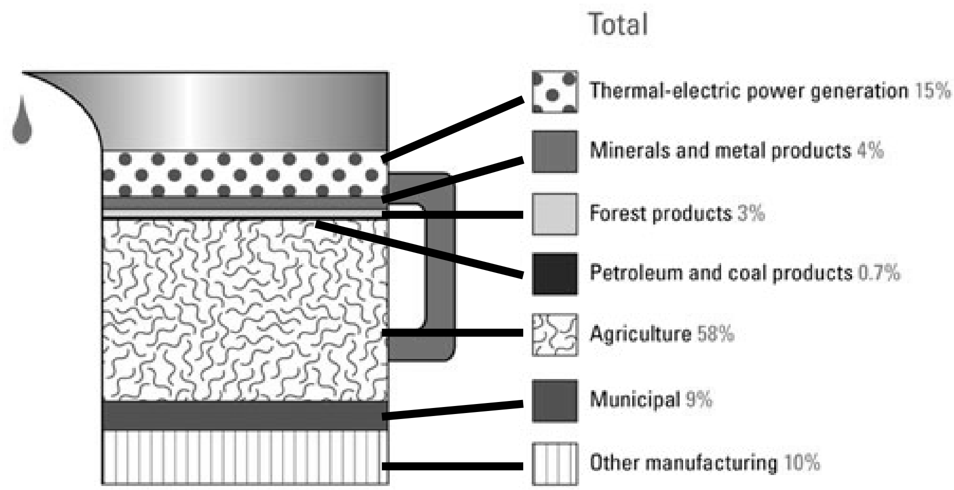



**Figure 6: Water Consumption by Water Use Sectors in Canada (Natural Resources Canada, 2009b)**

As a result of these high consumption levels relative to water distribution, many water bodies within the country have reached levels of serious concern. Total annual stream flows have experienced moderate declines over the last century (Schindler & Donahue, 2006). The World Wildlife Fund has identified 10 major rivers across Canada that are at risk and has identified flow regulation/fragmentation, water withdrawals and climate change as the major threats (World Wildlife Fund, 2008). Approximately 21% of municipalities have experienced water shortages due to increased consumption, drought or infrastructure constraints between 1994 and 1999 (Bakker, 2007, pg.5). These declines in stream flow affect not only us as humans but the entire ecosystems upon which we depend. As a nation we must work to lower our rate of water consumption.

### *B. Water Quality Issues on National Level*

In Canada we are lucky to have infrastructure which enables the treatment of water for drinking. There are national, scientifically based guidelines for water quality. Provinces and territories then use guidelines to create own objectives/guidelines. The Committee on Environmental & Occupational Health and the Canadian Council of Ministers of the Environment have the final say on guidelines (Environment Canada, 2004). Within Canada, the government relies on guidelines and objectives to measure water quality. Guidelines include everything from drinking water quality (standards set for more than 85 physical, chemical and biological attributes) to recreational water quality (standards for swimming, boating) to protection of aquatic life (chemicals, temperature, acidity) (Environment Canada, 2004). Water quality **guidelines** indicate the maximum allowable concentration of various substances for a particular water use such as livestock watering or swimming. Water quality **objectives** specify the maximum allowable concentration of substances for all intended water use at a specific location (lake, estuary, river etc.)  (Environment Canada, 2008a). The objectives are based on water quality guidelines for uses as well as public input and socio-economic considerations. These guidelines and objectives are targets for environmental protection.

Despite this, water experts agree that compared to other developed countries water in Canada is not as systematically monitored nor is water quality data as easily accessible (Bakker, 2007, pgs.6, 108) Compared to the U.S. or U.K. which both have separate well funded environmental protection agencies which enforce and monitor water quality, these key tasks often fall to independent, under-resourced non-governmental organizations within Canada. Drinking water quality is not nationally enforced or monitored in Canada; the federal government merely sets *voluntary* guidelines which only a few provinces follow in their entirety (Bakker, 2007, pg.6)

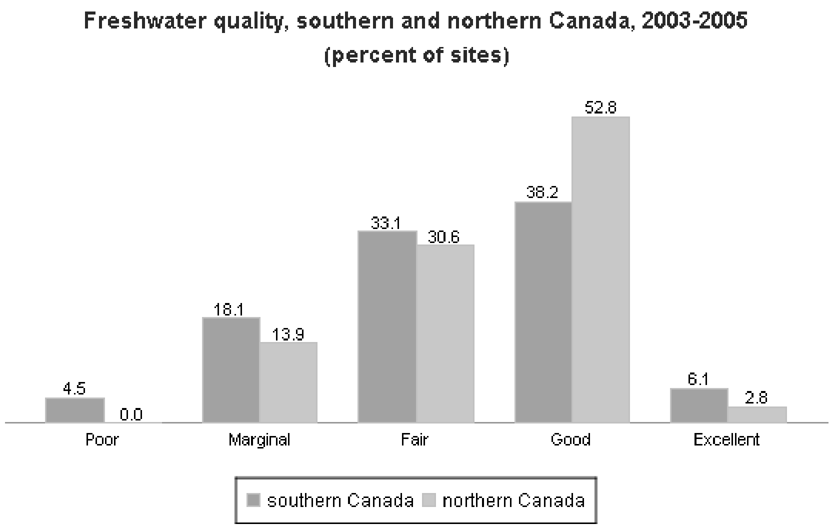



**Figure 7: Freshwater Quality within Canada (Environment Canada, Health Canada and Statistics Canada, 2007)**
Note: 1) Percentages based on data from water quality monitoring stations: 359 in the south and 36 locations in the north. 2) Northern Canada refers to the area above the 'North Line' which runs through the centre of most provinces As more extensive water monitoring has been done for southern Canada, information should be interpreted with caution for the relatively few northern stations.

Health problems related to water pollution in general are estimated to cost Canadians $300 million per year (Environment Canada, 2001). There are still often beach closures and local epidemics regarding bacterial or protozoan (such as Giardia and Cryptosporidium) contamination of water supply within local communities. In 2000, thousands of people became ill and seven people died after a deadly strain of E.Coli bacteria contaminated the water supply in Walkerton ON. In another case, in 2005, residents from the Kashechewan reserve in Northern Ontario were evacuated due to health concerns over water quality. Across the country, water quality concerns continue today for citizens within Fort Chipewyan as recent studies have shown that levels of contaminants such as arsenic, mercury, and polycyclic aromatic hydrocarbons (PAHs) are higher than they should be for safe consumption, particularly in the fish eaten by local residents  (CBC, 2009a). Many more examples exist, in fact over half of the water sampled from municipalities across Canada from 2003-2005 was listed as either “fair”, “marginal” or “poor”, demonstrating that water quality can be greatly improved within Canada (See Figure 7) (Environment Canada, Health Canada and Statistics Canada, 2007). We must continue to be proactive and push for the development and enforcement of federal guidelines.

Some specific sources of pollution entering our waterways and affecting quality of water include surface runoff containing residues of fertilizers, pesticides and other chemicals, industrial pollution or pollution from average households in the form of improperly treated municipal sewage. Canada produces three trillion litres of sewage annually (Environment Canada, 2006). There are three levels of sewage treatment: primary, which reduces some solids through a settling process; secondary, which further reduces solids and other pollutants; and tertiary, the most stringent. Only 40% of Canadians receive tertiary treatment (Cote, 2004). Five major cities within Canada (Victoria, Saint John (NB), Halifax, St. John's (NFLD) and Dawson City) still dump some or all of their raw untreated sewage directly into Canada's rivers, lakes and oceans, a total of 140 billion litres per year (Infrastructure Canada, 2009). Three other major cities (Vancouver, Montreal, and Charlottetown) discharge some or all of their sewage with only primary treatment (e.g. settling and skimming off of large debris). (Ecojustice, 2004) This means 6% of the sewage produced in Canada, 200 billion liters (enough to fill 40 000 Olympic-sized swimming pools, is dumped as raw sewage are dumped into major waterways such as the St. Lawrence River and the Pacific Ocean (Ecojustice, 2004).

This municipal wastewater effluent consists of sanitary waste from households, industry and commercial establishments. It usually includes human waste, pathogens, nutrients (such as phosphorus and nitrogen), microorganisms, chemicals and grit or debris (Environment Canada, 2001). Some impacts on the water bodies into which this wastewater is discharged include: increases in nutrient levels can lead to algal blooms and increased biochemical oxygen demand resulting in fish kills; a destruction of habitat from sedimentation and debris; acute and chronic toxicity from chemical contaminants can result in bioaccumulation and biomagnification along food webs; chemicals can also affect human health through drinking water (Environment Canada, 2001). Also emerging are new contaminants such as pharmaceuticals, endocrine disrupting compounds and brominated flame retardants, little is known about these new toxicants and therefore our current wastewater treatment facilities do not have infrastructure or guidelines to deal with them (Environment Canada, 2001). Many communities across Canada also have storm sewers which allow water runoff from the land to bypass water treatment (Bakker, 2007). Such sewage pollution is of paramount concern for its possible impacts on both human health and the larger environment.

Despite this concern, Canada lacks national sewage standards, though the provincial environment ministers have developed a strategy for " the management of municipal waste water effluent" including a standardized framework pushing for national standards and objectives for protecting human health and the environment (Canadian Council of Ministers of the Environment, 2009). This strategy has not yet been approved as policy. Environment Minister Jim Prentice has stressed the need for change:

> "This is a question of prioritization and this is the first time that we as a country are saying that . . . in the world of 2009, an industrial democracy like Canada can no longer be discharging its untreated sewage into our natural environment. It's not acceptable." (National Post, 2009)

In short, “water governance in Canada is in a state of crisis” (Bakker, 2007, preface). We need to adopt new water management guidelines and water conservation approaches within the near future if we are to meet the needs of 9 billion people while protecting the ecosystems upon which we depend. There is no question that our demands will only increase with time as population grows, in order for aquatic ecosystems to flourish we must attempt to slow and lower our rates of consumption.  In Canada we are lucky for the most part to have clean drinking water and easy access to it. Still we have our share of problems regarding water quality and distribution which must be tackled in order to create a sustainable future for our national watersheds and that all that lives within them. This research package will present the current and future forecasts regarding water issues particular to southern Alberta and then offer an overview of examples as to how we can manage and properly conserve this vital resource.

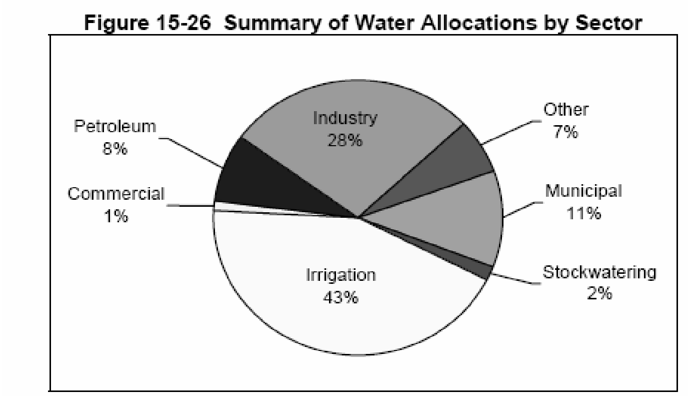


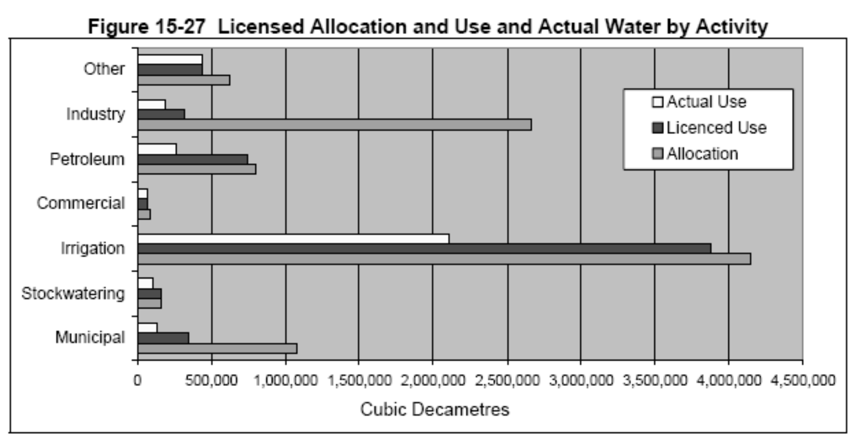

**Figure 8: Water Allocations by Sector within Alberta (Alberta Environment, 2007)**

## IV. Provincial Overview of Water Issues

"While the Alberta economy is fuelled by petroleum, it runs on water." (Water Research Institute, 2009)

### *A. Water Distribution and Consumption Concerns in Alberta*

As of 2006, Alberta has 10% of Canada's population, 7 % of the land area but only 2 % of Canada's water supply (Christensen, & Droitsch**,** 2008). The Western Prairie Provinces lie in the rain shadow of the Rocky Mountains making them one of the driest areas in Canada (Schindler & Donahue, 2006). In addition to low water supply, as a result of increased industrial development, Alberta has experienced a rapid population increase. Calgary and Edmonton with their surrounding suburbs now have populations larger than 1 million people each. This rapid growth is expected to continue making Alberta particularly vulnerable to water shortages with increasing demand (Schindler & Donahue, 2006). Agriculture has also been expanding. In addition to irrigated agriculture, intensive livestock operations have been established: 6.4 million cattle and 1.8 million hogs are stocked in the province further increasing the demand for freshwater (Schindler & Donahue, 2006). Much of their feed




**Figures 9: Allocated Use, Licenced Use and Actual Use of Water within Alberta, (Alberta Environment, 2007)**

is grown on land irrigated from the already over allocated Oldman and Bow Rivers and studies estimate that the number of livestock present in the province could double within the next decade (Schindler & Donahue, 2006).

As a result of the semi-arid climate, heavy agricultural reliance on water and high population growth Alberta shows higher water use rates than the rest of Canada (Schindler & Donahue, 2006). Like the rest of the country, the water within the province is mainly found north-flowing river basins yet the majority of the population lives in the south (Wood, 2008, pg. 166; Schindler & Donahue, 2006). This disparity means high demand in areas of low supply.

