WATER REUSE IN ALBERTA:

EXPERIENCES AND IMPACTS ON ECONOMIC GROWTH

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List of Acronyms

ACRWWC	Alberta Capital Region Waste Water Commission
AEDA	Alberta Economic Development Authority
AI-EES	Alberta Innovates-Energy and Environment Solutions
ASR	aquifer storage and recharge
Apportionment Agreement	1969 *Master Agreement on Apportionment*
BNR	biological nutrient removal
BRID	Bow River Irrigation District
BROM	Bow River Operational Model
BRP	Bow River Project
CAPP	Canadian Association of Petroleum Producers
CCME	Canadian Council of Ministers of the Environment
CRP	Calgary Regional Partnership
CSA	Canadian Standards Association
EID	Eastern Irrigation District
EOR	Enhanced Oil Recovery
EPEA	*Environmental Protection & Enhancement Act*
ERCB	Energy Resources Conservation Board
ESRD	Alberta Environment and Sustainable Resources Development
GoA	Government of Alberta
MDP	Municipal Development Plan
OSLI	Oil Sands Leadership Initiative
REDAs	Regional Economic Development Alliances
RMWB	Regional Municipality of Wood Buffalo
SAGD	Steam Assisted Gravity Drainage
SSR	South Saskatchewan Region
SSRB	South Saskatchewan River Basin
USEPA	United States Environmental Protection Area
WID	Western Irrigation District

1.0 EXECUTIVE SUMMARY

As outlined by the Alberta government in the *Water for Life: Alberta's Strategy for Sustainability* (Water for Life Strategy) almost a decade ago, there is a significant need to address our water supply challenges. As we adapt to meet growing demand, Alberta (the Province) has the opportunity to promote growth that is economically, socially and environmentally sustainable. The development of water management and reuse policy, legislation, technologies and practices will allow all sectors, especially high value sectors, the opportunity for continued growth and development.

The political support for water reuse has grown, as evidenced by the documented support of water reuse in provincial and regional water management strategies and policy reports across the Province. However, current legislation in Alberta does not appear to have allowed the practical application of water reuse to match this political will. Interviews conducted for this report suggest that this has been a significant factor in increasing constraints on economic growth. Significant municipal sector and upcoming energy sector growth in some areas of the South Saskatchewan Region (SSR) may increasingly be affected by difficulties in accessing water. It is expected that the oil and gas industry will bring two to three million more people to the Province in the next twenty years, with accommodation requirements for homes, roads, food and water. Implementation of updated water management practices and new technologies, as well as integration of water reuse concepts and regulatory dialogue into current governance and allocation systems, will help the Province deal with the inevitable increase in demand on resources and to maintain a competitive and sustainable economy.

This report is the outcome of work completed under the first phase of a four-phased approach to identify and assess the limitations of current water policy on economic growth. The work conducted under this phase included the following:

- An assessment of short and long term water shortages throughout the Province based on projected future development and sufficient access to water;
- An analysis and review of current water reuse policy and regulations and their possible effects on future economic development if left unchanged;
- An examination of case studies that convey the effects of water shortages and current legislation on economic development; and
- Interviews with municipal and industry leaders to understand perspectives and experiences related to water supply and water reuse as it relates to lost economic opportunities.

This report builds on the 2008 *Sustainable Water Management and Economic Development in Alberta* report conducted on behalf of Alberta Economic Development Authority (AEDA) by Alberta WaterSMART. It also draws from and provides updates to other projects Alberta WaterSMART has undertaken with respect to water supply and water reuse in Alberta. This includes: *Grey Water Recycling and Reuse in Alberta,* 2011; *Water Reuse in Alberta, Overview of Water Reuse: Regulatory Framework and Case Studies,* 2008; the Bow River Project; and the Oil Sands Leadership Initiative (OSLI) Oil Sands Water Valuation and Regional Water Management Initiative projects. All of these reports are publicly available, and all of the projects are ongoing.

To build on the understanding of the current water supply and reuse context and practical impacts of policy and legislation across the Province, primary and secondary research was conducted. As part of the primary research, a review of existing policies and regulations related to water reuse in Alberta, British Columbia, the United States, and Australia was undertaken to understand current barriers and opportunities; and a series of interviews with individuals from the water industry in five land use regions, as defined in Alberta's *Land-use Framework* (LUF) was

undertaken to obtain their perspectives and experiences. Through the interview process, individuals shared perceived challenges and successes with water reuse implementation under the current regulatory system, as well as perceived short and long term impacts of continuing to operate under this system.

Secondary research was conducted in order to provide greater context for the issues discussed by study participants, or to provide information in regions where interview participation was lacking. Based on this work, a number of challenges and opportunities were identified, and are summarized in the following table.

Challenge	Opportunity	Recommendations for Government
Water supply challenges—resulting from increasing water demand, water governance restrictions, and allocation system provisions—are limiting community development and economic growth.	Water reuse practices offer an opportunity to address the water supply challenges in the province.	❑ Support and develop water reuse legislation or regulations that are environmentally, economically and socially sustainable.
Water policy and legislation does not provide a clear definition of water reuse or its sources, thus creating confusion over who has the rights to reused water—the province or the license holder.	Establishing a clear definition for water reuse and identifying water reuse sources would promote more efficient discussions between stakeholders and help them identify who receives the economic benefit of water reuse.	❑ Develop a new regulatory framework that includes clear definitions of water reuse, including but not limited to municipal wastewater, grey water, and industrial water (such as boiler water, cooling water and process affected water).
The current regulatory framework is trailing behind the interest of communities to develop water reuse projects, thus hampering innovative solutions to water challenges.	Although water issues in each region differ, municipal and industry leaders from across Alberta have a great interest in developing water reuse projects if given the ability through legislation.	❑ Develop water reuse policy, regulations and standards as soon as possible.
Alberta appears to be lagging behind other jurisdictions in Canada and around the world in providing a legislative framework to support water reuse.	Legislative frameworks have been developed in British Columbia, the United States and Australia, amongst others, which in turn, can provide guidance for Alberta in updating its regulatory framework.	❑ Undertake a review of existing water reuse regulations in other jurisdictions to inform a new water reuse regulatory framework in Alberta.
Each land use region has unique water challenges and potential reuse opportunities.	Flexibility in regulations to accommodate regional needs will promote more sustainable economic growth across the province.	❑ Develop a new regulatory framework for Alberta that is sufficiently flexible to accommodate regional needs across the Province.
The relationship between water reuse and return flows is not well understood.	Return flow and water reuse are inextricably linked. A better understanding of this relationship can be developed with more modelling and analysis, as well as a review of how other jurisdictions are handling this issue.	❑ Undertake modelling and analysis of return flow in the South Saskatchewan River Basin, and undertake a review of how other jurisdictions manage return flow requirements, to inform the development of water reuse policy, regulations and standards.

Challenge	Opportunity	Recommendations for Government
Legislation has not kept up with advances in water reuse technology.	Water treatment technologies have advanced significantly over the last several decades, providing more opportunities for safe and cost effective reuse.	❑ Consider existing and future technological advancements when developing Alberta's new regulatory framework.
The economic drivers for implementing water reuse are not clear in all cases.	Further investigation into the cost-benefit and cost allocation of the investment in water reuse is required to convince stakeholders of economic viability. Understanding the true value of water will help support this economic case.	❑ Conduct analyses of cost-benefits and cost allocation to clearly identify the economic benefits of water reuse for various stakeholders.
People are concerned about the safety of water reuse systems, potential impacts on their health, and the security of the system.	Parallel government efforts on development of regulations and public education initiatives early in water reuse implementation phases will improve efficiency of adoption.	❑ Initiate the development of public education initiatives on water reuse to enhance the efficiency of water reuse implementation.

The report concludes with next steps based on possible future phases of work.

2.0 INTRODUCTION

"Alberta is facing significant pressures on its water resources. Population growth, droughts and agricultural and industrial development are increasing demand and pressure on the province's water supplies, and the risk to the health and well-being of Albertans, our economy and our aquatic ecosystems. In the past, Alberta has been able to manage our water supply while maintaining a healthy aquatic environment because there has been a relatively abundant, clean supply to meet the needs of communities and the economy. However, fluctuating and unpredictable water supply in recent years has stressed the need to make some major shifts in our approach to managing this renewable, but finite, resource." (*Water for Life: Alberta's Strategy for Sustainability*, November 2003)

As outlined by the Alberta government in the Water for Life Strategy almost a decade ago, there is a significant need to address our water supply challenges. As we adapt to meet growing demand, the Province has the opportunity to promote growth that is economically, socially and environmentally sustainable. The development of innovative water management and reuse policy, legislation, technologies and practices will allow all sectors, especially high value sectors, the opportunity for continued growth and development. These will also contribute to successfully meeting the desired outcomes of Alberta's LUF, which are to sustain:

- A healthy economy supported by our land and natural resources;
- Healthy ecosystems and environment; and,
- People-friendly communities with ample recreational and cultural opportunities.

The Province will accomplish these outcomes by addressing the following challenges:

- Current water supply shortages;
- Increased water demand for single and multi-sector development in water short regions;
- Limited alternative sources due to location;
- Limited alternative disposal options due to location;
- Fully allocated river basins;
- In-stream flow needs for environmental protection; and
- Integration of the water quantity and quality as priority issues.

The opportunity to address these challenges with strategies that incorporate water reuse is the focus of this report.

Work conducted up to December 2011 as part of the Water for Life Strategy is outlined in the 2012 *DRAFT Water for Life Implementation Review Committee, Committee Report*. The review identifies the need for water reuse, as follows:

"The re-use of water, from industrial and/or municipal effluent or from other specific uses, may allow Alberta to address some of its future water demands from sources other than new supplies. By taking an approach of treating water for purpose, it might be possible to provide water supplies for specific needs, as an alternate to treating water to potable conditions and then using that water to meet commercial and industrial needs where a potable standard is not required. Thus water re-use and policies surrounding the practice need to be evaluated."