Within Alberta, all interested groups or individuals (including municipalities and industries) must purchase a licensed allocation to use water from the river. The **allocation** is the maximum amount of water that the applicant expects will be required over the licencing period. The amount allocated therefore may be higher than the amount actually consumed by the user. For example, in years of high rainfall, there is more water available for agriculture so the demand for irrigation water will be lower and farmers will withdraw less than the total amount they have allocated for use. At the opposite extreme, the Bow, Oldman and South Saskatchewan Rivers have a moratorium on licenced allocations because if consumption levels match the amount of water allocated, these ecosystems will be in grave danger as there would not be enough water to sustain life in the rivers (see page 33 for more information).

The major **consumptive uses** (water diverted by a user that does not return to aquatic system) of water in Alberta are agriculture (irrigation accounted for over 43% of allocated surface water in 2005 consuming 65% of total licenced) (See Figures 8 & 9) (Alberta Environment, 2009d; Christensen & Droitsch, 2008). Industrial use is the second highest for allocations (28%) but returns most of the flow resulting in a 5% consumption rate.

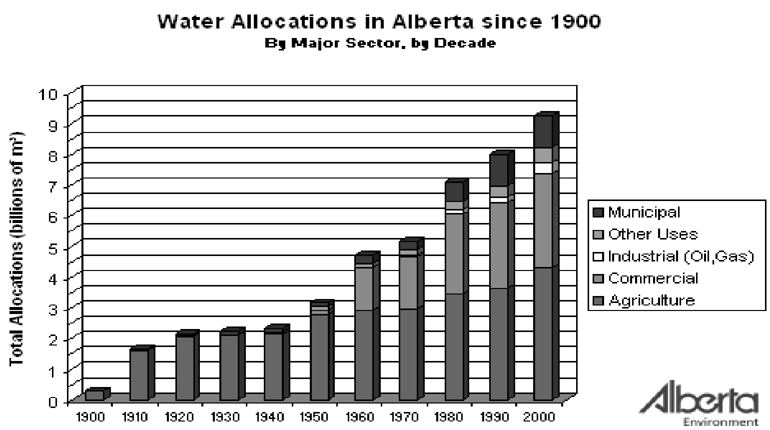



**Figure 10: Water Allocation in Alberta over the Last Century (Alberta Environment, 2007)**

As irrigation districts were implemented at the turn of the century, the amount of water allocated remained pretty stable. However after the '50's and '60's, industrial development and urbanization began and demand in the southern part of the province has continued to increase ever since (see Figure 10). Most of the water licences allocated within the province pertain to the Bow, Oldman, and North Saskatchewan Rivers. Irrigation Districts on the Bow and Oldman basins represent the majority of the water allocated in these areas, while thermal power plants are allocated the majority of the water in the North Saskatchewan basin (Christensen & Droitsch, 2008).

In Alberta, the peak for water consumption occurs during the summer months (May- August); as the hot weather increases so does water demand for irrigation and municipal purposes. Due to the high population demand in areas of low supply summertime flows in some southern rivers has dropped by more than 80 percent (Schindler & Donahue, 2006). Unfortunately, this high summer demand also coincides with in-stream flow needs (water levels required to sustain aquatic communities) (Schindler & Donahue, 2006). During the summer water levels are usually at their lowest and warmer waters mean reduced oxygen levels so the organisms present are already under stress. Human induced low flows at this time add further stress to aquatic communities with impacts such as: reductions in habitat availability, food production, and water quality (Bradford & Heinonen, 2008). These reduced flows due to high consumption along with long-term shift toward drier hotter weather have set Alberta on course for what aquatic scientists Schindler and Donahue (2006) call an “unprecedented crisis in water quality and quantity with far reaching implications”.

Due to these concerns, the Millenium Ecosystem Assessment (a UN research program that focuses on ecosystem changes over the course of decades, and projects those changes into the future) has identified the western prairie provinces of Canada as a “hotspot” for future environmental degradation (Schindler & Donahue, 2006). The Alberta Institute for Agrologists (specialists in agricultural science) agree stating that “Alberta is at a major crossroads…The limit of available water has been reached in a number of watersheds, is being approached in others and as growth continues, will be reached in Alberta’s remaining watersheds.” They continued on to say that these shortages were “inevitable and imminent.” (Wood, 2008, pg. 168). Overall provincial water use is expected to increase by 21% by 2025 for the most part due to increases in tar sands production and irrigation (Alberta Environment, 2007). Danielle Droitsch of the Alberta advocacy group Bow Riverkeepers reiterates that “we are looking at significant reduction of flows in provincial rivers and they’re going to get worse” (Wood, 2008, pg. 182).

In 1969, Alberta formed an inter-provincial agreement with Saskatchewan that prohibits Alberta from taking more than half the water that flows down major rivers crossing into Saskatchewan. As Alberta currently only extracts about half its entitlement under the agreement some Albertans are moving to install additional storage reservoirs to take up the remaining water the agreement says is “theirs” as a way to deal with the water shortage  (Wood, 2008, pg. 179). This will only lead to further decline in water levels. Currently licensed users are able to withdrawal large amounts of water during the summer to meet demand as long as the water flow later in the year meets the required levels under the inter-provincial agreement (Wood, 2008, pg. 180). Such an agreement creates devastating environmental impacts as the summer as already noted is a crucial time for aquatic life. Even as things currently stand, by the time the South Saskatchewan River reaches Saskatoon barely 15% of water that filled its banks a hundred years ago flows there today and flows into Lake Winnipeg (the final drainage spot for the basin before the Atlantic) are way down (Wood, 2008, p.180).

Alberta Environment has reacted to this high level of concern but by the time they decided to prohibit new licences in certain regions in 2006, three main river basins (Oldman, Bow and South Saskatchewan) were already severely degraded by low and altered flows  (Christensen & Droitsch, 2008). The Alberta government has reviewed and revised water legislation as it implemented a new Water Act in 1999 and the new Water for Life Strategy in 2004. Together these initiatives propose tools to address the current water crisis including: data gathering and synthesis, environmental objectives, regulatory oversight etc. While the aims of Water for Life are commendable, local advocacy groups such as Riverkeepers have pointed out that due to insufficient funding and lack of political commitment, few goals from the policy have actually been successfully implemented  (Christensen & Droitsch, 2008).

### *B. Water Quality Issues in Alberta*

In general, water quality ratings for major rivers in Alberta in 2005-2006 ranged from fair to excellent (Alberta Environment, 2009b). Water in the south of the province is not as clean as that in the north which is expected due to the disparity in population distribution (Alberta Environment, 2009b). A continual challenge is non-point source pollution as no single level of government has sole responsibility of integrating land use activities into water quality protection strategies (Alberta Environment, 2009c). Under the Water Act, Water Management Plans are being developed for Alberta's major watersheds. Noted within water sampling of wastewater treatment plant effluents and receiving rivers of Alberta has been the presence of human pharmaceuticals, endocrine disruptors, flame retardants and new agricultural chemicals (Sosiak & Hebben, 2005). These are of particular concern because at present, surface water guidelines have not yet been established for the vast majority of these compounds.

Alberta Environment does conduct inspections of municipal and industrial facilities to ensure that they are meeting provincial legislations designed to protect the environment from adverse effects (Alberta Environment, 2009c). Contaminants such as pesticides, metals and PCBs can accumulate in fish and wildlife to pose a risk to environmental health. Non-compliance can result in enforcement of action.

The province also has indicated that it is attempting to determine in-stream flow requirements as well as develop ecological indicators and guidelines to evaluate the health of aquatic ecosystems (Alberta Environment, 2009c). This is essential to sustain the myriad and biodiverse species of plants and wildlife that depend on water for part of their life cycle.

Overall, Alberta has not equipped itself for the certain and imminent water shortage. Dr. David Schindler, an aquatic expert, has likened the assessment of Alberta's current situation to "the view from the locomotive, 10 seconds before the train crash." (Christensen & Droitsch, 2008). The future of water in this province depends on our actions today; we need new and immediate plans for water governance, management and conservation that address the issues outlined above.

# V. Watersheds

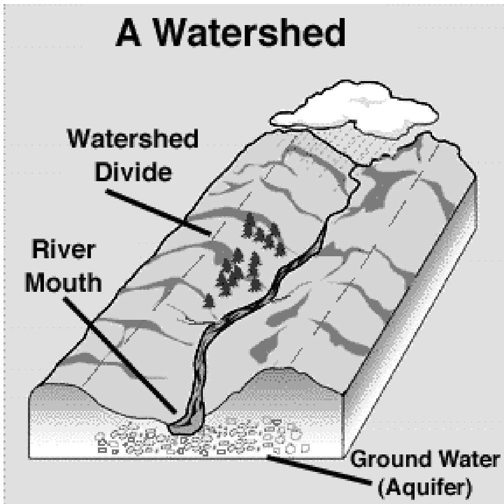



**Figure 11: Example of Aerial View of Watershed (Western Carolina University, 2009)**

We are linked across the country from coast to coast by networks of lakes and rivers, important channels carrying life giving water and nutrients. Canada is divided into 5 main watersheds. A **watershed** is the drainage basin where all the water for a region collects and flows into a common waterway. The boundary of the basin is the height of land from which water is shed in two directions. See Figure 11, the dashed line represents the divide of the basin from other surrounding watersheds. Surrounding rivers and tributaries drain into one common waterbody. The land area of a watershed acts as a catchment area for precipitation. As a result whatever occurs on the land ultimately affects the quantity and quality of surface water running off the land

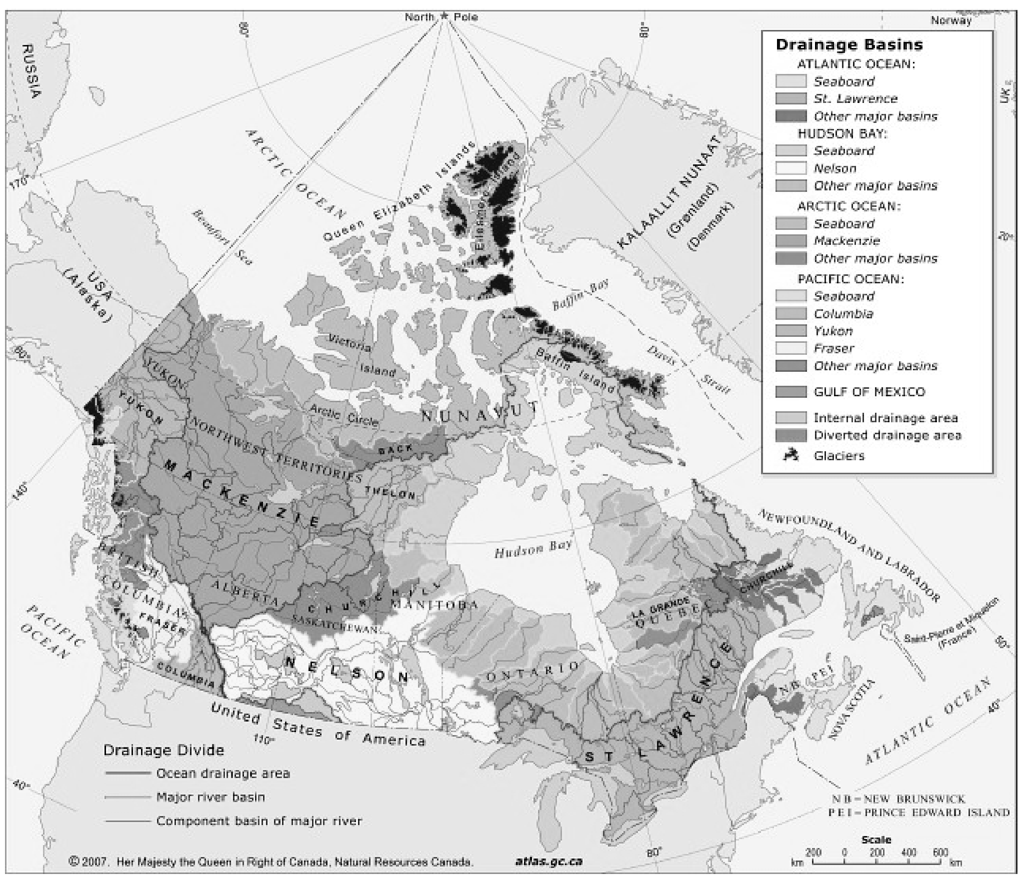



**Figure 12: Watersheds of Canada, (Natural Resources Canada, 2009a).**

and into streams, groundwater, river and lakes. The terms ‘watershed’ and ‘basin’ are used interchangeably.  A **sub-basin** is a drainage area within a larger watershed. The main watersheds in Canada are: the Arctic, the Atlantic, Hudson Bay, the Pacific and the Gulf of Mexico. Using Figure 12 can you find which watershed Lethbridge is found in? Where does it drain to?

## *A. Watersheds in Southern Alberta*

During the last ice age 10 000 years ago, the meltwater and runoff of retreating glaciers changed the course of some rivers and carved deep valleys within the landscape of Southern Alberta. This process shaped the watersheds of this region as we know them today. Lethbridge Alberta where the Helen Schuler Nature Centre is located is found within the Oldman River Watershed (a sub-basin of the South Saskatchewan Basin which is a sub-basin of the Saskatchewan River Basin which is a sub-basin of the Hudson Bay Watershed-whew!). Keep in mind that human made boundaries are of no consequence to rivers as the water from the Oldman eventually flows through three provinces so even though the focus of this research package is on the Oldman Watershed, the issues regarding water quantity and quality discussed here will end up affecting many other places.

Did you know that even if you live in the prairies in the middle of Canada, your daily actions can end up affecting fresh water habitats all the way to the Atlantic Ocean?! Our own backyards are connected to the nearby lakes and rivers. If you were to trace the water going down your drain or the runoff from your backyard into the nearby storm drain you would discover that this water all ends up in the Oldman River, which then meets up with the North Saskatchewan and finally in Hudson’s Bay, empties into the

Atlantic Ocean. How we treat our water in southern Alberta has far reaching effects! In fact, as the Oldman River is one of the headwaters of the Saskatchewan River Basin, anything that happens to the quantity and quality of the water in this local river will affect the 3 million people as well as the numerous plants and animals that live in this larger watershed.