The political support for water reuse has grown, as evidenced by the documented support of water reuse in provincial and regional water management strategies and policy reports across the Province. However, current legislation in Alberta does not appear to have allowed the practical application of water reuse to match this political will. Interviews conducted for this report suggest that this has been a significant factor of increasing constraints on economic growth. Significant municipal sector and upcoming energy sector growth in some areas of the SSR may increasingly be affected by difficulties in accessing water. It is expected that the oil and gas industry will bring two to three million more people to the Province in the next twenty years, with accommodation requirements for homes, roads, food and water. Implementation of updated water management practices and new technologies, as well as integration of water reuse concepts and regulatory dialogue into current governance and allocation systems, will help the Province deal with the inevitable increase in demand on resources and to maintain a competitive and sustainable economy.

This report is the outcome of work completed under the first phase of a four-phased approach to identify and assess the limitations of current water reuse policy and practices on economic growth. The work conducted under this phase included the following:

- An assessment of short and long term water shortages throughout the Province based on projected future development and sufficient access to water;
- An analysis and review of current water reuse policy and regulatory limitations and their possible effects on future economic development if left unchanged;
- An examination of case studies that convey the effects of water shortages and current legislation on economic development; and,
- Interviews with water industry leaders to understand perspectives and experiences related to water supply and water reuse as it relates to lost economic opportunities.

The remaining phases of the project include the following:

- **Phase 2: Develop Alternative Options**
    - Explore possible solutions on a local, national and global level;
    - Examine national and global solutions being implemented throughout the world; and,
    - Develop a set of options, addressing the economic impact of each option.

- **Phase 3: Collaboration**
    - Work with AEDA to evaluate and select the most attractive option; and,
    - Work in collaboration with AEDA and potential other project partners to select the ideal opportunities for implementation.

- **Phase 4: Implementation**
    - Identify 2-3 collaboration opportunities to illustrate the effectiveness of water reuse in municipal and industrial development; and,
    - Approach possible partners to address opportunities for a pilot project.

Previous to this work, the most recent water management related study conducted under the direction of the Alberta Economic Development Authority (AEDA) was the 2008 report *Sustainable Water Management and Economic Development in Alberta*, by Alberta WaterSMART. This report provided numerous recommendations

with respect to provincial water management and economic development within each of the seven land use regions in the Province. Among them was the need to explore water reuse as a water management strategy throughout the Province, specifically in the South Saskatchewan, North Saskatchewan, and Lower Athabasca regions.

This report builds on the above work, and other projects that Alberta WaterSMART has undertaken with respect to water supply and water reuse in Alberta. This includes *Grey Water Recycling and Reuse in Alberta,* 2011; *Water Reuse in Alberta, Overview of Water Reuse: Regulatory Framework and Case Studies,* 2008; the Bow River Project; and the Oil Sands Leadership Initiative (OSLI) Oil Sands Water Valuation and Regional Water Management Initiative projects. All of these reports are publicly available, and all of the projects are ongoing.

To understand the current water supply and reuse context and practical impacts of policy and legislation across the Province, experts in the field of water management in five land use regions were contacted to obtain their perspectives and experiences. They shared perceived challenges and successes with water reuse implementation under the current regulatory system, as well as perceived short and long term impacts of continuing to operate under this system. The bulk of the report provides a summary of these perspectives, success stories, and challenges by land use region. Specific examples of the economic losses that may be experienced without effective implementation of water reuse strategies at the local and regional scale are provided.

The report provides a brief description of how water supply and reuse impacts economic development, and a regional context of water supply and use throughout the Province. It briefly describes the existing allocation system, outlines recent work conducted to inform changes to the system, and provides an update on water reuse policy and legislation in Alberta and other jurisdictions. The report then moves to describe the water supply and reuse experience in five of the land use regions based on Alberta's LUF. Background information on the water supply situation in each region is provided, including the perspectives and experiences shared by individuals, and examples of how water reuse is currently impacting economic development. Based on the above work, a number of key challenges and opportunities are summarized at the end of the report.

2.1 Defining Water Reuse

Discussions on water reuse policy and technology are happening within and across all water use sectors, including agriculture, municipal and commercial, industrial, energy, recreation and environment. A working definition of water reuse will help to foster these discussions and provide transparency across sectors as the government seeks to develop water reuse policy that addresses challenges and opportunities in all sectors.

There are varying opinions on how water reuse should be defined. One's perspective is shaped by their experience of the key drivers for reusing water. In order to provide a context that applies to all sectors, the proposed definition of reused water in the context of this report is as follows:

> *"Water that has been altered from its original state through municipal, industrial, or agricultural use and subsequently used for the original purpose or a new purpose with or without treatment"*

The terms "water reuse" and "water recycling" are often interchangeable within the energy industry. The energy sector is required to report water reused within their process as a percentage of water recycled. Water recycling is encompassed in this definition of reuse.

One could separate this definition into two different water reuse functions: reuse of water to provide greater efficiencies; or, reuse of water to support another purpose. The first function describes water reuse in the context of efficiency opportunities, or reusing water to increase the cumulative positive impact of a water supply. By using

a lower quality of water where safely feasible, fewer resources are required to manage the inputs and outputs of the system. The energy consumed and waste generated from supplying, treating, and disposing of water is considered in the decision to reuse a specific source of water. The basis of this analysis is similar to the "water-energy nexus" discussed in the international community; the less water used, the less energy required, which leads to further reductions in water requirements. It is typical of the oil and gas industry, where regulations require a review of the cumulative environmental impacts of different options to ensure the option with the lowest total environmental impact is chosen. This may also provide a direct economic benefit; fewer inputs or resources and waste means less cost.

Furthermore, the reuse of water in a process may represent a greater net benefit or efficiency compared to finding and making an alternate source of water available. The emergence of eco-industrial parks in the North Saskatchewan Region represents the growing support of this concept. Lower quality water may have substances that represent beneficial inputs to certain systems. Reusing this water replaces the processes of removing these substances and then putting them back into the water before use. The best example of this is water reuse for irrigation purposes, where wastewater effluent has nutrients that would otherwise be added to the system in another form.

The second function describes water reuse in the context of a constrained system; reusing water to meet the needs and demands of another purpose. Water removed from the natural system may be used beneficially to meet demands that would otherwise not be met. A lack of supply may be the result of typical river sources reaching environmental limits of water withdrawals, unbalanced use of licensed volumes compared to associated development, or the proximity of demand to water supply sources. These demands might come from the residential, industrial, energy, or environmental sectors.

These functions of water reuse are integrated. The use of water for another purpose can result in increased reuse efficiencies. Both functions create a situation where more water remains in its natural state. The quality and quantity of the water that remains in the river are critical factors in the health of the river. This is the challenge of water reuse in a land-locked system.

Beyond the definition, policies and regulations are tools to clearly convey different levels of standards for different water sources and applications. These are discussed further in the report. However, the division of these functions into the potential sources of water, the sector reusing the water, or the reuse applications is very valuable and makes the applicability of the definition of reuse to each sector more transparent. The sources of water used in reuse applications are outlined in Table 1.

Table 1: Potential sources of water for reuse applications.

Water Reuse Source	Definition
Municipal Wastewater	Wastewater collected at a central facility for treatment to quality levels required by Alberta Environment and Sustainable Resources (ESRD) for release back to the environment.
Greywater	Untreated water from kitchen sinks, bathrooms and laundry drains, NOT including sewage.
Industrial Wastewater	Water which comes into contact with any raw material, product produced from the raw material, or by-product, including waste, from processing the raw material. This source also includes other effluents from water use within industrial facilities (e.g. cooling water, boiler blowdown).

The discussion of stormwater in the context of water reuse is controversial. At the local level, rainwater is often collected, stored and used for irrigation around the home. There are several facilities that harvest rainwater for toilet flushing and other non-contacting uses, including irrigation, such as the Calgary Water Centre and the Telus Spark building. As noted further in the report, Alberta has passed the 2010 *Alberta Guidelines for Rainwater Harvesting*. However, this guideline only covers rainwater collected on roofs. Officials in Alberta Municipal Affairs are very clear that once the rain water hits the ground and is collected in a storage pond or is carried to the river, that stormwater is owned by the Crown and is managed under the existing licenses. Stormwater is not 'reused' and therefore is not within the scope of this project work. That said, there is a lack of detailed knowledge on the interaction between different source water (including stormwater), water use applications, the amount of water returned to the river (return flow), and the resulting impact on the natural river systems. It is vital that these various types of water be clearly defined as some current license holders are not separating stormwater management and water reuse in their water management plans.

The same concept applies for produced water from traditional oil and gas activities. Produced water flowing from a well drilled to recover oil or gas has not been used for a purpose prior to the requirement of management of this water under provincial regulation. Therefore, it does not fall into the proposed definition of water reuse and is not considered further in this report.

In contrast, water used in Enhanced Oil Recovery (EOR), including for example water injected for water floods or water injected in the form of steam as in Steam Assisted Gravity Drainage (SAGD), which flows back to the surface, offers an opportunity for reuse. Water reuse in SAGD is subject to regulation and is already widely practiced. Likewise, some portion of the hydraulic fracture fluids prepared on the surface and injected into shale or tight rock formations returns to the surface, and is referred to as flowback, offering a reuse opportunity. These oil and gas streams fall into the category of Industrial Wastewater.

The sectors in which water is reused are outlined in the table below. Within these sectors, the types of applications are numerous, and include but are not limited to the descriptions in Table 2.

It is within the context of the above definitions that water reuse is discussed throughout this report.