Figure 13: The Saskatchewan River Basin, star denotes Lethbridge (Partners for the Saskatchewan River Basin, 2009b)

## *B. Saskatchewan River Basin*

The Saskatchewan River is the 4th longest in North America, it travels 1940 km through three provinces from the Rocky Mountains in Alberta to Saskatchewan and finally on to Lake Winnipeg in Manitoba (Partners for the Saskatchewan River Basin (PSRB), 2009a, pg.9). Lethbridge is found in the southern part of this basin, see red star in Figure 13. The Saskatchewan River Basin drains an area that is 405 864 km$^2$ (almost the size of France!) and half of this area is actually found in Alberta (209 560 km$^2$) (PSRB, 2009a, pg.9). People have lived in basin for 11 000 years and as of today, three million people live in basin, 95% of this population is found in urban centres (PSRB, 2009a, pg.3). Currently, there are 2.5 million people living in Edmonton to Calgary corridor alone with these populations steadily increasing (PSRB, 2009a, pg. 16). Even though the Saskatchewan River basin has 88% of Alberta’s population living within it, the watershed only contains 13% of Alberta's water. As a result, the management of water supply can be challenging. For the purposes of this research package we will focus in on a sub-basin of this mighty watershed: the South Saskatchewan River Basin.

## i) South Saskatchewan River Basin

This watershed is comprised of four major sub-basins: Red Deer River, Bow River, Oldman River and South Saskatchewan River (see Figure 14). The habitats within the basin are diverse: mountains and foothills in the west, aspen parkland in north and grassland in the south.

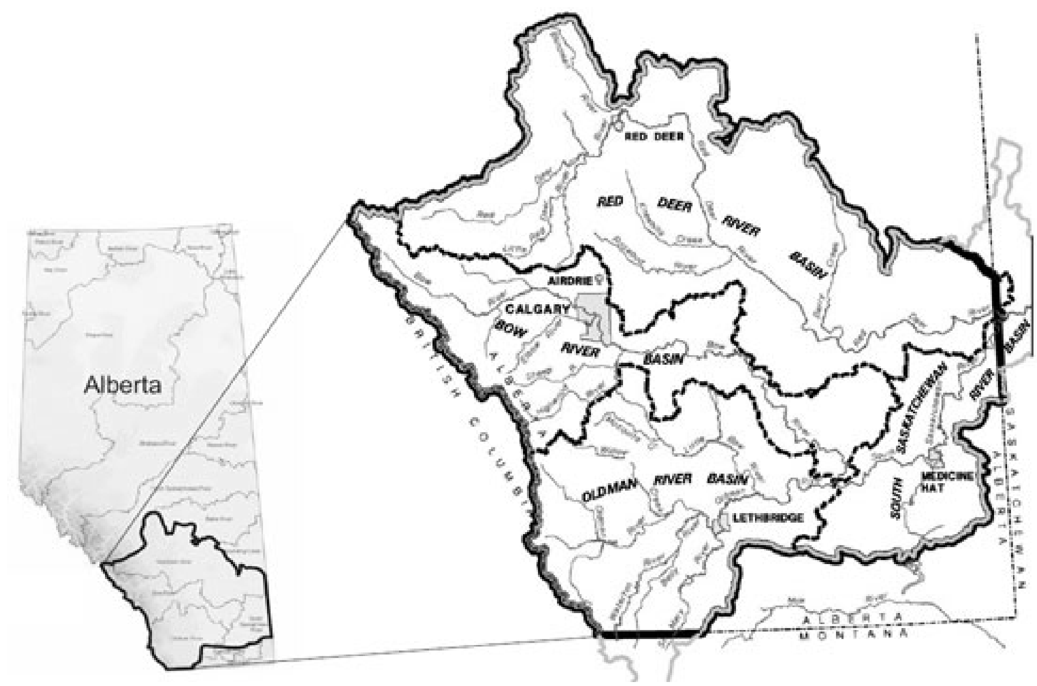


**Figure 14: Map of the South Saskatchewan River Basin (Alberta Environment, 2009a)**

## Water Towers

Most of South Saskatchewan River Basin stream flow originates from snowmelt in the Rocky Mountain eastern slopes. The headwaters of this area are known as the “**Water Towers**” of the basin. This term was coined to emphasize the importance of mountain environments to water resources (PSRB, 2009a, pg.55). Annual precipitation at higher elevations runs up to 1500 mm while in the lower foothills it usually reaches 600 mm (PSRB, 2009a, pg.56). Snow melts in spring and early summer leading to peak flows in the watershed from May until July. Some of this flow is augmented by spring rains. So the level of water supply for the basin is largely dependant on the accumulated snowpack in the mountains (PSRBa, 2009, pg.13). This is the main source of water that will nourish life across the southern prairies. At lower elevations the snowpack can be quickly depleted by Chinook winds. In a typical year, runoff from these mountain water towers accounts for 90% of the streamflow of the South Saskatchewan River (PSRBa, 2009, pg.57). Therefore, anything that affects water supply or quality within these water towers will in turn affect the health and sustainability of ecosystems across three Prairie Provinces.

As headwater streams tend to be small they have limited capacity to assimilate human impacts. Water quality is affected by commercial, industrial, municipal or recreational development in these areas. As was demonstrated in 1989 when the completion of a sewage treatment facility in Banff had extremely beneficial effects on water quality (PSRB, 2009a, pg.62). The montane region of these headwaters is home to a biodiverse community of plants and animals including more than 50 species of mammals, 250 species of birds and various cold water fishes (PSRB, 2009a, pg.62). Proper management of riparian areas and of water supply and quality is essential in maintaining this biodiversity.

After leaving the water towers, the water feeding the South Saskatchewan flows down through the foothills and eastward through the semi-arid prairies of southern

Alberta. Here we will focus on a sub-basin of the South Saskatchewan, the Oldman River Basin.

## ii) Oldman River Basin


**Figure 15: Map of the Oldman River Basin (Oldman Watershed Council, 2000)**

The Oldman River sweeps through a vairety of habitats within the province of Alberta: starting with its headwaters in eastern slopes of the Rocky Mountains it moves though rangelands, foothills and prairies of southern Alberta, then down into Montana. With a total area of 26 000 km$^2$ (which represents 4% of Alberta) and a length of 450 km, the Oldman Watershed as a sub-basin makes up 22% of South Saskatchewan River Basin (Oldman Watershed Council, 2000; Lalonde, Corbett, & Bradley, 2005, pg.7; Alberta Environment, 2007, pg.59). There are several major tributaries off of the Oldman including the Livingston, Crowsnest, Castle, St.Mary, Belly and Waterton rivers (Oldman Watershed Council, 2000). The Oldman River generally flows north east where it joins up with the Bow River and flows into the South Saskatchewan River.

There are roughly, 70 towns and villages within the basin including 26 urban municipalities, 11 rural municipalities and 2 First Nations' Reserves resulting in an average population density of just less than 6 people per $km^2$ (Oldman Watershed Council, 2000; Lalonde, Corbett, & Bradley, 2005; Alberta Environment, 2007, pg.59). The largest city located within the watershed is Lethbridge with a population of 85 492 (City of Lethbridge, 2009a). Other large population centres include Taber, Coaldale, Pincher Creek and Claresholm. Within the watershed there are many different types of land use including: recreation, urban and industrial development, dry land farming, and intensive livestock agriculture.

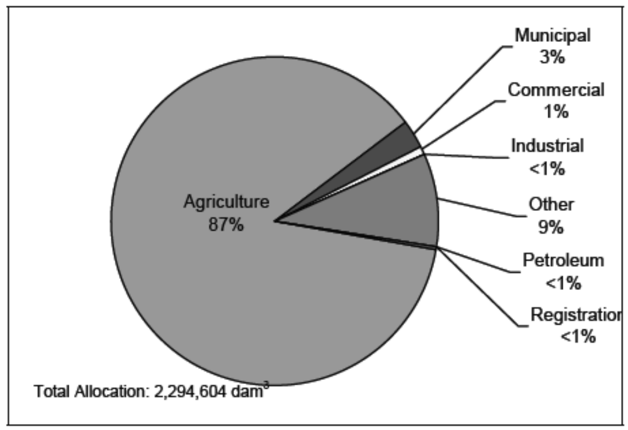


**Figure 16: Water Allocation by Sector in the Oldman River Basin (Alberta Environment, 2007, pg. 59)**

About 33% of the watershed's land cover is agricultural, 29% is forested and 17% is native vegetation (Oldman Watershed Council, 2000). Based on estimates derived from the 2001 Census of Agriculture, there were about 4,394 farms (eight % of the Alberta total) with an average size of 1,194 acres in the Oldman Basin (Alberta Environment, 2007, pg.74). These farms cover an area of nearly five million acres; this is equivalent to about 21,000 km2 or about 80 % of the basin (Alberta Environment, 2007, pg.74). Out of this, 46 % of the land in the Basin is used to raise crops, about 7% is summer fallowed and the remaining land is pasture (Alberta Environment, 2007, pg.74). There are 1.5 million cattle (90% of the livestock in the Oldman Basin), this is about 9.3 times the human population of the Oldman River Basin (Alberta Environment, 2007, pg.74)! Other livestock include pigs, sheep, lambs, bison and horses among others. Of the farms in the Oldman sub-basin, 44.1% are cattle farms, 15% are grain and oil seed farms, and 10.8% are wheat farms (Water Matters, 2009). As a result, within the basin approximately 87% (nearly 2 million $dam^3$) of total surface water and groundwater is allocated to agriculture see Figure 16 (Water Matters, 2009). Irrigated agriculture is also the highest consumer of water in the basin accounting for 80% of total consumption (PSRB, 2009a, pg. 106).See page 35 for more background as to why irrigation is such a high consumer of water. The other category evident in Figure 16 refers to water allocated for water management. Most of the commercial use of water goes toward food processing.

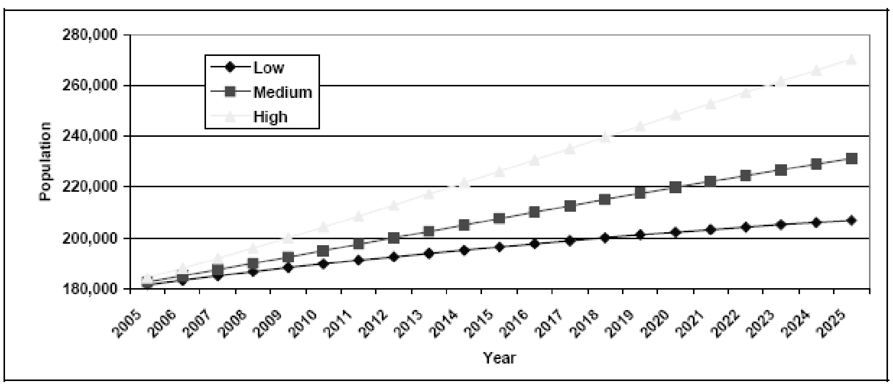



**Figure 17: Population Growth Forecast for Oldman Basin (Alberta Environment, 2007, pg.72)**

The Oldman basin accounts for about 65 percent of the district licences issued in Alberta and overall water is allocated to approximately 845 licence holders (both private and public) within the watershed (Alberta Environment, 2007, pg.59). It is an area of extremely high demand and low supply. Due to the high demand for irrigation water in this basin, there are numerous dams and diversions along the river. The Oldman River dam located upstream of Pincher Creek supplies water for irrigation and municipal supply to Lethbridge and surrounding towns. The flow regimes of rivers and tributaries have been highly altered as spring flows are stored above the dam reducing downstream flows and affecting the habitat of aquatic organisms (Lalonde, Corbett & Bradley, 2005, pg. 14).

The water quality of the rivers deteriorates as you move downstream from the mountains (Lalonde, Corbett & Bradley, 2005, pg. 14). This is due to natural changes such as waterfowl gathering sites and high summer temperatures but also due to human contaminants from both point source (know exactly where pollutant is coming from) and non point sources (cumulative sources of pollution eg. runoff) (Lalonde, Corbett & Bradley, 2005, pg. 14). Large withdrawals also change water level and therefore water temperature and chemistry (Lalonde, Corbett & Bradley, 2005, pg. 14). As the human population within the watershed is expected to increase (see Figure 17) water use is expected to increase anywhere from 14-47% percent which will only intense the already dire water supply situation (Alberta Environment, 2007, pg. 73).