Table 2: Water reuse defined by application.

Sector	Application
Agriculture	Irrigation
Municipal and Commercial	Landscape irrigation, domestic use, fire protection, road cleaning
Industrial	Cooling water, process water, dust control, concrete mixing, soil compaction, domestic use
Energy	Injection for extraction, process water, boiler make-up water, domestic use
Recreation	Surface water augmentation, recreational and aesthetic features
Environment	Wetland management, surface water augmentation

3.0 METHODOLOGY AND PRELIMINARY FINDINGS FROM INTERVIEWS

Two lines of research were adopted for this study: primary research through a review of existing policies and regulations, and gathering local and regional perspectives; and secondary research through a gathering of existing research on the state of water in the Province. This section summarizes the methodology used to develop observations and challenges, and preliminary research findings from the gathering perspectives of local and regional perspectives.

3.1 Primary Research

Between July 2012 and October 2012, Alberta WaterSMART reviewed legislation, regulations and policy directions in Alberta. Research was also undertaken to understand how other jurisdictions in Canada and abroad have dealt with legislation and policy as it relates to water reuse to identify pertinent policies and legislation that may provide learning opportunities for the Province. This research built on detailed research that was done in 2008 by Alberta WaterSMART, and presented in *Water Reuse in Alberta, Overview of Water Reuse: Regulatory Framework and Case Studies*.

The second component of the primary research was the gathering of local and regional perspectives. Alberta WaterSMART sought perspectives from leaders in the water industry from each land use region in Alberta, with varying backgrounds and experiences. These perspectives provided an understanding of the water issues affecting different economic sectors in different areas of the Province. Participants were chosen based on their specific expertise related to water supply and demand management, and their ability to provide valuable and representative perspectives of their industry and land use region to inform the desired outcomes of this project.

To ensure a bias was not introduced, Alberta WaterSMART developed an interview backgrounder and interview guide. The documents were provided to all study participants prior to the interviews and contained broad, open-ended questions to provide them the opportunity to share whatever perspectives they felt most relevant and important. A separate set of questions was developed for individuals representing municipalities, industry, Alberta Innovates – Energy and Environment Solutions (AI-EES) and ESRD. These documents are provided in Appendix A.

The interview guide was developed to provide a more rigorous investigation. Due to variations in knowledge and experience of participants, not all individuals answered all of the questions, and follow up questions were often required in order to improve the understanding about attitudes, feelings and beliefs.

Potential study participants were contacted by telephone and/or e-mail and an in-person or telephone interview was requested. Approximately 25 percent of the interviews completed were in person while 75 percent of the interviews were completed by telephone. The interview process started in September, 2012 and ended early October, 2012.

3.2 Secondary Research

Alberta WaterSMART undertook secondary research on existing water supply and demand research, and impacts of water on the economy. In some cases, information on specific initiatives or statistics brought up by interviewees was researched in order to provide a more complete analysis for the report. Therefore, this research is integrated into various sections of the report.

3.3 Summary of Participant Interviews

The number and sector representation of study participants is outlined in Table 3 below. One individual representing the municipal sector in the SSR also represented an economic alliance in the same region. The individual is therefore counted as both a municipal sector and an economic alliance representative. The role of economic alliances is described in the following section of the report. One individual from the energy sector provided perspective based on experience and understanding of situations in the South Saskatchewan and North Saskatchewan regions. These considerations are denoted in Table 3 below. In addition, one individual from ESRD and one individual from AI-EES were interviewed. Thus, a total of 15 individuals were interviewed.

Given the commitment made to study participants that they would not be identifiable in the report, responses have been recorded without attribution.

Table 3: Summary of study participant interviews

Region	Study Participant Sector Representation			
	Municipal	**Residential Developer**	**Economic Alliance**	**Energy and Industry**
South Saskatchewan	5[1]	1	2[1]	1[2]
North Saskatchewan	1	0	0	1
Red Deer Region	0	0	0	0
Lower Athabasca	1	0	0	1
Upper Peace	2	0	0	0
Upper Athabasca	0	0	0	0
Lower Peace	0	0	0	0
Totals	9	1	2	3

Qualitative and quantitative data is provided in Table 4. However, due to the limited number of interview participants, and the nature of experience held by participants, findings from this study cannot be considered statistically representative of larger constituencies. In addition, in the cases where the number of opinions in the Table does not represent 100 percent of participant opinions, it should be inferred that participants did not provide their perspective, instead of assuming they did not have a perspective on the issue.

Table 4: Summary of study participants' perspectives

Interview Question	Study Participant Perspective
Do you anticipate residential, industrial and/or commercial development in the future? If yes, please describe.	• All municipal sector representatives indicated they anticipate development either in the short or long term.

[1] One individual representing the municipal sector also represented an economic alliance in the SSR. The individual is counted as a representative from both sectors. One individual represented the Calgary Regional Partnership (CRP).
[2] One individual from industry represented perspectives from both the South Saskatchewan and the North Saskatchewan regions and as such, is counted under both sectors.

Interview Question	Study Participant Perspective
How do you think this anticipated development might impact (negatively or positively) your water situation? Do you think future development will be influenced by water supply? If yes, how?	• 3 of 5 municipal representatives from the SSR said water supply has already been impacted, or will impact development in the near future. • 1 of 2 industry representatives indicated that water supply may impact future development of oil and gas in the SSR, and has the potential to create tension between sectors for access to water. • 1 of 1 residential developer from the SSR indicated that water supply has already restricted growth of their planned development. • 1 of 1 municipal representative from the Upper Peace Region indicated that water supply may impact future residential development. • 2 of 2 economic alliance representatives indicated that the perception of difficulty to access water is more likely to impact future development instead of an actual difficulty to access water. Note the individuals represented the same economic alliance. • 1 of 1 municipal representative from North Saskatchewan indicated that future development is not influenced by water supply. • 1 of 1 industry representative from North Saskatchewan indicated that future development is not influenced by water supply. • 6 of 12 study participants thought water supply would influence development in the future.
Have you undertaken a formal water needs assessment? If yes, is this assessment available to the public? Do you have a water management strategy in place? If yes, is this strategy available to the public? Do you have structures and processes in place to operationalize your strategy? If yes, what are they?	4 of 5 municipal sector representatives indicated a water needs assessment has been completed. 2 of 2 industry representatives from the North Saskatchewan region indicated their company had a long term water strategy, which included reuse strategies.
How would you define water reuse?	Of the 15 interviewed, 6 answered this question. Responses included: • It is about building strategies for using reclaimed water, whether this is stormwater, effluent or greywater. It is about matching water quality to water use. • Reuse has a number of different meanings and all are related to context. • Creating as many uses as possible from the water being mindful that we need to return as much water to the river system as possible so we can maintain the long term health of the river system. • Division into three categories – industrial (governed by industry standards not *Safety Codes Act*), agriculture and municipal reuse. • The primary problem is there is no shared understanding of this term. There is no shared understanding within the GoA and the public. There is a need to distinguish between upstream (i.e. private ownership) and downstream (i.e. municipal ownership). • When a wastewater can be reused without treatment and can be used to offset supply of new water. An avoidance of the introduction of foreign substances into the river and removing water from its natural state.

Interview Question	Study Participant Perspective
What is your current experience with water reuse? Are you currently reusing water? If yes, in what ways? What has been your experience in implementing a reuse initiative?	• 12 of 14 participants indicated that they were aware that water reuse projects had been undertaken in their region. • 4 of 5 municipal sector representatives indicated there are existing examples of wastewater effluent reuse for agricultural irrigation. • 6 of 9 municipal sector representatives indicated that legislation was a hindrance to the implementation of water reuse. • 1 of 1 developer indicated an inconsistency within ESRD in terms of support for reuse initiatives. • 1 of 9 municipal sector representatives indicated they are reusing treated wastewater for golf course irrigation. • 1 of 9 municipal sector representatives indicated they are reusing treated wastewater for sports field irrigation. • 1 of 9 municipal sector representatives indicated they are harvesting rain for use in toilets. • 1 of 9 municipal sector representatives indicated they are using stormwater for drip irrigation in residential developments and street sweeping. • 2 of 9 municipal sector representatives are providing wastewater effluent for oil and gas activities. • 2 of 9 municipal sector representatives indicated they know of municipalities providing wastewater effluent for oil and gas activities. • 2 of 9 municipal sector representatives indicated wastewater effluent is used for industrial purposes.
Are there water reuse opportunities you are planning to explore? If yes, what are they? What benefits would these opportunities provide? Do you envision there will be challenges in implementing these reuse opportunities? If yes, what are they?	• At least 2 of 5 municipalities with long term water management plans have water reuse as an integral part of their water management strategy. • 3 of 9 municipalities indicated they are in the early stages of providing wastewater effluent to residential developments for domestic purposes. 2 of these 3 indicated they have verbal government support. They indicated that current legislation is the key challenge. • 1 of 9 indicated they would like to undertake aquifer storage and recharge. The major challenge is current legislation. • 1 of 9 municipal representatives indicated they know of irrigation projects in the works. No challenges provided. • 3 of 9 municipal representatives or municipal development plans (MDP) indicate the use of wastewater effluent for the industrial and/or oil and gas sector. • 1 of 1 industry representative indicated a challenge of understanding water quality chemistry and technology capability, and adapting water reuse technologies used in other industries to the oil and gas sector. • 1 of 1 industry representative indicated that for regional solutions to be effective there are multiple decision criteria that need to be visited. Transparency about the issues and the challenges between multiple stakeholders will promote effective process and implementation. 1 of 9 municipal representatives indicated managing risk and legal aspects was another major challenge. • 2 of 9 municipal representatives indicated security of water supply for end uses is a challenge.