# VI. <u>Watershed Concerns for the South Saskatchewan and Oldman River Basins</u>

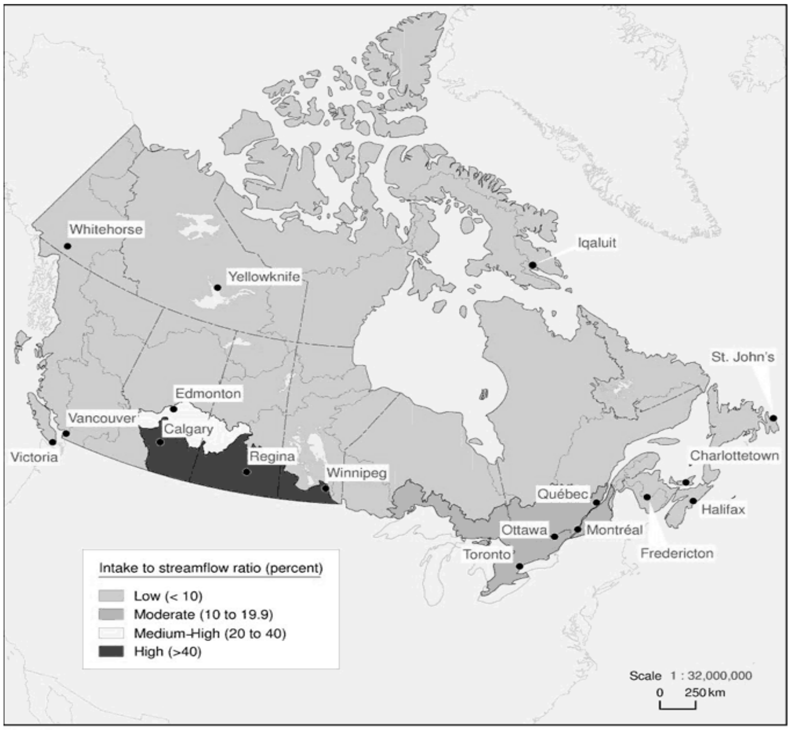



**Figure 18: Water Use and Availability Ratio by Drainage Area in Canada (Environment Canada, 2008c)**

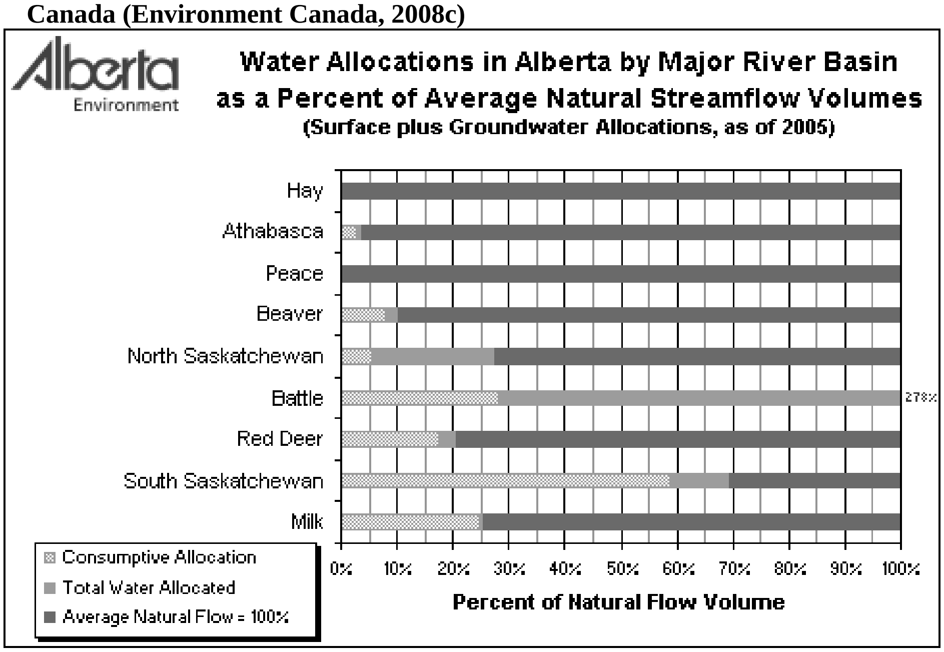
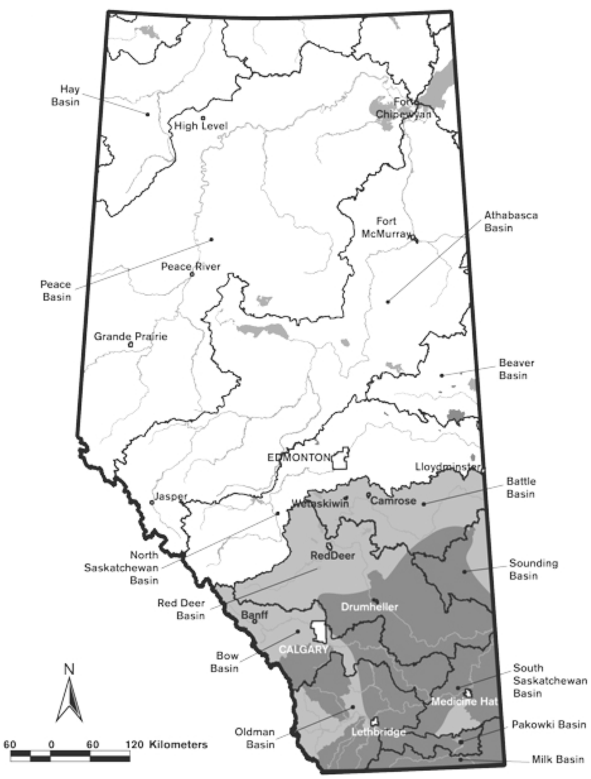



**Figure 19: Water Allocation as a Percentage of Natural Streamflow Volumes (Alberta Environment, 2006)**

According to The Organization for Economic Co-operation and Development (OECD) a ‘stressed watershed’ is one in which more than 40% of the available renewable water within the watershed is being withdrawn for human use (Environment Canada, 2008c). The OECD sets a minimum of at least 60% of the original flow to maintain a functioning ecosystem (Environment Canada, 2008c). Even 60% is not enough in many cases as ecosystem requirements are complex and variable. In southern Alberta **we live in the drainage area of greatest concern within the country** as it exceeds OECD’s 40% threshold (Environment Canada, 2008c).

Heavy exploitation and the arid climate in this region have made the **South Saskatchewan River Canada’s most threatened river** in terms of flow (World Wildlife Fund, 2008). In the basin, water allocations are the highest for any Canadian river, making up 70% of the natural river flow, see Figure 19. Approximately, 58% of all the total flow is consumed (World Wildlife Fund, 2008; Alberta Environment, 2009c). Of the 200 000 water licences in the Saskatchewan River basin all but several hundred are found in the South Saskatchewan sub-basin (PSRB, 2009a pg.22). In some areas, more water is allocated for use than is available and the river almost runs dry (World Wildlife Fund, 2008).

These low flows are at crisis levels and in 2006 Alberta made the unprecedented decision to place a moratorium on new applications for water withdrawals from the Bow, Oldman and South Saskatchewan rivers, see Figure 20. This research package will briefly detail a few of the main issues in order to emphasize the need to conserve and properly manage water within this watershed.



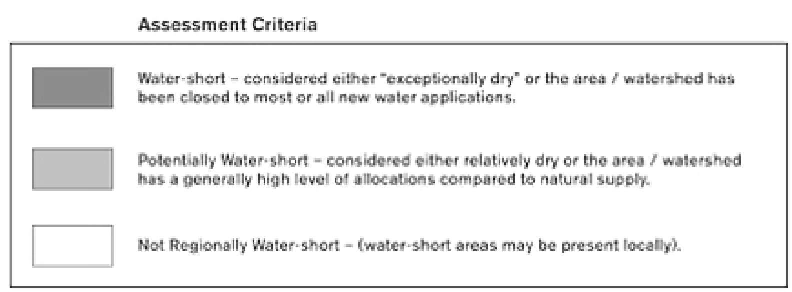




**Figure 18: Critical Areas of Water Shortage within Alberta (Alberta Water Portal, 2009b)**

## A. Irrigation and Agriculture in the South Saskatchewan

Irrigation refers to the artificial supply of water to dry land in order to grow crops. In an agricultural area such as the southern Prairies, this process is usually a vital part of growing food. Irrigated water supply greatly supplements the low levels provided by local precipitation and thus provides a stable way of farming. Southern Alberta throughout history has had lots of sun, warm temperatures and long growing seasons but little rain! For 1998-2008, annual precipitation levels averaged at 267 mm while the average crop requirement was 601 mm resulting in a net irrigation requirement of 334 mm (Water Resources Alberta, 2009). Southern Alberta is typically semi-arid although the demand for irrigated water varies according to winter precipitation, weather and soil moisture each year. Chinook winds also remove moisture from soil.

Southern Alberta is a hotspot for agricultural production. However, the dry climate in this region cannot satisfy the large amounts of water required to grow crops. As a result, water is brought in via pipes and canals and applied through irrigation. In fact, 60% (625 000 ha) of all the irrigated land in Canada is found in Alberta (Environment Canada, 2008e).

Irrigation has been practiced in Alberta for just over 100 years. The implementation of irrigation transformed the landscape of the southern part of the province as canals and reservoirs of now dot the landscape where few water bodies existed before. In 1900, Mormon settlers completed the first large scale irrigation canal (184 km long) which diverted water from St. Mary's River and enabled thousands of hectares to be farmed in the Lethbridge region(CBC, 2009b). The town council of

Lethbridge purchased ads reading “No drought there!” and “Ever man his own rainmaker” (CBC, 2009b).

Today, irrigation plays a large and important role in the livelihood of many southern Albertans. Irrigated land contributes 20% of the provincial gross agricultural production (CBC, 2009b). Some of the most heavily irrigated crops include potatoes, sugar beets, corn, peas, beans as well as many cereal and oil seed crops. There are approximately 50 southern Alberta communities that draw and/or store all the water they need from irrigation infrastructure (Alberta Water Portal, 2009a). Most rural households get the water they need for domestic use from the same network that provides water for their crops. Approximately, 30% of all regional employment in southern Alberta is related to irrigated agriculture, Alberta Agriculture estimates that irrigation adds 35 000 jobs and $940 million to the provincial economy (CBC, 2009b). Irrigation has also created or enhanced more than 80 000 acres of wetland habitat within the province (Alberta Water Portal, 2009a).

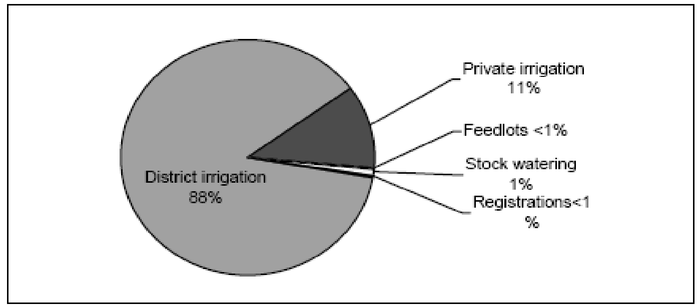



**Figure 19:Water Allocation for Agricultural Use in the Oldman River Basin (Alberta Environment, 2007, pg. 73)**

The impact of irrigation on southern Alberta watersheds cannot be understated. Irrigation makes up 71% of the Alberta’s total use of surface freshwater (CBC, 2009b). Irrigation makes up 75% of all water allocations in the SSRB and 87% of the allocations from the Oldman River (Alberta Water Portal, 2009a). Most of the water allocated for agricultural use in the Oldman River Basin agricultural goes toward district irrigation, see Figure 21. As a result water conservation as it pertains to feedlots and stock watering will not be discussed, instead there will be a focus on irrigation of crops as it is such a high water consumer in Southern Alberta.

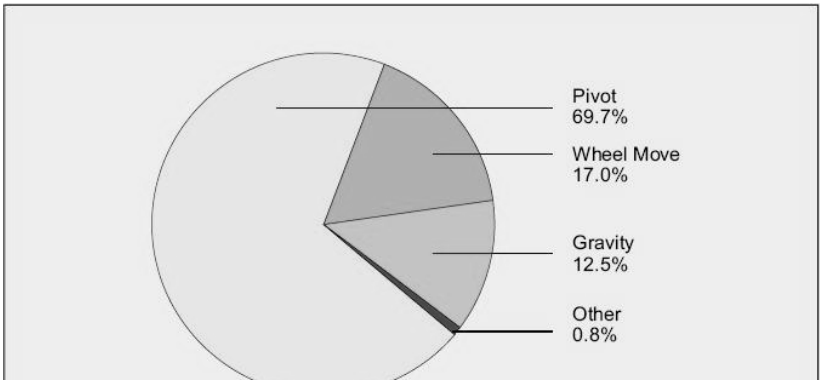



**Figure 20: Irrigation Techniques used in Alberta (Water Resources Branch, 2009)**

There are four major types of irrigation used in Southern Alberta. **<u>Gravity/Flood irrigation</u>** is mainly used by farmers in sugar beet industry (EdQuest, 2009; U.S. Geological Survey, 2009). Canals near a farm are opened up and water flows throughout the land according to gravity. A field is flooded with a few inches of water. It also usually results in a lot of water being wasted either through evaporation and transpiration or runoff (EdQuest, 2009;U.S. Geological Survey, 2009).

There are three types of pipe and sprinkler irrigation where water is pumped from a canal into pipes, then distributed by sprinklers. **<u>Hand move pipe and sprinklers</u>** involves the periodical movement pipes from one site of irrigation to another regularly by human labour so as not to over irrigate a section of farm (EdQuest, 2009). **<u>Wheel move pipe and sprinklers</u>** involves pipes attached to wheels where a motor drives the piping system over a field. **<u>Pivot irrigation</u>**, the most common form of irrigation entails a system of pipes and sprinklers mounted on wheels with a motor (EdQuest, 2009). The system moves in a circular manner which unlike the wheel move system allows you to continually irrigate without need to control how far it will go in one direction (U.S. Geological Survey, 2009). If you've been in an airplane you can easily locate center-pivot irrigation systems on the ground, they are the green circles of irrigated land below. This is the most common type of irrigation used within Alberta, see Figure 22.

This constant diversion and redistribution of water can have large impacts on the water cycle and the resident ecosystem. The type of crop as well as the way in which they are managed can affect infiltration and the flow of water through the soil profile. This in turn can modify the flow patterns of water on and below the ground. As a result, there can be events of peak runoff and silt loading in rivers, while in other cases there can be reduced infiltration, lowering groundwater recharge needed to sustain wetlands and other waterways (Environment Canada, 2008e).  This water level fluctuation can end up destroying habitat for aquatic organisms. Runoff can also contain pesticides and fertilizers presenting an increased risk of contamination of the water (Environment Canada, 2008e, Natural Resource Council, 2009c). As well, reservoir construction can cause flooding of forest and riparian habitat.

A lot of the water used in irrigation is captured during spring snowmelt and stored behind dams or reservoirs for use later in the growing season. As a result, there are significant loses due to evaporation (Environment Canada, 2008e). Recently there has been significant investment by the federal government, the provincial government and the Irrigation Districts to improve the efficiency of water management infrastructure in southern Alberta (Lalonde, Corbett, & Bradley, 2005, pg. 40). Despite these gains there is still room for improvement. Overall, there needs to be significant conversion and uptake of best practices within irrigated agriculture to increase water efficiency within the systems used.

## *B. Climate Change*

During the last century at least 20 droughts have happened in Southern Alberta (CBC, 2009c). These are periods of dry weather leading to a moisture deficit within the soil which in turn has a negative impact on the local vegetation, wildlife and human citizens. The most recent one in southern and central Alberta occurred in the spring of 2009. The region saw less precipitation than it has experienced in the past 50 years (CBC, 2009c). The drought prompted 10 Alberta counties (mostly central locations) to declare states of emergency. Hardest hit by this most recent drought were the tens of thousands of farmers in west-central Saskatchewan and central Alberta (CBC, 2009c). They live in an area known as Palliser's Triangle that extends from southwestern Manitoba to southern Alberta see Figure 23 and it is home to much of Canada's farmland.