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Interview Question	Study Participant Perspective
	• 1 of 2 industry representatives indicated security of water supply for end uses is a challenge. • 3 of 15 interviewees indicated that a major challenge for water reuse is the economic viability of going back and retrofitting existing infrastructure to accommodate or support reuse. • 4 of 9 indicated there could be infrastructure cost savings in implementing more water reuse projects, or being "reuse ready". • 2 of 9 indicated that water reuse is currently not economic and only when price of potable water or other alternative increases will it become economic. • 2 of 9 municipal representatives identified utilizing return flow as a major potential opportunity in terms of water supply, which is limited by the current licensing system. • 1 of 9 municipal representatives identified that water users have a moral obligation to return flow to the river. • 2 of 2 industry representatives think it is better to reuse return flows if water is of lower quality than river water. • 1 interviewee that does not represent a specific sector identified return flows as a topic of confusion amongst different sectors.

Interviewee perspectives are summarized below.

- There is no consistent definition or understanding of what water reuse is across the Province.
- Water reuse is currently being practiced in most regions around the Province. There is significant wastewater effluent reuse in the North Saskatchewan and Lower Athabasca regions for industrial and energy sector development. There is significant use of wastewater effluent for irrigation in the SSR.
- There is limited access to water in the SSR. This is currently influencing development and is expected to influence development to a greater degree in the future.
- Access to water in the northern areas of the Province is perceived as less of an issue than southern areas of the Province.
- All municipal sector representatives indicated they anticipate development either in the short or long term.
    - 62.5 percent of individuals interviewed in the South Saskatchewan Region thought water supply would influence development in the future.
    - 50 percent of individuals across the Province who answered the relevant question thought water supply would influence development in the future.
- Municipalities are aware of the long term needs for water supply.
    - 80 percent of municipalities indicated they have a long term water management plan.
    - Two of five municipalities with long term water management plans have water reuse as an integral part of their water management strategy.
- The existing legislation framework was deemed the greatest barrier to the implementation of water reuse projects.
- There are varied perceptions on the cost benefits of water reuse projects. While some believe that water reuse is currently not economical, some believe that planning for water reuse now is economically beneficial.

- There are varied and competing perceptions of the role of return flow in water management for accessing water supply and maintaining healthy ecosystems.

These perspectives suggest some key challenges and opportunities for the Province with respect to implementing water reuse for economic development. The experiences within each region with respect to the above mentioned issues are discussed in more detail further in the report. A summary of the key challenges and opportunities is provided at the end of the report.

4.0 OVERVIEW OF WATER IN ALBERTA

4.1 The Connection between Water and the Economy

The Government of Alberta's task force on Sustainable Communities identified access to adequate supplies of clean water as the most significant economic development concern in 54 of the Province's rural communities (Alberta WaterSMART, 2008b). However, water quality and quantity issues impact more than the rural communities within the Province. They are affecting economic development in major urban centers in the SSR where the majority of residential growth is expected; to a lesser degree in the Industrial Heartland in the North Saskatchewan Region where significant industrial development is planned over the next few decades; and the Lower Athabasca Region, where water for the oil and gas industry must meet environment requirements of a "social license to operate", and be balanced to support diversification of their economy through growing residential and commercial development.

The CRP is one of the 11 Regional Economic Development Alliances (REDAs) in the Province. These alliances were formed, developed and are supported by the Provincial Regional Alliance Strategy Initiative to enable regions to compete more effectively in a global marketplace and attract more global investment, resulting in greater prosperity locally, regionally, and provincially (Alberta Government, Regional Economic Development Alliances, accessed September 18th, 2012). The CRP includes 14 member municipalities and communities in the SSR, including the City of Calgary (Calgary). The CRP indicated through their Regional Water and Wastewater Servicing Committee that there is a need for a more secure, reliable, long term water supply to enable growth and development for partner municipalities. The CRP plans to address these issues by increasing shared regional infrastructure systems. Current, the CRP strategy does not include specific actions related to water reuse.

Based on conversations with the SouthGrow economic alliance in the South Saskatchewan Region, they have recently finalized their "Water for Economic Development Project," which concluded there is sufficient water in the region for economic growth until 2050 if there is continued cross-sector cooperation and a willingness to use best practices and technologies. This conclusion was based on a regional commitment to protect the environmental needs of the basin. Due to the confidential nature of the above report, it was not possible to provide a full analysis of the project findings herein. The twenty-two SouthGrow communities are presently engaged in a major water reuse study, which will provide more clarity on the opportunities of water reuse in this region.

There is limited documentation by the remaining nine economic alliances throughout the Province that water supply is a threat to development. This may be due to the focus of each alliance on products and service business related aspects of economic development, a lack of understanding of water supply issues in their regions, or the lack of a perceived connection of water supply to the economic development efforts of these government supported alliances.

Water valuation is a growing interest for government and policy decision makers. The Canadian Council of Ministers of the Environment (CCME) released a document on water valuation in order to help with water management decision making processes (CCME, 2010). It provides an economic context for discussing water supply and its alternative uses.

In determining the economic benefits of any new policy initiatives related to water and specifically water reuse, it is helpful to think of the marginal value of using water for competing uses. This can be defined as the additional economic value that is generated by the last unit of water for a particular use, in terms of both quantity and

quality; it is typically driven by relative scarcity. Thus, the marginal value of using water depends on the economic sectors, populations, and seasonal differences in any particular region (CCME, 2010).

The opportunity cost of using water for a specific market good or service is a similar economic assessment. Comparing the value of the next best alternative use of certain water sources, the most economically efficient use will generate the highest value. However in most analyses of water, this value is ultimately related to social benefit, generally the health of the ecosystem. However, due to a lack of understanding of the economic value of water, this can be difficult to identify. This has led to the pricing of publicly supplied water that does not reflect the total economic value of water; pricing typically does not fully consider costs related to supply and maintenance of infrastructure, or the social and environmental impacts of removing water from certain sources. In terms of water reuse, this has been seen as a major barrier for the implementation of water reuse programs; in order for a project to move forward, there must be a cost-benefit based on present value of benefits versus present value of costs (CCME, 2010). This topic is discussed further in the report.

At the regional scale of economic impacts, water reuse is linked to a strong economy as a means to support growth; by extending current and future water supplies. In California, the Public Policy Institute of California indicates in their 2012 report *Water and the California Economy* that although water is a scarce resource with numerous competing uses, the economy has sustained itself. It credits this resilience to water management innovations including the following:

- Water use efficiency;
- Water markets;
- Underground storage; and
- Reuse of highly treated wastewater.

In addition, the overall reliance on water intensive activities for economic growth has been reduced. Eighty-five percent of water use for business and domestic purposes is for agricultural and related manufacturing; however, this makes up just 2 percent of GDP and 4 percent of all jobs.

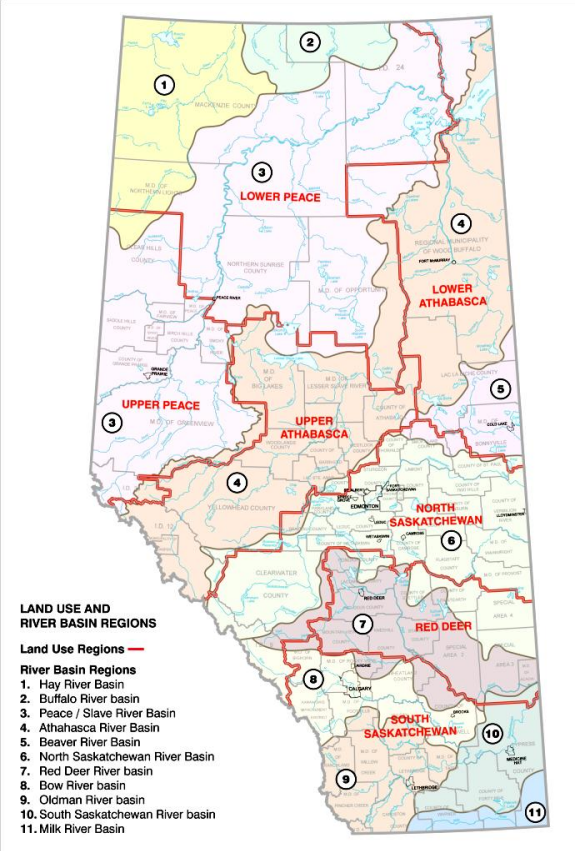
A study conducted by Martz et al. (2007) identified the South Saskatchewan River Basin (SSRB) as a significant contributor to the economy of Alberta. In 1996, approximately 47 percent of Albertans lived in the SSRB and generated approximately 40 percent of provincial economic activity. Approximately 58 percent of the GDP for the Province the same year came from the SSRB (AMEC, 2009). This is a noteworthy statistic, considering this is the region experiencing restrictions of growth due to difficulties accessing water.

A more detailed analysis may consider the economic impact of restricting water supply to each sector. In California, some indicate this is due to the priority of water supply provisions during drought periods, in order to protect the economy from job losses. During drought conditions, urban conservation programs that institute water rationing are imposed on residential users (Public Policy Institute of California). This circumstance would create similar reactions in Alberta. Although the first-in-time, first-in-right system allows senior license holders the first right to water during drought conditions, the 13 irrigation districts in the Province, who make up a majority of senior license holders, have recently signed a declaration that indicates that within their rights to control, they will *"participate in water sharing by temporary assignments with other license holders with lower priority… so that sufficient water can be distributed for human needs and livestock sustenance"* (Canadian Wire, 2011). While water sharing agreements such as this one may play a role in avoiding negative economic impacts in the short term, as development of competing sectors in some regions grows, it will become more difficult to provide continued support to the municipal and commercial sector while ensuring minimal economic losses from other sectors.

Although conveyance and storage management systems exist in Alberta to control flows and optimize river water levels, the risk of long term drought will remain. Added to that is the uncertainty of how long seasonal storage in snowpack and mountain glaciers can be relied on for water supply, as well as long term climate variations in precipitation. Implementing flow optimization schemes and using new potential storage facilities should be coupled with additional strategies to further reduce the potential for business and industry to be negatively affected during long term droughts. The Bow River Project is an example of how this can be accomplished.

4.2 The Current State of Water in Alberta

Figure 1: Alberta land use regions (Alberta WaterSMART, 2008a)



Water availability is emerging as one of Alberta's primary resource issues and each region has unique challenges. Approximately 80 percent of the water supply in this Province is located in the north, while approximately 80 percent of water demand is in the south (Alberta WaterSMART, 2008a). Water supply and demand is the major challenge in the south, and water management of highly variable flows is the main challenge in the north. In the northern areas of the Province, where greater industrial and energy sector development has occurred, water quality has been the major focus.

The major consumptive water uses in Alberta are irrigation and agriculture. Municipalities, industrial cooling and hydropower production are also significant users, but have lower degrees of consumptive use. In addition to the differences of water distribution across the Province, the predominant use of water varies significantly.

Water use for agriculture predominates in the south, while water use for industrial and energy production predominates in the northeast, and water use for forestry operations and habitat management predominates in the northwest.

The main challenges for each land use region are outlined in the 2008 *Sustainable Water Management and Economic Development in Alberta* report.

The major challenges for water supply to meet proposed future development needs are in the SSR. *The South Saskatchewan Regional Plan*, an output of Alberta's LUF, noted that water will likely be the limiting factor on the future population and economic growth in southern Alberta. Since approval of the *South Saskatchewan Regional Water Management Plan* in 2006, the Bow, Oldman and South Saskatchewan River sub-basins within the South Saskatchewan Basin have been closed to new licenses. This has restricted residential development and growth in a number of areas in the south eastern part of the Province. The Red Deer River sub-basin will also consider closing the river to new licenses, pending a review of the maximum allocation limit that will occur when allocations reach 550 million cubic meters.

Compared to the South Saskatchewan and Red Deer Regions, in the Lower Athabasca Region a significantly less percentage of river flows are withdrawn from the river system. However, due to the nature of oil and gas activities in this region, a significant percentage of water that is withdrawn from the river is not returned. The *Athabasca River Water Management Framework* has been developed to ensure the river system remains protected. It has set maximum amounts of water that oil and gas companies can withdraw from the river during specific flow conditions.

In 2005 existing surface and ground water allocations across the Province allowed for the diversion of up to 9.6 billion cubic meters annually. Approximately 62 percent or about 6.0 billion cubic meters of allocated water was licensed for use, while the remaining 38 percent was assumed to remain in the rivers. It was estimated that 3.3 billion cubic meters, or 55 percent of these allocations was consumed. In the absence of any significant policy or conservation measures, water consumption was forecasted to grow by about 23 percent, to 4.0 billion cubic meters by 2020. With some select water policy and conservation measures, the increase in water consumption could be reduced to half this growth level, increasing to 3.6 billion cubic meters by 2020 (Alberta WaterSMART, 2008a).

Although new water use data is limited, recent statistics provided by ESRD indicate that water allocations in Alberta have grown by seven percent since 2000, surpassing 9.9 billion cubic meters in 2010. However, during this period the rate of growth has decreased slightly compared to the rate over the past 30 years. Figure 1 shows the difference between allocations in 2005 compared to 2010 in the major river basins across the Province compared to average natural flow in the river systems. Based on the major river basins maps in this Figure, allocations in the South Saskatchewan Basin rose about ten percent. Since the 2008 report, ESRD reports that allocations in the SSR have increased from 56 percent to 72 percent of natural flows within the basin. According to ESRD, allocations in the North Saskatchewan basin have dropped from 38 percent to 28 percent since 2008 (Alberta Environment, 2012). The water needs of each region and how water reuse may affect each region are described in the subsequent section of this report.

The existing state of water in each of the land use regions throughout the Province was outlined in the 2008 *Sustainable Water Management and Economic Development in Alberta* report by Alberta WaterSMART, and is summarized in Table 5. The summary outlines the allocation, licenses, use and return flow in each region. More detailed information for each is provided throughout the report in the respective regional discussions.

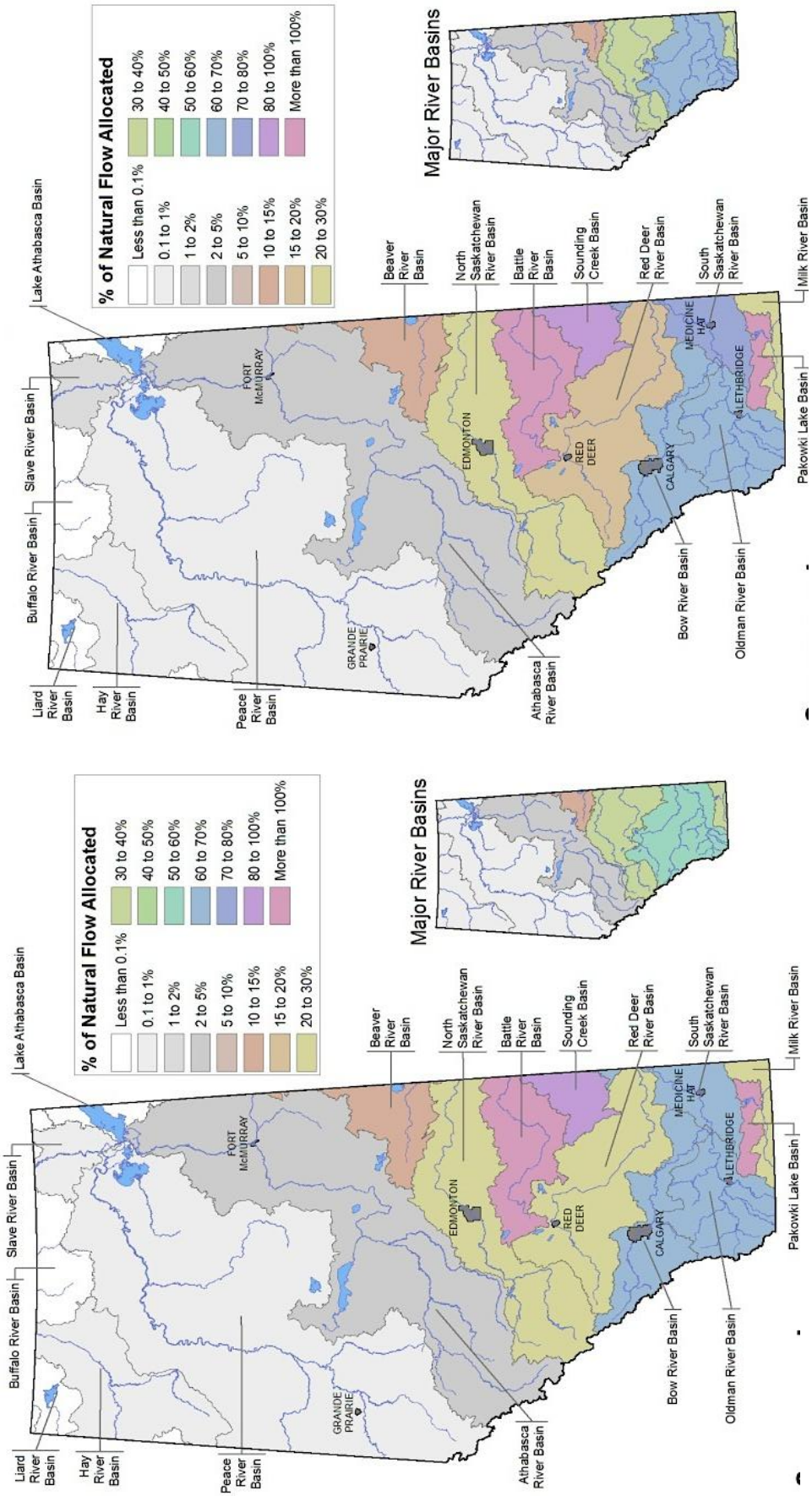


Figure 2: License allocations in 2005 (left) and 2010 (right) by river basin compared to average natural flow (ESRD, 2012)

Table 5: Summary of 2005 water allocation, licenses, use and return flow

Land Use Region	Major Land / Water Use	Annual River Flows[3]						
		Natural[4]	Protected	Allocated	Licensed Use (% Allocation)	Estimated Use (2005) (% Allocation)	Forecast Increased Use[5] (2020) (% Allocation)	Return Flow (% Allocation)
South Saskatchewan	Irrigation, Municipal, Commercial, Industrial	9.40	3.55	5.235	83	46	52	17
Red Deer	Private Irrigators, Municipal	1.85	N/A	0.372	72	62	66	28
North Saskatchewan	Industrial Cooling, Municipal	7.55	3.78	2.808	18	10	14	82
Upper Peace and Upper Athabasca	Municipal, Forestry, First Nations	66.0	N/A	0.573	59	38	57	41
Lower Athabasca	Oil and Gas, Mining	20.0	N/A	0.551	86	23	65	14
Lower Peace	Municipal, Forestry, First Nations	70.0	N/A	0.023	66	39	43	34

4.3 Water Allocations and Licensing

The 2008 *Sustainable Water Management and Economic Development in Alberta* report, Alberta WaterSMART provides a thorough background for the current approval, allocation and licensing system. The reader is referred to this document for an understanding of the basic concepts and current requirements of the system.