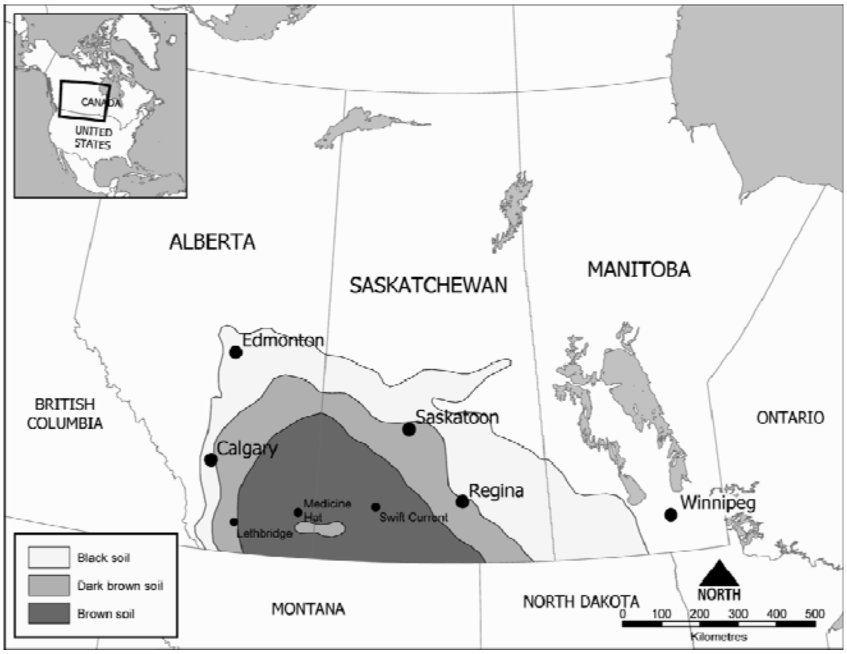


**Figure 21: Palliser's Triangle (boundary is outer line that includes Edmonton) (Wikipedia, 2009)**

The region is named after Irish explorer Capt. John Palliser who declared the land too dry to be suitable for settlement when he first saw it in the 1850s (Geological Survey of Canada, 2007). Despite his warning many people settled there and began to farm, so many in fact that today over half of Canada’s agricultural production occurs here and it is now known as the "breadbasket of Canada" despite the fact that it is the driest region of the Canadian prairies (Geological Survey of Canada, 2007). Such drought conditions are a natural part of such a semi-arid climate but the conditions are being compounded through human impacts such as climate change.

A 2008 report by Natural Resources Canada predicts increased aridity and more frequent droughts as climate change takes its toll in the region (CBC, 2009c). The South Saskatchewan and Oldman River Basin are of particular concern, as they rely on snow melt for most of its summer flows and predictions of reduced winter snow coverage due to global warming could reduce flow in area where the demand already outruns the supply.

Future water conditions within these watersheds are uncertain due to climate change. It is expected that in the mountain headwaters of the Oldman River warmer temperatures will cause quick melting of snow packs and winter-spring precipitation that falls as rain rather than snow leading to rapid spring runoff and lower summer flows. This in turn could result in greater water shortages during peak demand periods (Ryder, 1998). It is also anticipated that there will be higher temperatures in the prairies meaning more evaporation from rivers and reservoirs (Cohen & Miller, 2001). Increased temperatures could stress also water supplies by depleting soil moisture, reducing snowpack and streamflow, and diminishing ground water supplies. The complexity of ecosystems make it hard to anticipate all changes however, over the last 30-50 years in southern Canada, the annual mean streamflow has declined, with the greatest decrease happening during peak demand months of August and September (Schindler & Donahue, 2006). This decrease is forecasted to continue as a result of climate change and will inevitably fall short of meeting growing demand (Zhang et al., 2001).  This change in the magnitude and timing of river flows would have major effects on agricultural production and include environmental implications such as soil erosion and degradation, reduced water quality and availability affecting all of those living within the watershed (Shrubsole & Draper, 2007, p.43).

### *C. Impact of Fragmented, Polluted and Diminished Flow on Ecosystems*

To support the high amount of demand for water for irrigation, numerous dams and reservoirs as well as extensive withdrawals have substantially altered the river and the tributaries in the South Saskatchewan (World Wildlife Fund, 2009). The basin contains 13 large hydropower dams and hundreds of smaller dams. The water level fluctuations cause habitat instability disrupting plant and wildlife populations.

One example of this is that the cottonwood forests that provide shelter, food and breeding habitat for many bird and animal species in the area can be seriously affected by changes in river flows resulting from water diversions, and land uses. The cottonwood trees require high flows in the spring every few years to re-seed. So diminished flows deprive them of water and they struggle to grow. This is particularly apparent in the lower reaches of the Bow, Oldman, St. Mary, Belly and Waterton Rivers, and also the South Saskatchewan River, where water diversions have changed river flows over time and the cottonwood forests downstream have suffered as a result (Rood et. al., 2005).

In another example Joe Rasmussen at the University of Lethbridge has found that the weir on the Oldman River near the Lethbridge water treatment plant has a significant influence of the food web of the river (Innovation Alberta, 2005). As the river starts to warm up in the summer, Rocky Mountain whitefish move upstream to try to stay in colder water and normally goldeye and mooneye, the warmer water species will move in to replace the whitefish during this time (Innovation Alberta, 2005). However, this is not happening because they are blocked by the weir. As a result, whitefish are living above their preferred temperature above the weir because competitors aren't moving in to displace them (Innovation Alberta, 2005). Even these small shifts in fish migration may have far reaching effects within aquatic food chains.

Agricultural pollutants such as pesticides and fertilizers are also having an impact on the fish within the Oldman River. The University of Lethbridge's Alice Hontela, says there is great potential for these pollutants to enter the waterway as runoff from one the many intensive livestock operations and large irrigation networks in the region (CBC, 2008a). These chemicals can greatly affect the endocrine system that produces hormones within the fish. Most of these chemicals still lack guidelines and therefore escape treatment within municipal systems. Harry Swain, a director of the Canadian Institute for Climate Studies at the University of Victoria says “Most pesticides and fertilizers that get into our streams and rivers never pass through a sewage treatment plant. It is really, really serious.” (CBC, 2008a).

Within southern Alberta, the Alberta Species at Risk Program has identified 130 animal and plant species that depend on aquatic ecosystems as requiring special attention so that they do not become extinct or extirpated (Lalonde, Corbett & Bradley, 2005, pg. 22). This includes 8 species of fish which have been influenced by diversions of streamflow for irrigation, reducing populations downstream (Lalonde, Corbett & Bradley, 2005, pg. 22). One third of the 402 known bird species in Alberta are reliant on aquatic ecosystems for all or part of their life cycles (Lalonde, Corbett & Bradley, 2005, pg. 22). Twenty of these bird species are assessed as “At Risk”, “May Be At Risk” or “Sensitive”. Virtually all of Alberta’s 95 species of mammals rely on water for their daily lives and 3 of these are sensitive (Lalonde, Corbett & Bradley, 2005, pg. 22). All ten amphibian species aquatic systems in southern Alberta and 7 of these are sensitive. All four reptiles found here are also assessed as “sensitive”. In addition to this, 86 plant species dependent on ecosystems in this area have been assessed as “At Risk” or “May Be At Risk” (Lalonde, Corbett & Bradley, 2005, pg. 23). As well, the Alberta Natural Heritage Information Center has also found 37 rare or threatened plant communities within aquatic ecosystems here. Clearly, the riparian and aquatic areas within Southern Alberta are some of the most distinct and biodiverse areas in the provinces and they all rely on our actions to ensure that they remain that way.

# VII. Water Conservation Practices South Saskatchewan and Oldman River Basins

## *A. Water Conservation Practices within Irrigated Agriculture*

Generally, flood irrigation often results in surface water losses of up to 50% (Irrigation Water Management Study Committee, 2002). There are some ways that farmers can conserve water using flood irrigation and therefore make more efficient use of the water supply: a) **Level fields**- As this type of irrigation uses gravity to move water, it means that water will not collect on hills even if they are small, as a result some farmers use leveling equipment to ensure even flow of water throughout the field and therefore maximum uptake by crops b) **Surge flooding**- water is released in organized intervals to reduce runoff c )**Capture & reuse runoff**-farmers can capture runoff of water from the edges of fields in ponds and then pump it back out to the front of the field for reuse in the next cycle of irrigation (U.S. Geological Survey, 2009). Even with these methods of conservation, there are many problems with this type of irrigation as it reduces soil stability, kills the microbacteria that form humus and leaches useful nutrients from the soil (U.S. Geological Survey, 2009).

In Alberta, the conversion from flood irrigation to more efficient pivot systems has increased irrigation efficiencies by 40% (Environment Canada, 2008e). There is still a great deal of water loss through sprinkler methods however. In the dry and windy environment of Southern Alberta a lot of the water sprayed through this method will evaporate or be blown away from the field before it hits the ground (U.S. Geological Survey, 2009). The use of micro-irrigation systems (trickle or drip) has further increased the optimization of water use for crop production, and has the potential to eliminate surface loss and restrict subsurface losses. In trickle irrigation water is gentle sprayed from a hanging pipe which increases water efficiency from 60% in traditional spray irrigation to 90% (U.S. Geological Survey, 2009). Drip irrigation involves plastic pipes running along the base of fruit and vegetable crops which release water drop by drop into the soil. As moisture is applied directly to the plant, this cuts evaporation way down (U.S. Geological Survey, 2009).

Alberta is the only province in Canada that has a mandatory requirement for land classification for irrigation within irrigation districts (Agricultural and Rural Development, 2000). Land classification is done to determine the suitability of land for irrigation. Sections of land are then grouped into one of seven classes depending on their capability for sustained production under irrigation depending on soil and topographic features such as soil depth, drainage, salt content and soil pH. Depending on such factors a specific type of irrigation will be recommended. Land in class 1 to 4 is deemed suitable for irrigation, while 5-7 have severe limitations as the hazard to the land under irrigation conditions is high (Agricultural and Rural Development, 2000). This system also acts as an inventory of land characteristics, identifying potential problems that could occur and offering recommendations for proper management.

This land classification for irrigation is required: a) as input to an agriculture feasibility report to obtain a water licence for irrigation development outside an irrigation district; and b) to obtain a water right for irrigation development within an irrigation district (Agricultural and Rural Development, 2000). Only land classified as suitable for irrigation can be granted a licence or water right for irrigation in Alberta (Agricultural and Rural Development, 2000). In this way, environmental impacts can be reduced by irrigating only those lands that are suited to irrigation. Determining the suitable of land for irrigation through this system can be a large initial step in conserving water.

Best management practices for irrigation can go a long way in conserving water as well. One example is conservation tillage (30% or more of previous crop is left on soil surface) as it results in less runoff and erosion of soil (Environment Canada, 2008e). Grassed waterways and buffer strips also significantly reduce over land movement of water (Environment Canada, 2008e). Other suggestions include:

- Select crops suited to the local soil and climate (low water requirements).
- Change water requirements depending on the crop type, variety and stage of growth.
- Use irrigation scheduling to ensure that soil moisture is kept sufficiently high to promote active plant growth, while avoiding unnecessary water applications.
- To prevent runoff, ensure that the irrigation application rate is equal to or less than the soil's infiltration rate.
- Use computer software and weather data to continuously adjust the irrigation schedule. (Agricultural and Rural Development, 2004)

There has also been significant renovation of canal systems in the 13 irrigation districts It is estimated that projected canal rehabilitation will reduce seepage losses to about 54 million $m^3$, (down from 471.76 million $m^3$ in 1991) which represents 1.5% of the gross volume of water diverted on an annual basis (Irrigation Water Management

Study Committee, 2002).

Such practices can have a dramatic impact on water use. As an example, the St. Mary River Irrigation District in Alberta has reduced the total amount of diverted water "lost" in return flows to the river system to less than 7% (Irrigation Water Management Study Committee, 2002). Internal storage reservoirs, lining of irrigation canals, replacement of surface canals by pipelines and conversion of flood irrigation systems to high efficiency pivot systems have also resulted in more efficient use of water (Irrigation Water Management Study Committee, 2002). Irrigation is the largest consumer of water in southern Alberta and the success of any water management policy largely depends on this sector's reaction. The moratorium on new water licences within the Oldman and SSRB is a big step in the right direction as any future demand for water will have to be accommodated through existing allocations.

Snow-melt and rainfall can also wash nutrients from agricultural lands as runoff into water bodies causing excessive algal blooms which result in a depletion of dissolved oxygen and fish kills (Lalonde, Corbett & Bradley, 2005, pg. 17). Best management practices for agriculture including proper storage, disposal and application of manure, and fertilizers can go a long way in controlling nutrient additions to water bodies. Nutrient management includes practices such as implementing setbacks from streams for manure application, liquid manure injection and fostering vegetative waterways. Livestock management includes: controlling access of livestock to waterways, riparian and pasture management and managing the timing of grazing (Agriculture and Rural Development, 2008).

### *B. Water Conservation with the Entire Ecosystem in Mind*

One important tool for ensuring that aquatic ecosystems are maintained and enhanced is determining the Instream Flow Needs (IFN) of a river. This refers to the flows necessary to sustain the natural ecological processes and diversity that maintain aquatic habitats over the long term (Lalonde, Corbett & Bradley, 2005, pg. 23). This assessment focuses on four key ecosystem components: water quality, fish habitat, riparian vegetation and channel maintenance (Lalonde, Corbett & Bradley, 2005, pg. 23). Data collection, analysis and computer modeling integrate these components to provide an indication of how much natural flow can be withdrawn without compromising the ecosystem (Lalonde, Corbett & Bradley, 2005, pg. 23). Both the Prairie Conservation Forum and the World Wildlife Fund have assessed IFN flows to be much higher than the existing flows (85% of flow required for instream needs while only 30% is currently available) within the SSRB (World Wildlife Fund 2009; (Lalonde, Corbett & Bradley, 2005, pg. 24). Restoring flows to meet Instream Flow Needs is currently impossible given the degree of allocation. As a result, the Prairie Conservation Forum states that “the aquatic environment is believed to be in a state of long term declining health.” (Lalonde, Corbett & Bradley, 2005, pg. 24). More scientific research and communication needs to be done to improve understanding of these Instream Flow Needs.

Although it is impossible to fully understand all of the processes taking place in an ecosystem and therefore how to properly manage for them, there are useful indicators. These are measurements which will monitor and describe change in an aquatic system over time such as: status of water quality (which can be used to assess levels of nutrients and productivity), loss of biodiversity or hydrological changes (Lalonde, Corbett &

Bradley, 2005, pg. 26). By continuing to monitor these indicators we can assess the health and sustainability of these important ecosystems. This in turn can provide us with tools for improved management of the basin as a whole.

### *C. Governance of Water Supplies within the Saskatchewan River Basin*

The Government of Alberta owns rights to all water within borders and is the lead player in water management. Through legislation it regulates activities that might impact rivers, lakes and groundwater. The Federal government has jurisdiction for interprovincial and international water agreements, fish habitat protection, navigable waters and rivers within national parks (Lalonde, Corbett & Bradley, 2005, pg. 39). Historically, federal and then later provincial governments authorized the withdrawal and use of water under licence agreements (Pearson, 2006). Until the mid 1970s, water was perceived to exist in unlimited abundance and licences were given in perpetuity at no cost to the user (Pearson, 2006). After 1999, the new Water Act was created which meant that licences purchased after this date were dependent on watershed plans, environmental priorities and renewal reviews. As already mentioned there is a moratorium on new licences within the Oldman River Watershed because it is already over-allocated.

Water allocation in Alberta gives priority to those who have had their water licences the longest. This “first in time, first in right” policy dates back to 1894 (Water Portal, 2009b). As a result, during a drought municipalities could be asked to ration water while farmers with older licences can still irrigate their crops. As of 2008, Alberta announced that it would undergo a systemic review of its water allocation system which is a century old (Water Portal, 2009b). Currently, there are instream flow objectives for the rivers of the SSRB; when flows decline to the instream flow objective levels, Alberta Environment limits withdrawal according to licence conditions and priorities (Lalonde, Corbett & Bradley, 2005, pg.40). However, these objectives were established with the main goal of satisfying allocation commitments and water policy advocates are urging the government to set water aside specifically for the environment and to establish legally enforceable objectives for the timing and amount of flows supported through water management plans (Lalonde, Corbett & Bradley, 2005, pg.40). This is in hopes of improving water quality and better meeting the instream flow needs.

As the South Saskatchewan River is a **transboundary river**, both Saskatchewan and Alberta must work together to restore flows and properly manage water use. The Prairie Provinces Water Board has created a “Master Agreement on Apportionment” between the two provinces which has served as an effective mechanism for apportioning shared water, however it has absolutely no provisions for environmental flows to support natural ecosystem needs (Pearson, 2006). With threat of climate change and new dam proposals, adding legally enforceable environmental flow limits to the apportionment agreement would be best option for the long term sustainability of southern Saskatchewan watershed.

The “Water for Life” strategy was implemented by the Alberta Government in 2003 with the aim to provide “safe, secure drinking water supplies, healthy aquatic ecosystems and reliable, quality supplies for a sustainable economy” (Government of Alberta, 2009a). The strategy contains several key goals to ensure healthy aquatic ecosystems:

**1) Assessment of aquatic ecosystem health:** This initiative continues the development of the initial assessment of aquatic ecosystem health in Alberta. A focus on provincial fish, enhanced assessment of water quality and biological data, wetlands and a synthesis of riparian health inventory information. **2) Science-based knowledge of aquatic ecosystems:** This initiative targets gaps in research knowledge regarding aquatic systems. Efforts include; refining water quality models, instream flow needs tools and fish community index development. **3) Watershed management and decision support tools** The main goal is to ensure that current knowledge and management tools developed for aquatic ecosystems are accessible and understood. These efforts will support integrated land and water regional management processes. **4) Education and public awareness** This initiative is developing public education and information materials to inform Albertans about facts on water and healthy aquatic ecosystems. (Government of Alberta, 2009b)

Water for Life also states that the major sectors in Alberta that will work toward more efficient and productive water use are: irrigation, municipal, oil & gas, forestry, mining, power generation and chemical/petrochemical (Government of Alberta, 2009c). The strategy states that these sectors have committed to producing a water Conservation, Efficiency and Productivity (CEP) plan by 2010 or earlier (Government of Alberta, 2009c).

Although these objectives are promising, The Water for Life strategy has been critiqued for remaining solely a plan of action, as a lack of political, administrative and financial commitment has prevented several of the key actions from being implemented (Alberta Wilderness Association-AWA et al., 2007). The strategy itself is not enforceable by law and this lack of legal grounding means that if the Alberta Water Council is unable to make progress, the Government can't be held accountable if initiatives could fall to the wayside (AWA et al., 2007). Signs of slow implementation are already evident, for example the Wetland Policy originally supposed to be released in 2009, has now been postponed until 2012 (CBC, 2009e). As the CEP planning is not legally enforceable there is nothing to hold the sectors to the goal of 30% water conservation and currently there are only two sectors that have completed CEP plans (Government of Alberta, 2009c; AWA et al., 2007).

In 2007, several NGOs produced a collective report stating that the strategy would only realized with full financial, political and administrative support (AWA et al., 2007). There are no direct monetary commitments listed for the initiatives within the strategy and so far funding has been insufficient for proper implementation (AWA et al., 2007). The NGO report recommends that the Government focus on four areas for immediate implementation: healthy aquatic ecosystems, source water protection, watershed plans, and innovative water use for a sustainable economy (AWA et al., 2007). Key recommendations for implementation include:

• Identifying and prioritizing critical aquatic ecosystem areas and aquatic ecosystem objectives
• Developing a comprehensive and enforceable source water protection strategy
• Acknowledging and incorporating First Nations water issues into the strategy
• Establishing responsibility, accountability, and authority to roles of stakeholders
• Researching thresholds and incorporating them into watershed plans

• Including mandatory compliance obligations for sectors, sub-sectors, and individual companies

• Using progressive innovative approaches to achieve water conservation objectives and improve water management

• Ensuring sufficient financial and human resources, information, and tools to ensure balanced implementation and progress in all aspects of Water for Life

(AWA et al., 2007).

The Water for Life strategy also sets out several key partnerships will that assist the government "in achieving an integrated approach to water and watershed management" (Lalonde, Corbett & Bradley, 2005, pg.42). These are listed below:

1) Provincial Water Advisory Council, multi-stakeholder body to oversee the strategy is implemented and investigates and makes recommendations to the Alberta government on water issues.

2) Watershed Planning and Advisory Council- multi-stakeholder body leads the way in watershed planning: developing best management practices, reporting on the state of the watershed and educating water users.

3) Watershed Stewardship Groups-community based groups that share information and take action to protect and enhance their local watersheds (Lalonde, Corbett & Bradley, 2005, pg.41)

This approach to involve various interest groups and address the watershed from a sustainable resource and environmental management perspective is essential to guide future planning. The Water for Life Strategy calls for overall efficiency and productivity of water use in Alberta to improve by 30% by 2015 (Government of Alberta, 2009a).

Such a goal will require the development of best practices for agriculture and the continual research and development of innovative technologies to improve water efficiency. There is also a great need to increase our research base of topics such as: instream flow needs, impacts of climate change on hydrologic cycle, precipitation patterns, intensity duration and frequency of drought cycles and recharge patterns for groundwater (Lalonde, Corbett & Bradley, 2005, pg.44). The Water Institute for Semi-Arid Ecosystems, Prairie Adaptation Research Collaborative, Alberta Ingenuity Research Partnerships, Climate Change Impact and Adaptation Program have collaborated to form a multi-disciplinary water research centre called "The Alberta Water Research Institute" which will add this essential research component to guide future management. Throughout governance, it is also imperative to recognize and manage uncertainty. There is a need to increase the ability to respond to long term changes (such as climate change and technological advances) (Lalonde, Corbett & Bradley, 2005, pg.44). This means erring on the side of precaution and ensuring that instream flows are high enough not only for human use but for ecosystem services.

"There is simply no way to overstate the water crisis of the planet today. No piecemeal solution is going to prevent the collapse of whole societies and ecosystems. A radical rethinking of our values, priorities and political systems is urgent and still possible." ~Maude Barlow, 2001

## *D. Municipal Water Conservation*

As most industrial and municipal withdrawals are returned to the watershed, conservation within these areas will not have a dramatic impact on the amount of water available instream (Lalonde, Corbett & Bradley, 2005, pg. 38).Even though changes in our individual consumption won't have major impacts, every drop counts! By adopting water conservation practices citizens can reduce demand and consumption of water sources. River flows in Alberta have declined as a result of growing demand for water by agriculture municipal and commercial interests. If everyone from major industry to city households begins to adopt water conservation practices, the cumulative effects of reducing consumption will not only help protect our water supply for the future but also go a long way in ensuring  the health of the plants and wildlife within the watersheds.

## i) Bottled Water

"Canadians wanting to do something about the environment can start by drinking tap water" ~ David Suzuki (CBC News, 2007)

Globally bottled water is a 60 billion dollar industry and worldwide we consume 188 billion litres of it (CBC, 2008b; CBC, 2009d). In Canada, bottled water consumption was estimated at 24.4 litres per person in 1999 by 2005 that had increased to about 60 litres per person (a total of 1.9 billion litres of bottled water consumed) with sales worth $652.7 million (CBC, 2008b). As of 2006, three in 10 Canadian households consumed bottled water. People in high-income homes are more likely to drink bottled water than people in low-income homes (CBC, 2008b).  Often these bottles can cost $2-3 but if you turn on the tap in Lethbridge, you can fill a glass over 2 000 times for just a loonie (City of Lethbridge, 2009d).

According to the Canadian Bottled Water Association, 186 million litres of water were bottled on the Prairies in 2008 (CBC, 2009d). The largest bottled water company in Alberta is Coca Cola which filters water from Calgary's municipal supply to make their product "Dasani". The second-oldest bottled water company in Canada is also found in Alberta: Nanton Water and Soda Ltd., it was founded in 1979 (CBC, 2009d).

Two of the largest bottled water sellers, Coca-Cola and Pepsi, use municipal water. The unprecedented demand for their products increases demand for public water, which they purchase at a substantially lower price than households are asked to pay (CBC, 2008b). Unlike other industry such petroleum or forestry, the bottled water companies pay no royalty fees for using water (CBC, 2006). Experts speculate that if the trend for bottled water consumption continues, it could lead to the privatization of some municipal water supplies (CBC, 2008b). This troubles many water protection agencies who see water access as a fundamental human right.

Although advertising by bottled water companies gives consumers the impression their product is safer and healthier than tap water, Health Canada says it is a matter of personal taste and preference and there is no evidence to support claims that bottled water is safer (Health Canada, 2009). In fact, municipal water is more stringently tested: in Canada local water supplies are inspected every day, whereas bottled-water plants are inspected at three-year intervals (CBC, 2008b). In Canada, bottled water is regulated as a food and therefore it must comply with the *Food and Drugs Act* (Health Canada, 2009). While bottled water is regulated federally as a food, the tap water distributed by municipalities is regulated by the appropriate province or territory (Health Canada, 2009).

The production of the bottles themselves has a high environmental impact. The two primary raw materials in polyethylene terphtalate (PET plastic, used is most single serve bottles) are terephthalic acid (PTA) and monoethylene glycol (MEG), toxic chemicals that are derived from crude oil. It takes more than 17 million barrels of oil to produce the bottled water consumed in the U.S. for a year (Polaris Institute, 2009b). This doesn't include the energy needed to ship raw materials to the plants and finished products to where they are sold, which can be high especially for brands shipped from different continents (eg. Fiji water from Fiji, San Pellegrino from Italy). Such oil consumption contributes to global warming in the production of greenhouse gases (further exacerbating the problems mentioned in the Climate Change section of this research package). Twice as much water is used in the production as what is sold in the bottle as well (Polaris Institute, 2009b).

The amount of plastic waste generated by the consumption of bottled water is also of great concern as potable tap water is already available in most Canadian communities. According to the Container Recycling Institute (CRI), a U.S. nonprofit organization that promotes recycling, more than 80 per cent of plastic water bottles in the U.S. end up being incinerated or sent to landfills (CBC, 2008b). This results in an estimated 144 billion containers were wasted in 2005, approximately 18 million barrels of crude oil equivalent were used to replace these bottles (Polaris Institute, 2009b). Canadian provinces with deposit return programs for bottles have much higher recycling rates. The average recovery rate (2002) for beverage bottles in non-deposit programs was 33%, compared with an average of 75% where these programs are in use (Polaris Institute, 2009b). Overall, there was an average recovery rate of only 48% in 2002 for all plastic beverage containers in Canada (Polaris Insitute, 2009b).

The concern over high consumption from water scarce sources, the privatization of the water supply, the high amount of fossil fuel consumption and the amount of waste created has fuelled many towns to ban bottled water. The Federation of Canadian Municipalities voted in March 2009, to “encourage members to phase out the sale and purchase of bottled water” (Polaris Institute, 2009a). You too can make a difference by using a reusable water bottle (made from aluminum or stainless steel) and filling it with tap water.

## ii) Virtual Water and Calculating our Water Footprint

**Virtual water** is the amount of water that is consumed in the production process (from source to shelf) of making an item (World Water Council, 2004). It measures how much water is embedded in the production and trade of food and consumer products. Through this calculation we can measure our personal water footprint, the amount of water we consume within a year including everything from the water it takes to grow the cotton for our t-shirts to the water needed to produce gas for our cars.

The total 'water footprint' of a nation is a useful indicator of a nation's consumption of global water resources. The water footprint of a nation is highly related to dietary habits of people, with higher consumption of meat meaning a larger footprint (GDRC, 2009). Finally, nations in warm climate zones have relatively high water consumption (ie. heavy irrigation) for their domestic food production resulting in a larger water footprint (GDRC, 2009). In Canada our national water footprint is 2049 cubic meters/per capita/ year (a cubic meter is equal to 1000 litres) (Water Footprint Network, 2009a). This means that per capita, Canadians consume around 5,600 litres of virtual water every day. This is over triple the amount consumed daily by someone in China (Water Footprint Network, 2009a).

Virtual water has major impacts on global trade policy and research, especially in water-scarce regions, and has redefined discourse in water policy and management. By explaining how and why nations such as the US, Argentina and Brazil 'export' billions of litres of water each year, while others like Japan, Egypt and Italy 'import' billions, the virtual water concept has opened the door to more productive water use (GRDC, 2009). This has also meant countries are implementing “virtual water imports” via food as an alternative water source to water scarce regions (GRDC, 2009).

Virtual water also helps to create awareness that individuals don’t just consume water through showers and running the tap but that water is embedded in the processes of creating the food and products that we use. Behind that morning cup of coffee are 140 litres of water used to grow, produce, package and ship the beans (GRDC, 2009). That is roughly the same amount of water used by an average person in England for drinking and household needs for one whole DAY (GRDC, 2009)! The ubiquitous hamburger needs an estimated 2,400 litres of water (GRDC, 2009). On average fruits and vegetables require much less water to produce than meat (CBC Radio, 2008; GRDC, 2009). Food isn’t the only thing that we can consume that requires a lot of water for its production. Each piece of paper we use involved 10 litres for its production (CBC Radio, 2008). The average t-shirt has 2-3000 litres go into its creation and 1 pair of leather shoes alone has consumed 8000 litres of water (CBC Radio, 2008). The production of a single car requires 250 000 litres of water and it takes 33 000 litres to assemble the average computer (Shrubsole and Draper, 2007). Visit **www.waterfootprint.org** to see some

1 cup of coffee needs 140 litres of water.
1 litre of milk needs 1000 litres of water.
1 kg of wheat needs 1350 litres of water.
1 kg of rice needs 3000 litres of water.
1 kg maize needs 900 litres of water.
1 kg of beef needs 16 000 litres of water

**Figure 22: Examples of Virtual Water Needs for various products (GRDC, 2009)**

more estimates for the daily products that you use or to calculate your own water footprint.