Alberta's Water for Life Strategy sets out three key goals and directions. One of the three key goals is to provide reliable, quality water supplies for a sustainable economy. Under this goal, a key action from the *2009 Water for Life Action Plan*, and the *2008-2011 Water for Life Progress Report* is to develop and implement a viable governance system that supports sustainable management of water, including development and implementation of an enhanced water rights transfer system by 2015. An additional action is to assess future water supply demands and management options at the watershed level. Options proposed include conservation, storage and water allocation transfers.

Improvements to the water allocation transfer system could create a significant impact on regional water conservation by promoting current license holders to save water to sell to prospective developers. Water reuse plays a role in the ability for license holders to reduce continuous raw water inputs into their operation or development.

The government has taken steps towards the development and implementation of an enhanced water rights transfer system. Specifically, four related reports on water allocations and licensing issues were developed by the Minister's Advisory Group, Alberta Water Council, the Alberta Water Research Institute, now Alberta Innovates – Energy and Environmental Solutions, and Water Matters and Ecojustice. A review of these reports is provided in Appendix B. ESRD has used this work to consider policy changes, with plans to undertake stakeholder and public engagement on the issue.

The Province has taken steps towards assessing water supply demands and management options. In the north, the *Athabasca River Water Management Framework* has been developed, which sets limits on how much water oil sand companies may remove from the Athabasca River. The Regional Advisory Council for the *Lower Athabasca Regional Plan* is currently developing recommendations on how to fit the framework into a regional plan.

Water allocation transfers may occur provided the Lieutenant Governor in Council authorizes an associated Water Management Plan; such a Plan is only in place in the SSRB. This market for the trading and transfer of water allocations is still in its infancy and has not changed significantly since its inception in 2006. ESRD oversees and approves every transfer application. However, the terms, conditions and process for approval remain uncertain, and can be cumbersome, lengthy and expensive. For example, the Province can request an applicant to withhold up to 10 percent of an allocation of water being transferred (for conservation purposes), and hold open public hearings, which can lead to ESRD requiring an applicant to submit significant amounts of detailed information during an application process. Considerable discretion is available to ESRD in their decision-making process.

4.3.1 Return Flows

Another issue that must be addressed as part of the allocation and licensing system is return flow requirements on existing and new licenses. The return flow allowance is important because water that is returned to the river represents water that has been assumed available for use by other licensees in this over-allocated basin. Return flows from different licenses holders will change with the emergence of water reuse initiatives; both quality and quantity will be impacted. The amount of water returned to the river after it is reused depends significantly on how the water is reused (Alberta WaterSMART, 2008a).

Return flows are being taken into consideration by ESRD when assessing of water availability for additional licensing, and were specifically taken into account when developing the SSRB Water Management Plan. However, the return flow allowances are often not enforceable. This represents a significant policy challenge: balancing the desire for increased conservation and reuse with the need to maintain flow levels in the river for downstream users and a healthy aquatic ecosystem (Alberta WaterSMART, 2008a). The government has initiated an effort to re-issue existing and expiring licenses with increased return flow requirements in some areas of the Province.

The language in the 1999 *Water Act* (the Act) as amended is quite clear: "The property in and the right to the diversion and use of all water in the Province is vested in Her Majesty in right of Alberta except as provided for in the Regulations." The Act is administered by ESRD and the Minister of ESRD is accountable for the Act. Under the Act, a Director is appointed who is responsible for administering the Act and Regulations. The Director has discretionary powers that are quite broad in interpreting the Act and Regulations.

Water is defined as 'fresh' if the water contains less than 4000 parts per million of total dissolved solids. All surface water in a river, stream or lake must be licensed for use; groundwater that is considered fresh must also be licensed. In the Act, 'Use' includes but is not limited to use for the purposes of drainage, flood control, erosion control and channel realignment.

Water is licensed to a License Holder for a specific use and a maximum withdrawal volume. In all basins except the South Saskatchewan, a potential user can apply to the Director for a license. The Director has discretion to grant or deny the request, but operates to a set of Guidelines that have been developed over the years to ensure that the licensed use and volumes do not compromise the basin, as outlined in the Act and Regulations. No transfers of licenses are allowed in a basin that does not have a Water Management Plan. Currently the only basin that has such a plan is the South Saskatchewan.

Starting in the mid-1990's, water licenses were issued with a requirement for a review after a certain period of time, usually around ten years. Over the last several years, it became common for licenses to be granted with provisions for 'return flow', that is, a specific amount of water is to be returned to the water body once the licensed use is completed. As the licenses with terms come up for renewal, in many cases ESRD considers including a new provision mandating a certain return flow. This is of particular interest in the South Saskatchewan basin, where the allocation of the basin through existing licenses exceeds what most environmental practitioners would consider a minimum base flow to ensure a healthy aquatic ecosystem. Since the South Saskatchewan Basin is closed to new licenses, mandating a level of return flow provides some comfort to the Director that sufficient water will remain in the river basin to support the licenses that have been issued.

As a general rule, the more senior licenses do not have a provision for renewal and do not have a requirement to return flow to the watercourse. Examples of these license holders are the irrigation districts and the more senior licenses of the major cities, particularly Calgary and the City of Edmonton (Edmonton). The more junior licenses almost always have provisions for renewal and return flow. Examples of these license holders are new developments in Rocky View County and the Town of Okotoks (Okotoks). These situations are all featured as case studies in the report.

The requirement to return a certain volume of water back to the water source could be in conflict with the desire to reuse water *if* the reused water is consumed and if the water would not otherwise have been removed from the watercourse. This issue is outlined further in the following section on the Bow, and in the case studies.

4.3.2 Calgary Assessment Case Study

In 2010, the Bow River Project Research Consortium was established to explore options for re-managing the Bow River system from headwaters to confluence. Participants worked with an interactive, hydrologic simulation model to develop plausible and achievable scenarios for protecting the health of the river throughout the basin while also meeting the needs of water users. A major outcome of the Bow River Project (BRP) was the fully functioning, data-loaded Bow River Operational Model (BROM).

In order to gain a better understanding of the effect water reuse might have on the actual water flow within river systems, three scenarios were run using the BROM to show impacts on the three variables, as depicted in Models A, B and C. For all scenarios it was assumed that withdrawal levels remained the same, and reductions in return flow were based on water being removed from the system due to reuse. The following is a description of each scenario. The numbers that were observed in all three scenarios were taken from the data provided by the BRP.

> **Current Operations:** This scenario acted as the control case, which represents the approximate withdrawal and return flow in the Bow River under Calgary's current conditions.
>
> **Scenario 1: 25% Reduced Return Flow:** Scenario 1 calculated the change in total flow in the Bow River if 25% of the return flow from Calgary was not returned to the river. The goal of running this scenario was to determine the effect on river quantity if 25% of the water within Calgary system were not returned to the river.
>
> **Scenario 2: 25% Reduced Return Flow on a Re-managed System:** Re-management of the Bow River is meant to create a consistent flow of water in the river. The goal is to be able to provide water for all users, including the environment, when they need it. Although this re-management plan is still in the planning stages, it is proving to be an effective and efficient way of managing the Bow River. For that reason, scenario 2 was assessed in order to observe the effect of a 25% reduction in return flow in a re-managed system.

Model A depicts the number of days that senior license holders experience water shortages. These include the Western Irrigation District (WID), the Eastern Irrigation District (EID) and the Bow River Irrigation District (BRID). Withdrawals from these license holders are downstream from Calgary in the order above.

Models B and C depict the required allocation volumes for Apportionment Agreement with Saskatchewan (Note: the Apportionment Agreement requires that 50 percent of the annualized flow of the South Saskatchewan River must reach the Saskatchewan border) compared to water available for each scenario. Volumes from the Oldman, Red Deer and Bow River basins are presented, although the Bow River basin is the basin of interest for this analysis. The Model B represents flow conditions during historical periods of high flow in 1994, while Model C represents flow conditions during historical periods of low flow in 1930. The resulting volumes of water based on changes to return flow represent volumes measured at the Bassano Dam, downstream of Calgary.

Figure 3: ***Model A - Number of Consecutive-Day Shortages***

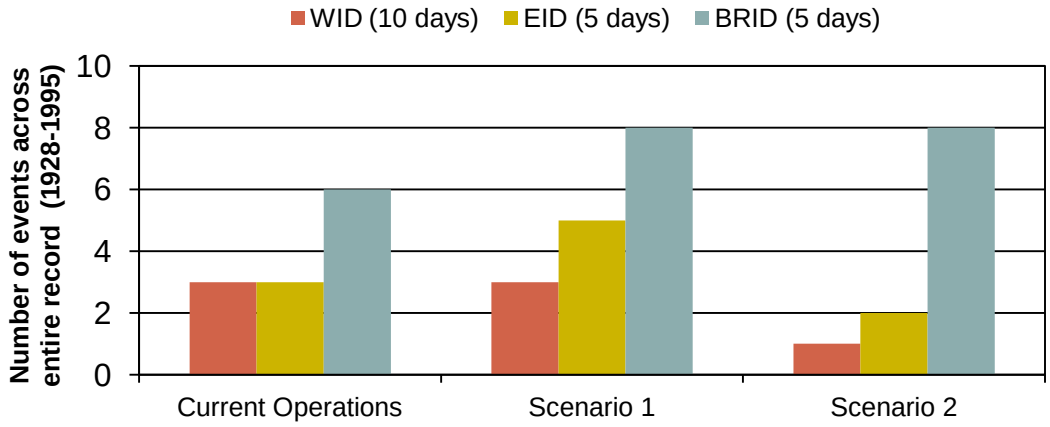


Figure 4: ***Model B - Apportionment versus available volume 1994 (high) flow conditions***

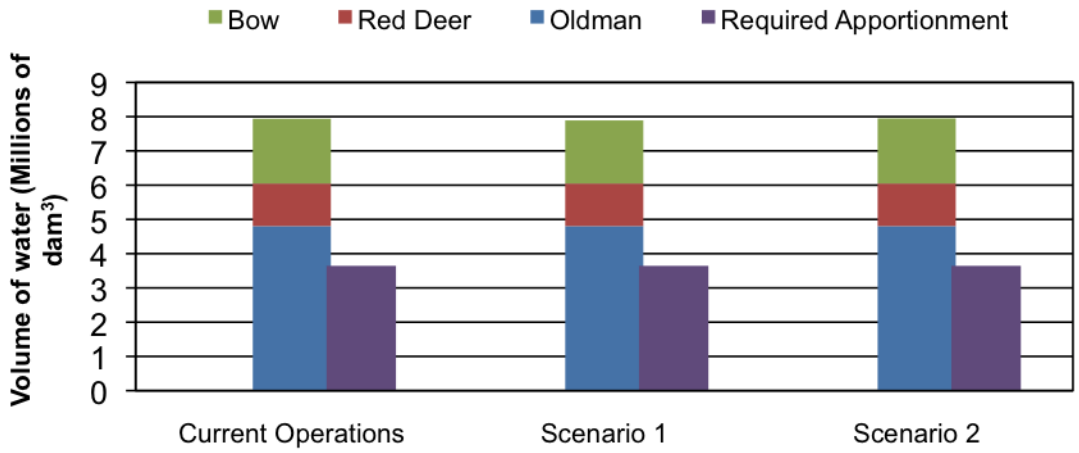
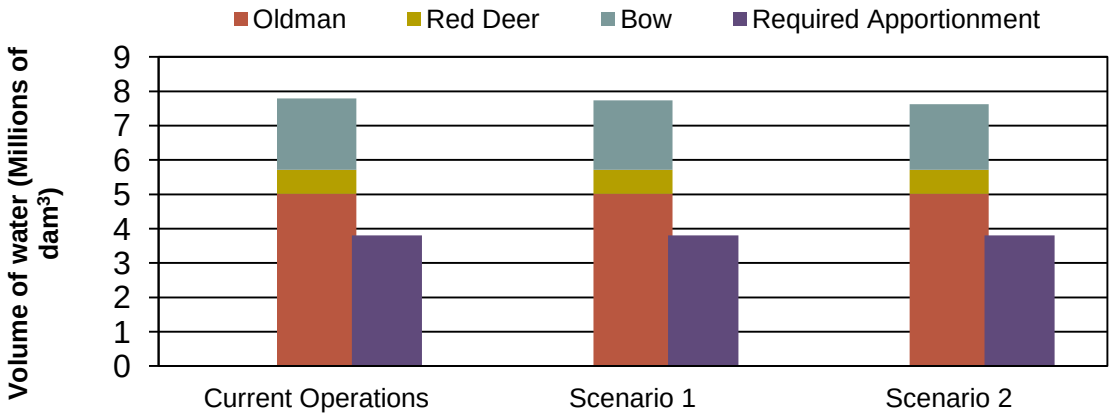


Figure 5: ***Model C - Apportionment versus available volume 1930 (low) flow conditions***



As illustrated in the above models, it is clear that a 25 percent reduction in return flow (scenario 1) does have an impact on the natural flow within the Bow River. While all license users shown in Model A experience increased shortages with reduced return flow, scenario 2 indicates great improvements to river flow. These improvements are due to the ability to re-manage flows in this stretch of the river. Models B and C show that although there is some minor variance in the Bow River volumes for each scenario, the reduction in return flow has little effect on Alberta's ability to maintain required apportionment from the SSRB.

This high level analysis shows that a reduction of return flow to the Bow River at Calgary has some impact for downstream users; however, this is mitigated to some degree by the re-management of the river (scenario 2). This demonstrates that with effective re-management of the river flows, it is possible to reuse water, while meeting apportionment quantity as well as meeting the needs of all users.

This analysis is directional only. Further analysis of the percent reduction in return flows due to water reuse is required to obtain a more accurate assessment of downstream impacts. However this analysis does provide some comfort that water reuse may not have as large an impact on return flow as is currently hypothesized. Additionally, adaptation models may further ease the impacts.

5.0 WATER REUSE POLICY AND LEGISLATION

A review of existing federal and provincial policy that affects water reuse in Alberta was provided in the report *Water Reuse in Alberta*, 2008 developed by Alberta WaterSMART. The following information provides an update to that report including some analysis of the current legislations. It illustrates small positive changes to the existing regulations, the publication of two federal water reuse standards and guidelines, and the development of one new provincial guideline for water reuse. It draws from perspectives of individuals interviewed in terms of the ongoing need for further development of provincial legislation to support implementation of water reuse infrastructure.

5.1 National Level

A number of national guidelines and codes influence water reuse implementation. Since the *Water Reuse in Alberta* report the following guidelines have been updated:

- *Guidelines for Canadian Drinking Water Quality* (summary tables were updated in 2010); and
- *Guidelines for Canadian Recreational Water Quality* (2009).

These guidelines do not have a direct impact on water reuse technology and infrastructure implementation. However, they may influence a resistance to the philosophy of appropriate water quality requirements for appropriate water uses. Existing guidelines that directly affect the implementation of water reuse infrastructure include the following:

- *National Plumbing Code of Canada* (2010);
- *The Canadian Standards Association (CSA) B128.1-06/B128.2-06 (R2011)/B128.3-12 Design* and Installation of Non-Potable Water Systems (2006), Maintenance and Field Testing of Non-Potable Water Systems (2006), Performance of Non-Potable Water Reuse Systems (2012); and
- *The Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing* (2010).

The 2010 *National Plumbing Code of Canada* has been updated since the *Water Reuse in Alberta* report. Sections of the Code exempt certain features from having to connect to sanitary drainage systems, with a requirement of backflow preventers in some cases. These fixtures must be connected to the storm drainage system. Fixtures include:

- Drinking fountains;
- Drainage pans on heating and cooling systems; and
- Floor drains that only receive clear water.

In addition, fixtures that only discharge “clear water waste” can be connected to the storm drainage system or be drained onto a roof. This has changed from the last edition, which required all fixtures to be connected to a public or private sewage system.

The Code has an entire section on non-potable systems, which indicates that they can only be used to supply water to water closets (flush toilets), urinals, and directly connected to irrigation systems that dispense water below the surface of the ground. The Code references the CSA B128.1-06/B128.2-06 standard.

The CSA B128.1-06/B128.2-06/B128.3-12 delineates the design, installation, maintenance and field testing of non-potable water systems, and the performance requirements of non-potable reuse systems. The B128.1 and B128.2 standards were in the consultation process at the time of release of the *Water Reuse in Alberta* report. Since then,

it has officially been adopted as a National Standard of Canada. The B128.3 standard was released early in October 2012.

In 2010, Health Canada published the *Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing*. The goal of the document is to provide a uniform set of tools that may be adopted by jurisdictions across Canada in developing water reuse and conservation policies. The document provides guidelines for reclaimed water quality, recommends a management framework approach that can be applied by authorities to manage risks of domestic reclaimed water systems, and outlines the science and technical considerations pertaining to risk assessments. While providing the quality levels required for such systems, the document recognizes the risks associated with such systems. By providing and recommending a risk-based approach, the document aims to "identify all of the potential hazards in a reclaimed water treatment system, assess their potential impact on water quality and public health, and find ways to mitigate those risks" (Health Canada, 2010, p.4). This guideline is the first national guideline for reclaimed water quality. It recognizes that together with the new CSA non-potable water standard it represents the latest contribution to a national approach of safe and sustainable use of reclaimed water that Provinces may use to inform their own policies.

The CSA B128.1-06/B128.2-06/B128.3-12 and Health Canada Guidelines have not been used in Alberta to develop provincial water reuse policies and regulations.

5.2 Provincial Level

ESRD recognizes the need for the development of "appropriate regulations, and water quality and technical standards or guidelines to facilitate the safe use of reclaimed wastewater". Although such standards and guidelines have been published and described in *Section 3.1,* ESRD states that "reclaimed wastewater from any source **cannot** be used inside buildings or for other domestic applications in Alberta" (Government of Alberta, 2012).

5.2.1 Water Use within Structures

Regulations governing water reuse inside buildings in Alberta include the following:

- *National Plumbing Code of Canada* (2010) (described above);
- *Alberta Building Code* (2006; 2012 proposed change consultation process ongoing); and
- *Alberta Guidelines for Rainwater Harvesting* (2010).

The 2010 *National Plumbing Code* supports the use of reclaimed water. However, as of the date of this report and to our knowledge, this has not yet been adopted by Alberta Municipal Affairs. The Water for Life – Progress Report December 1, 2008 to March 31, 2011 reports the following: *"A management framework containing Alberta-specific amendments to the 2010 National Plumbing Code is expected to be finalized in a cross-ministry agreement by the third quarter of 2011. This framework will include implementation mechanisms such as standards and guidelines to ensure that onsite water reclamation systems are designed, installed, and maintained safely and assure acceptable levels of water quality. The framework will also establish approved uses for reclaimed water and provide for a system of managing the data on reclamation systems."*

The 2012 proposed changes to the *Alberta Building Code* defer the issue of non-potable water system requirements to the *National Plumbing Code* (Alberta Municipal Affairs, 2012). The Code currently indicates that "every plumbing fixture shall be piped to the plumbing system" however; this was deemed redundant with the National Plumbing Code, which "requires plumbing fixtures to be connected to a sanitary drainage system and also places restriction on the connection of non-potable water to various fixtures."

The 2012 proposed changes identify conflicting requirements regarding non-potable water systems between the National Plumbing Code and the National Building Code. The document indicates that the changes are proposed for the following reason:

"to address conflict between the National Plumbing Code and the National Building Code. The National Plumbing Code 2010 permits water reclamation, which may be seen to conflict with Subsection 9.31.5. of the National Building Code 2010, which requires the building sewer to discharge into a public sewer system."