## iii) Reducing Municipal Pollution

In nature nothing exists alone. Living things relate to each other as well as to their non-living, but supporting, environments. These complex relationships are called *ecosystems*. Each body of water is a delicately balanced ecosystem in continuous interaction with the surrounding air and land. Whatever occurs on the land and in the air also affects the water.

Toxic chemicals can enter waterways in different manners including seepage where chemicals soak into the groundwater from waste disposal sites and agricultural lands. Best practices can help control this. Chemicals (including pesticides and fertilizers for our gardens) can also be carried in runoff from land where they were used or spilled or air into which they were emitted. They end up untreated going into the Oldman River degrading water quality and numerous plant and wildlife habitats. Although, we can't make much of a difference when it comes to increasing water supply, we can greatly improve water quality through our collective actions as citizens. What can you do to help ensure that our waterways are protected from pollutants? Here are some suggestions:

**a) Around the House**

Try to use natural products and when you have to use chemical based products try to only buy as much as you need. Choose organic products or make your own cleaners with common household substances such as lemon juice, vinegar, salt and baking soda. Look for the EcoLogo on cleaning and chemical products which indicates that the item is environmentally friendly. Make sure to return hazardous and chemical waste to the Waste and Recycling Centre in Lethbridge. To find this centre follow the extension of 28th St. North, the centre is located approximately 7 km after the houses on 26th Ave. North. The road will bend naturally to the right, the centre is located on the left hand side of the road. This centre will recycle paint and electronics as well. Call if you have questions on what counts as hazardous waste, 327-3288 (City of Lethbridge, 2009b).

**b) In the Garden and Yard**

Also be mindful of what waste you leave on the ground. Items like pet waste, oil, garden pesticides and fertilizers will be washed into runoff with rain and snow-melt and as a result the chemicals will eventually drain into the Oldman River. Around your neighbourhood there are storm drains (gates found on the street by the curb). Once the water enters these grates it goes through a network of tunnels and then enters the Oldman River untreated. In a survey done in 2004, 67% of 900 Oldman residents used herbicide or chemical fertilizer on their lawn and the majority of them had no idea that stormwater is not treated before it enters the Oldman River (Oldman Watershed Council, 2004). Compost out of kitchen scraps, lawn clippings and other organic materials makes an excellent alternative to chemical fertilizers. By leaving grass clippings on the lawn you also help to fertilizer the grass. Try to pull weeds instead of using chemicals.

**c) On Driveways and Sidewalks**

It only takes 1 drop of oil to contaminate 25 litres of drinking water (Yellowfish Road, 2009). Try to ensure that any leaks on your car are fixed. Even simple things like soapy water can end up being harmful to aquatic life. Instead try to use biodegradable cleaning products when cleaning items like your car outside. Or take the car to the local carwash, the water used there goes into the sewage treatment plant instead of directly into the river. Use salt and sand sparingly in the winter. Spreading salt on a walkway before a snowfall is more effective than putting it on top of snow or ice (Yellowfish Road, 2009). Salt can damage vegetation, soil and water quality. Sand can also clog storm drains and increase turbidity in the waterway.

**d) Within the Community**

You can also join a program like Yellowfish Road to help mark storm drains to inform the public about their impacts on the watershed. Participate in the Coulee Cleanup in the spring to ensure that we clear the land of any waste that could eventually end up in the river. We are lucky within Lethbridge to have excellent treatment facilities for our water. Take a field trip to the water and wastewater treatment to learn where our water comes from and where it ends up. It is also fun to visit local water bodies like the Oldman River and Elizabeth Hall Wetlands to get know the plants and animals that share our waterways.

## iv) Reducing Municipal Water Consumption

There are lots of water conservation practices that you can do around your home as well. See below for some important water saving tips.

**a) Around the house**

In the house, toilets (31%) and showers (19%) make up for roughly half of all the water consumed (Statistics Canada, 2008). The average toilet uses 20 litres every time you flush (CBC Radio, 2008)! This means that everyday you use on average 100 litres just to flush the toilet. Place a brick or jug of water in the back of the toilet to reduce the amount of water you are flushing each time. Also, inspect the toilet flapper to ensure it is not leaking. A shower also uses a high amount of water, approximately 75-150 litres, this results in 36500 litres a year (CBC Radio, 2008). If half of all Canadians have a daily shower this would mean 584 billion litres of water for a year (CBC Radio, 2008)!! This is drinkable, treated water and enough to fill 234 000 Olympic sized swimming pools (CBC Radio, 2008). Install a low flow showerhead. This usually results in 60% less water being used each time, approximately 50 litres being used each time (CBC Radio, 2008; City of Lethbridge, 2009c). Also try to aim for shorter showers, five minutes in length. Also, try to use only full loads of laundry or switch to a side loading machine, as the average top loading laundry machine uses 150 litres per use (CBC Radio, 2008).

A dishwasher uses 15-25 litres per cycle on average whereas washing dishes by hand entails 3-5 times more water than this (CBC Radio, 2008)! Scrape plates rather than rinsing them before putting them in the dishwasher. If you do hand wash, do not use running water, instead fill sinks (or a pan if you only have one sink) partway full and use one for washing and one for rinsing. Avoid running the taps, fill sink to wash fruit or veggies. Running water uses 19 litres per minute (City of Lethbridge, 2009c)!! Capture grey water (used water from non-toilet sources) in a big bowl in the sink as you wait to warm up water or cool it down. B.C. based Envirosink has a large storage tank connected to the sink where you can capture greywater for reuse (Vasil, 2007, pg.235)

**b) In the Yard and Driveway**

Canadian water use goes up by 50% in the summer (Vasil, 2007, pg.234). In a study of over 900 residents of the Oldman Watershed, 70% water their lawns weekly or more often (Oldman Watershed Council,  2004). Instead of using the sprinkler frequently water deeply once a week. Lawns only need 2-3 cm of water per week, if soil is too moist, plant roots will not spread.  Do not water the grass more than once every 4-6 days. When you do water, try to use a sprinkler that is low to the ground to reduce evaporation. Also water early in morning or evening to stop water from evaporating in the hot sun. To measure you much water you are using place a glass jar on the grass that you are watering and then measure the depth collected and the amount of time it took. Capture rain water for your garden and plants. A cistern or rain barrel located on the corners of your house where eaves troughs drain will capture and store rainwater for watering vegetation. A screen will prevent bugs and other debris from entering.  To clean your driveway use a broom, do not use a hose. By using a broom instead you will save at least 200 liters every time.

The term "xeriscaping" is a portmanteau of the Greek **'xeros' (**meaning dry) and land**scape** (City of Lethbridge, 2008). It refers to the landscaping of plants whose natural requirements are suited to the local environment. Here in Lethbridge that means finding plants that are drought tolerant and do not need a lot of watering. The average suburban lawn sucks up about 45 500 litres of water every summer (Vasil, 2007, pg.236). Instead of Kentucky blue grass, try fescues or perennial rye grasses (Vasil, 2007, pg.236) This in turn will mean that a great deal of water is conserved. This also helps prevent erosion of coulee slopes and river banks from overwatering. Less time and maintenance are needed to upkeep the yard as well as fewer pesticides and fertilizers because the plants chosen in xeriscaping are so well adapted to the area. Most greenhouses in Lethbridge are starting to carry a variety of local native plants. Some of them are listed in Figure 25.

Another way to reduce watering on your lawn is to enhance the moisture retention of your soil. This is done by using nutrient rich compost or mulch. Mulch is useful as it covers soil and reduces evaporation, soil temperature and erosion. Organic mulches include: wood chips, straw, sawdust, leaves, and grass clippings. Inorganic mulches include: rock, gravel and fabricated materials. Put mulch in open dirt spaces to prevent weeds from entering the area.

| Prairie Flowers | Prairie Grasses | Prairie Shrubs |
|---|---|---|
| Prairie Smoke | Sideoats Gama | Saskatoon Berry |
| Golden Alexanders | Crested June grass | New Jersey Tea |
| Butterfly Weed | Prairie Dropseed | Grey Dogwood |
| Canada Milk Vetch | Big Bluestem | Fragrant Sumac |
| Blazing Star | Little Bluestem | Early Wild Rose |
| Wild Bergamot | Canada Wild Rye | Meadowsweet |
| Purple Prairie Clover | Switchgrass | Silverweed |
| Yellow Coneflower | Indian Grass | Dwarf Birch |
| Black-eyed Susan | Tufted Hair | Snowberry |
| Blue Vervain | Sweetgrass | Fringed Sage |
| Culver's Root | Alpine Bluegrass | Sagebrush |
| Ox-eye | Green Needle Grass | Bog Cranberry |

**Figure 23: Examples of Native Plant Species for Southern Alberta (City of Lethbridge, 2009c)**

### c) In the Community

Those Canadians that pay a flat rate use 467 litres a day while those of us who pay for each drop use about 266 (Environment Canada, 2007). If you don't have water metering within your community lobby your local municipal officials to instate it. Get informed. Learn more about water conservation in general. See the resource section for a network of partners who can provide more information. Visit a wetland (see below for their significance to water conservation).

## v) The Role of Wetlands in Water Conservation

Wetlands are nature's way of conserving water. These areas provide storage capacity for runoff. The organic soils in wetlands act like a sponge to retain water and allow infiltration of surface water into groundwater. As a result, runoff volume decreases and therefore reduces the chance of erosion and flooding. When fast moving water hits the vegetation within a wetland it slows down and suspended particles settle out. This means that nutrients such as phosphorus and nitrogen are trapped in sediments or are taken up by resident plants and bacteria. Due to the high nutrient load there is an abundance of plant life which fuels aquatic food chains and makes wetlands excellent wildlife habitat.

In addition to providing homes to a variety of wildlife, guarding against floods and buffering shorelines against erosion, one of the wetlands most important roles is filtering water. Nutrients like phosphorus and nitrogen can enter the water system from agriculture and industrial development and can seriously pollute water and harm the life that depends on it.  Research has shown that the sediments, plants and organisms within wetlands can trap, breakdown or absorb these nutrients. In fact, up to 92 per cent of phosphorus and 95 per cent of nitrogen draining from the surrounding watershed can be removed from water passing through a wetland (Ducks Unlimited, 2009). Wetlands can also trap up to 70 % of sediments found in runoff (Ducks Unlimited, 2009). This is important because it helps to reduce the sediment load entering the river. Wetlands are so good at this process that specially constructed wetlands have been used to treat wastewater (sewage) in Europe for over 50 years (Ducks Unlimited, 2009). Visit the Sunridge housing development in Lethbridge to see an example of wetlands used to treat stormwater or the Elizabeth Hall Wetlands to see the abundance of life that thrives there.

Unfortunately, approximately 66% of the wetlands within the Saskatchewan River Basin over the last 50 years have been drained or altered to the point where little of the ecosystem function remains (PSRB, 2009, pg.11). The Government of Alberta is planning to release a Wetland Policy regarding future management plans but it doesn't have a commitment to establish it until 2012 and the province won't set up actual implemented practices based on it until 2015 (CBC, 2009e). The Alberta Wilderness Association says delaying the release of the policy (it was originally supposed to be released in 2003) is not acceptable at such a time of urgency regarding water conservation within the province (CBC, 2009e).

## VIII. <u>Conclusion</u>

Globally, nationally and provincially water issues are of paramount concern. Here in Southern Alberta, population growth, climate change, agricultural and industrial development are also increasing demand and pressure on water supplies when already there is a severe water shortage in the region. The Saskatchewan River Basin is particularly at risk as it contains the most heavily utilized rivers in the province. It is essential that integrated watershed management plans are immediately put into action to not only meet demands of the growing human population but also protect the long term sustainability and ecological integrity of these water sources. Collectively, government, industry and individual citizens must work together to conserve and protect the water sources that we share with all life on earth. The severity of the issue cannot be understated as when it comes to water there is no substitute.

**"When the well runs dry, we shall know the value of water."**
**~ Benjamin Franklin**

Water Resources for Southern Alberta

## Networks

**Alberta Water Portal –** www.albertawater.com
In Alberta, there are over 1,000 water-related organizations, each with different stakeholders and perspectives on the province's water challenges, opportunities and solutions. The Alberta Research Council, the Suncor Energy Foundation, and the Alberta Water Research Institute are developing the not for profit Alberta WaterPortal Project. This portal will provide links to all water related resources within Alberta. They want the WaterPortal to be a "catalyst and capacity builder for the sharing of water knowledge and a place where anyone can easily find and contribute to the information and knowledge needed to make better water management decisions".

**Alberta Water Council-** http://www.albertawatercouncil.ca/
A multi-stakeholder group of NGOs and industry representatives that advise the government on policy; this council provides water quality and conservation recommendations.

## Education Materials

**Alberta Environment Water Related Educational Resources**
http://environment.gov.ab.ca/info/library/7553.pdf
**Running Water** (Grades 7-9): Poster with description of activities that link to Social Studies and Science. Topics include water quality, stream uses, plants and animals, riparian areas and land uses associated with northern streams.
**Stream Connections** (Grades 7-9): This poster kit supports Freshwater and Saltwater Systems. The poster represents the semi-arid environment of Southern Alberta. You will learn about water use, water conservation, and water management while making connections to science, technology, society and the environment..
**Wetlands: Webbed Feet Not Required** (Grades 1-4): This poster kit supports wetlands. You will learn about the functions and types of wetlands, wetland plants and animals, and environmental issues related to wetlands.

**Alberta Tomorrow-** www.albertatomorrow.ca
An interactive web-based computer simulation to teach the long term effects of natural resource management on ecological and economic values in Alberta. The computer simulation allows users to design their own strategy for resource development and ecological protection, run it through the simulator, and see the consequences. This free web based simulation shows the complexities of designing a land use plan to satisfy the goals of all people in Alberta. Lesson plans specific to the Alberta Curriculum are available including student activity sheets and answers for Outdoor and Environmental Education, Science 7, Social Studies 9 and 10, Science 20 and Biology 20.

**City of Edmonton Drainage Education-**
http://www.edmonton.ca/environmental/wastewater_sewers/drainage-education.aspx
The City of Edmonton has created *Treat it Right!* teaching materials. *Treat it Right! Stormwater* (Grade 5) supports the Wetlands in Alberta science curriculum and *Treat It Right! Wastewater* (Grade 4) supports the Waste in Our World Science Curriculum.

**City of Lethbridge- Water Related Lesson Plans**
The City of Lethbridge has created lesson plans regarding stormwater and bottled water and other environmental initiatives for grades 4 and 8.
http://www.lethbridge.ca/home/City+Hall/Departments/Helen+Schuler+Nature+Centre/Educational+Resources/Educational+Resources.htm

**Canadian Wildlife Federation (CWF)-**
http://www.cwf-fcf.org/en/educate/lessons-activities/water-education/
Water resources for educators: "Teaching each other about the importance of water and the best practices for maintaining healthy rivers, lakes and oceans has never been more crucial." Lesson plans and activities including "Water Conservation in Lethbridge"- http://www.cwf-fcf.org/assets/pdf/en/lesson-plans/waterconservlessonplan.pdf and "Sewage"- http://www.cwf-fcf.org/assets/pdf/en/lesson-plans/sewagelessonplan.pdf

**Centre for Watershed Protection-** http://www.cwp.org/Resource_Library/index.htm
U.S. NGO which provides educational resources and background information as to why watershed conservation is important**.**

**Cows and Fish-** http://www.cowsandfish.org/youth/education.html
Cows, Fish, Cattledogs and Kids! Game Show and Board Game: Fun interactive game to introduce water as shared resource.

**Ducks Unlimited- Educational Resources--**
http://www.ducks.ca/resource/education/index.php
This organization works to preserve and protect wetlands and waterfowl. Visit their website for specific wetland related resources for educators, landowners, researchers and other citizens.

**Every Drop Counts-** http://www.everydropcounts.com/page5.htm
Water information, teacher resources (curriculum materials for Alberta's grade 8 teachers and students), water activities and links to a vast selection of water related web sites. Every Drop Counts has been developed by the Alberta Irrigation Projects Association in conjunction with the United Nations Water for Life Decade, Iunctus Geomatics, and Alberta Education.

**Freshwater Teachers' Corner- Environment Canada**
http://www.ec.gc.ca/water/en/info/pubs/e_teach.htm
Environment Canada provides free print and electronic resources for primary, intermediate, secondary and post-secondary audiences. Factsheets, activity booklets and more are available.

**Geocache your Watershed- Environment Canada**
http://www.ec.gc.ca/geocache/default.asp?lang=En&n=E923094B-1
The objective is to have high schools promote information on their watershed to others that use that watershed. The students will research their local watershed and develop information pamphlets about what they have learned. This knowledge will then be transferred to the public who visit their watershed location through geocaching.

**Inside Education-Hidden Water-** http://www.insideeducation.ca/hidden/water.html
(Grade 8 with applications in Grade 5, Grade 9 Science, Biology 20 and beyond) An informative multimedia presentation (free online) that will introduce students to the science of groundwater in Alberta. Topics include groundwater quality, links to the hydrologic cycle, as well as the distribution and uses of groundwater within the province.

**Partners FOR the Saskatchewan River Basin**
Click on Climate- An outdoor field based program for ages 8-13, developed to target conservation practices and other stewardship behaviour in order to reduce human impact on climate. http://www.saskriverbasin.ca/page.php?page_id=12
Water Watchdog- An outdoor monitoring program. Participants are encouraged to take action by testing and reporting on the water and water ecosystem in their own backyard streams, rivers, lakes and ponds. The goal of the Water Watchdog program is to increase understanding about water quality, management issues, and to encourage water conservation. Water Watchdog materials are now online and participants will be shown how to best use these resources, including a new database to help keep track of your water quality test results. http://www.saskriverbasin.ca/page.php?page_id=11
Moopher's Amazing Journey to the Sea is an exciting board game designed for children ages 7-12. By helping Moopher (a mischievous gopher) travel to the sea, children learn about their place within the Saskatchewan River Basin, its diverse culture, and how their actions can influence the greater watershed basin. This game is available in English and French. http://www.saskriverbasin.ca/page.php?page_id=13

**Water Under Fire-** http://waterunderfire.com/index.php
"Water Under Fire" is a series of educational 'webisodes' and public service announcements developed in partnership with University of Lethbridge and the Canadian Wildlife Federation. This series explores the issues, the science, and the human impacts on water through a series of interviews with top water scientists , . This project is spearheaded by Dr. Jim Bryne and Dr. Rick Mrazek (University of Lethbridge).They are joined by internationally renowned aquatic ecologist Dr. David Schindler, Killam Memorial Professor of Ecology, University of Alberta. The whole series is available complete with teachers guide. The resources are free via the website but can also be purchased for use by education institutions through info@filmwest.com.

**Wetland Education Program in Lethbridge** http://www.city.lethbridge.ab.ca/hscc/
The Elizabeth Hall Wetland is an oxbow pond nestled beside the beautiful cottonwood forest of the Oldman River. A short walk from the parking lot to the wetland will be

rewarded with an abundance of wildlife viewing opportunities! Interpretive signs allow you to experience the wetland on your own or you can plan ahead and book a special guided program. Grade 5 and public programs are available. Located beside the Bridge Valley Golf Course on Highway 3a W (Bridge Rd.) Lethbridge, Alberta. For information about the Elizabeth Hall Wetland, contact the Helen Schuler Coulee Centre.

**WILD Education-** www.WildEducation.org
CWF also has curriculum-linked resources and offers professional development workshops such as Fish Ways and Project WILD for teachers.

**Yellowfish Road-** http://yellowfishroad.org/
The Yellow Fish Road program's goal is to help Canadians understand that stormdrains are the doorways to our rivers, lakes and streams. Preventing pollutants from entering our stormdrains is critical to protecting and improving water quality and aquatic habitat. Through this program participants mark storm drains with yellow fish and distribute pamphlets about stormwater pollution. This program runs nationwide.

## Water Governance/Policy

**Alberta Environment: Water for Life Strategy-**
http://www.waterforlife.alberta.ca/548.html
Alberta's *Water for Life* strategy was adopted by the Government of Alberta in November 2003. The strategy contained the following three goals: safe, secure drinking water supply, healthy aquatic ecosystems and reliable, quality water supplies for a sustainable economy

**NGO Review of Water for Life Strategy-**
http://www.toxwatch.ca/files/Recommendations_for_Renewal.pdf
Alberta Wilderness Association, Ecojustice and several other non-profits released this critique of the "Water for Life" Strategy in 2007. Due to a lag in implementation regarding several key goals, these organizations put forth a series of essential recommendations.

**Government of Alberta: Water Act-**
http://www.environment.alberta.ca/3.html
Current legislation related to water within Alberta including drinking water, water allocation, environmental protection measures and boundary treaty agreements.

**Southern Alberta Watersheds: An Overview** by Lalonde, K., Corbett, B., & Bradley, C. (2005). Lethbridge: Prairie Conservation Forum. **F2-24**
Overview and critique of water governance in Southern Alberta see pages 37-45.

**WWF Rivers At Risk Report –** http://wwf.ca/conservation/freshwater/riversatrisk.cfm
World Wildlife Fund assesses some national rivers to be in a critical state and offers recommendations for conservation.

## Irrigation

**Alberta Irrigation Projects Association**- http://www.aipa.ca/index.php?cID=71
Association of irrigators within Alberta; has education material and resource links.

**Alberta Water Portal- Agriculture and Irrigation –**
http://www.albertawater.com/index.php?option=com_content&view=article&id=84

**Agriculture and Water Quality: Beneficial Management Practice (BMP) Resources- www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/aesa5826**
Information and additional resources available to agricultural producers for developing individual management plans to protect water quality**.**

## Municipal Conservation

**Alberta Urban Municipalities Association**- Draft water conservation, efficiency and productivity plan
http://www.auma.ca/live/digitalAssets/26/26231_Attachment_to_Draft_Water_CEP_Plan.pdf

**City of Calgary-** Water Policy Outline
http://www.calgary.ca/portal/server.pt/gateway/PTARGS_0_0_104_0_0_35/http%3B/content.calgary.ca/CCA/City+Hall/Business+Units/Environmental+Management/Strategic+Environmental+Initiatives/Triple+Bottom+Line/Policy+Framework/Environmental+Supporting+Policies/Protecting+Water+Resources+.htm

**City of Lethbridge-** Water Conservation Site
http://www.lethbridge.ca/home/City+Hall/Departments/Environmental+Management/Programs+and+Initiatives/ENVwater.htm

**Great Canadian Shoreline Cleanup**- http://www.vanaqua.org/cleanup/
Join a group or form your own to participate in this annual event to clean up local shorelines.

## Science/Research

**Alberta Research Council -Integrated Water Management**
http://www.arc.ab.ca/areas-of-focus/water-resource-management/integrated-water-management/
A branch of the research council that develops scientific and technological solutions for emerging issues while taking into account ecology, land use and socio-economics.

**Alberta Water Research Institute-** http://www.waterinstitute.ca/
Established in 2007, a research think-tank funded by the Government of Alberta and operated through the Alberta Ingenuity Fund. The scope of research includes the quality and quantity of Alberta's water resources.

**Canadian Water Network-** http://www.cwn-rce.ca/
In collaboration with universities, government and industry, the CWN has developed a variety of scientific projects and initiatives that address key water-related issues facing Canadians.

**Water Data Module**
http://www.albertawater.com/index.php?option=com_content&view=article&id=72
The Water Portal in collaboration with the Alberta Research Council is creating a water data module to provide free and open access to over 1000 different sources of water data and information.

## Water Stewardship

**Alberta WaterSMART**- http://albertawatersmart.com/index.html
Alberta WaterSMART is a not for profit society dedicated to the improvement of water management awareness, technologies and practices in Alberta.

**Cows and Fish-Alberta Riparian Habitat Society** http://www.cowsandfish.org/
Strives to foster a better understanding of how improvements in grazing and other management of riparian areas can enhance landscape health and productivity, for the benefit of landowners, agricultural producers, communities and others who use and value riparian areas.

**Go Blue**- http://www.goblue.org/en/
National initiative funded by Unilever to encourage Canadians to cut their water use by half.

**Oldman Watershed Council-** http://www.oldmanbasin.org
The OWC seeks to maintain and improve the Oldman River Watershed through partnerships, knowledge, and the implementation and integration of sustainable water management and land use practices.

**Partners FOR the Saskatchewan River Basin-** http://www.saskriverbasin.ca/
Since 1993, Partners FOR the Saskatchewan River Basin (PFSRB) has promoted stewardship and sustainability of the Saskatchewan River Basin , an international watershed stretching over the three Prairie Provinces and a portion of Montana . More than 3 million people live within the basin which includes the North Saskatchewan, Red Deer, Oldman, Bow, Highwood, South Saskatchewan, Battle, Saskatchewan, St. Mary, and Carrot Rivers.

**POLIS Centre for Ecological Governance-**Water Sustainability Project
http://www.polisproject.org/researchareas/watersustainability
Establishing a demand management paradigm for water in Canada requires careful attention to the broad issues of governance – a main focus of the Water Sustainability Project at POLIS. By focusing on fundamental governance issues such as long-term comprehensive watershed based planning, decision making, innovative institutional and ecosystem-based legal reforms, the WSP seeks to establish a new water paradigm based on conservation, stewardship and sustainability.

**Trout Unlimited Canada -**http://www.tucanada.org
Organization with a mission to conserve, protect and restore Canada's freshwater ecosystems and their coldwater resources for current and future generations.

**Vision for Land Use Planning-** http://www.albertabydesign.ca/
Canadian Parks and Wilderness Society, The Pembina Institute, and Water Matters have created this website based on information gathered from the Government of Alberta, reports developed by our respective organizations, and information available from other non-governmental organizations. It features information regarding the Land-use Framework and provides up to date information to Albertans concerned about land uses issues. It hopes to promote sustainable land use and advocate for environmental protection.

**Waterlution**-www.waterlution.org
A water learning organization that brings together young leaders – interested or working on water-related topics – for peer-to-peer and inter-generational learning programs. Workshops and activities often take place over a weekend, or are customized to work with partners and groups at selected events. Waterlution often focuses our programs on geographical areas engaging local stakeholders. In 2008, workshops took place in Ontario, Quebec, Alberta, British Columbia, and the Yukon and Northwest Territories.

**Water Matters -**http://www.water-matters.org/home
Alberta NGO formed in 2007 by citizens concerned about watershed protection in Alberta. Aim to raise awareness regarding watershed issues, empower the public to take action and promote progressive watershed policies.

**Directory of watershed stewardship groups in Alberta**-
http://www.ab.stewardshipcanada.ca/index.php/directory_of_watershed_stewardship_in_alberta

# Conservation Acts

## Xeriscaping/Native Plant Gardens

**Calgary Horticultural Society**- http://www.calhort.org/gardening/waterwise.aspx
Information in creating a water wise garden in Southern Alberta.

**Evergreen-** http://www.evergreen.ca/nativeplants/
Non-profit environmental organization with information regarding restoring and enhancing naturalized areas. Also has a useful native plant database and tips for starting a native plant garden.

**Prairie Urban Garden (PUG)**- http://www.prairieurbangarden.ca/
PUG is an initiative of the Oldman Watershed Council's urban team that has the goal of demonstrating the beauty and benefits of having a xeriscaped garden in Southern Alberta. Website contains resources regarding xeriscaping and native plants.

**Xeriscaping Brochure-** http://www.lethbridge.ca/NR/rdonlyres/0A45A58D-FD3A-4A1E-A0EA-443E360FF7D6/11566/XeriscapeBrochure_CityofLethbridge.pdf
The City of Lethbridge has prepared this informational booklet filled with helpful planning ideas for xeriscaping your lawn. Also provides resources for further research.

## Home Water Use

**Alberta Conservation Team-ACT-** http://www.water-matters.org/topic/water-conservation/household-tips
Water conservation tips for around the house.

**Environment Canada** -http://www.on.ec.gc.ca/reseau/watertips/watertips_e.html
Water use tips and calculator.

**Envirosink**- http://www.envirosink.com/
Saves grey water used within your sink into a storage tank, or a rain barrel for reuse later.

**Go Blue- One minute water calculator** - http://goblue.zerofootprint.net/?language=en

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