The *Alberta Guidelines for Rainwater Harvesting* was published in 2010 and outlines the design and installation requirements for rainwater harvesting systems. They define how rainwater may be harvested and reused for domestic purposes in accordance with the *Alberta Plumbing Code*, 2006 and the *National Plumbing Code*, 2005. These guidelines may be used in existing and new developments.

5.2.2 Water Use outside of Structures

Alberta Wastewater and Storm Drainage Regulation 1993 is the section of the *Environmental Protection and Enhancement Act* (EPEA), which concerns water reuse. It references the *Guidelines for the Application of Municipal Wastewater Sludges to Agricultural Lands*, *Guidelines for Wastewater Effluent Irrigation,* and *Standards and Guidelines for Municipal Waterworks, Wastewater and Stormwater Drainage Systems*, all of which govern the design, installation, and operation of water reuse applications. These guidelines have not changed since the *Water Reuse in Alberta* report.

It is notable that Section 9.1 of the *Alberta Wastewater and Storm Drainage Regulation 1993* (with Amendments up to and including 2003) restricts the context of water reuse to treated wastewater, and does not address the use of stormwater for beneficial uses. It recognizes the risks associated with water reuse by requiring documentation on potential adverse effects, but also provides flexibility by ultimately leaving authorization of the project to the discretion of the Director. Note that the Director is a defined position in the 1999 Water Act.

The *Private Sewage Disposal Systems Regulation 2009,* which adheres to the *Safety Codes Act*, defines how sewage from private systems must be handled. It recognizes the potential for wastewater effluent irrigation, but defers to other more strict provincial standards for quality requirements of end use.

Changes to the existing standards and guidelines that govern water reuse in Alberta have been minimal. However, the Government of Alberta recognizes the potential for water reuse in domestic applications to meet water efficiency and productivity goals set out in Alberta's Water for Life Strategy. They have established a Reclaimed Water Working Group, which include ESRD, Alberta Health and Wellness and the Alberta Health Services Board, Alberta Municipal Affairs, and Alberta Transportation. This group, which has been in existence since 2008, has been working to develop a framework to establish water quality standards and guidelines for non-potable water systems, approved uses for reclaimed water, and an appropriate management system to guide safe and sustainable implementation and operation of the systems.

A Fact Sheet entitled "Alternative Solutions Guide for Reclaimed Water Reuse" was released by Alberta Municipal Affairs in October, 2012 and provides clarification on how stakeholders should proceed with developing proposals for obtaining approvals of water reuse applications. The Fact Sheet indicates that individuals must obtain a variance under the *Safety Codes Act* and a variance by the technical administrator of the equipment used for the application. It also indicates that individuals must obtain approvals to use certain natural source water through the authority having jurisdiction or ESRD, as well as a number of other detailed information requirements.

One issue identified by study participants was the negative impact of the current water governance structure in Alberta on water reuse project implementation. Currently, ESRD is responsible for water use outside of buildings, and Municipal Affairs is responsible for water use within buildings. If a wastewater effluent reuse project varies from current regulations, the EPEA project application requires special approval from the Director, at his or her discretion. Similarly, a variation to the currently accepted plumbing practice requires specific approval from Municipal Affairs. This results in an inconsistent, lengthy process that may result in the rejection of a project application previously deemed favourable for implementation, as currently experienced by municipalities.

One individual shared that the requirement of a detailed review and discretionary nature of approvals for water reuse projects seems unrealistic. Further, the individual felt that government must prioritize the development of their capacity to provide expert knowledge on this subject, and to streamline the approval process. As noted previously, there is no solid regional understanding of the subject, or a regional group that has legislative standing. Comparatively, the individual noted that British Columbia provincial government has taken leadership with respect to the responsibility for approving water reuse projects, and has developed a transparent decision making process through their Provincial regulation sited previously in the report.

5.3 Water Reuse and Recycling in Industry

Reuse of industrial process water has different policies and regulations for water reuse, which are governed by industry standard practices developed and enforced by the Energy Resource Conservation Board (ERCB). Some of the challenges and opportunities created by existing policies and regulations developed by ESRD and ERCB with respect to water conservation are identified in the experiences in the Lower Athabasca region.

5.4 Water Reuse in Other Jurisdictions

5.4.1 British Columbia

In Canada, British Columbia is the only provincial jurisdiction with its own wastewater effluent reuse guidelines. In 1999, the Municipal Sewage Regulation was approved. Subsequent to four amendments, this regulation was repealed and replaced with the Municipal Wastewater Regulation in 2012. The regulation includes but is not limited to requirements for the use of greywater, reclaimed water, distribution, storage, monitoring, and emergency response.

The original regulation separated wastewater into two categories of restricted access and unrestricted access. However, a number of issues were found with the implementation of this regulation. Stakeholders have commented that the two types are limiting and there were inconsistent references in the regulation. The Province of British Columbia did a review of other jurisdictions regulations and replaced the 1999 regulation with a division of standards into four different types of wastewater effluent use. One standard addresses water reuse that may present environmental risks and three standards address water reuse applications that present varying degrees of public exposure potential. The definitions and applications are listed in Table 6. This appears to be a useful template for consideration in Alberta.

Table 6: British Columbia Municipal Wastewater Regulation that includes standards and guidelines for reuse of wastewater effluent

Type	General Definition	Applications
1 Environmental Risks	Uses that could or will directly impact the environment such as streams, wetlands and other aquatic environments.	Impoundments and wetlands, habitat restoration, stream augmentation, aquaculture, direct groundwater recharge, and indirect potable reuse (community watersheds that are intake water or a drinking water source).
2 High exposure potential	Activities where there is a high likelihood of public contact (treatment requirement is virus removal via coagulation and filtration).	Urban irrigation, toilet flushing and washing machines, recreational, and spray irrigation for food crops eaten raw, seed crops and pasture.
3 Medium exposure potential	Activities where there is minimal likelihood of public contact or where there is restricted public access and user education.	Commercial, industrial, municipal (application when public is not likely to be present), spray irrigation for non-food crops, drip irrigation not directly contacting food crops and commercial processed food crop not eaten raw, and recreational and aesthetic purposes.
4 Low exposure potential	Activities where there is limited access or no likely contact or for emergency situations where contact is unlikely.	Numerous commercial, industrial, municipal and emergency uses.

5.4.2 United States

The United States Environmental Protection Area (USEPA) has extensive policy and regulations around water reuse. In addition, a National Research Council committee recently completed a three-year study with the release of *Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater.* The report provides a comprehensive assessment of technical, economic, social, and regulatory issues associated with both potable and non-potable reuse, including an original analysis of the risk of two potable reuse scenarios compared to common water supplies. This report has just been received and will be reviewed for additional guidance and insights for the next phases of this work.

In 2012, the USEPA updated their 2004 National *Guidelines for Water Reuse*. The guidelines provide information including but not limited to the following:

- Recommended water reuse guidelines as a reference for the development of state regulations;
- Outline and definition of various water reuse applications that occur in the U.S.;
- Summary of technical issues related to planning water reuse projects;
- Summary of the legal and institutional issues as they relate to U.S. federal law; and
- Matrix and comparison of state regulations and guidelines.

The 2012 National *Guidelines for Water Reuse* include "updated discussion of regional variations of water reuse in the United States, advances in wastewater treatment technologies relevant to reuse, best practices for involving communities in planning projects, international water reuse practices, and factors that will allow expansion of safe and sustainable water reuse throughout the world" (USEPA, 2012). There are varying levels of state support for

water reuse with respect to the adoption of guidelines and standards. As of August 2012, the following was factual:

- 22 states have adopted regulations regarding the reuse of reclaimed water;
- 11 states have guidelines or design standards with water reuse as the primary intent;
- 8 states have regulations and 4 have water reuse guidelines primarily for reference of water reuse as a disposal option; and,
- 27 states have undergone or just completed revisions to their current water reuse regulations or guidelines.

Beneficial water reuse programs may still be permitted on a case-by-case basis in states without regulations or guidelines. The following provides an overview of the number of states with regulations or guidelines for specific water reuse applications as of 2002. An updated table that outlines the regulations and guidelines adopted in each state was developed for the 2012 USEPA *Water Reuse Guidelines*. The definition of each application type as defined in the USEPA can be found in Appendix C.

Table 7: States with regulations or guidelines for specific water reuse applications.

Type of Reuse	Number of States
Unrestricted Urban	28
Irrigation	28
Toilet Flushing	10
Fire Protection	9
Construction	9
Landscape Impoundment	11
Street Cleaning	6
Restricted Urban	34
Agricultural (Food Crops)	21
Agricultural (Non-food Crops)	40
Unrestricted Recreational	7
Restricted Recreational	9
Environmental (Wetlands)	3
Industrial	9
Groundwater Recharge (Non-potable Aquifer)	5
Indirect Potable Reuse	5

California has developed a set of Public Health laws related to recycled water that are summarised from the *Health and Safety Code*, the *Water Code*, and *Titles 22 and 17 of the California Code of Regulations* in a publication known as the Purple Book. These laws have been referenced and adopted around the world as de facto standards, or have formed the basis of standards developed by other states and countries (Alberta WaterSMART, 2008). Based on the Purple Book publication, piping systems for reclaimed water are manufactured in a purple colour and reclaimed water piping systems are often referred to as “purple pipe” systems. California has installed purple pipe in some areas for over 20 years prior to being used. Potential future and long term water shortages has forced planners to look at long term cost implications of infrastructure development, while considering real time barriers based on public perception issues.

Orange County, California was one of the first places to practice aquifer storage and recharge (ASR), albeit with major public perception challenges. The Orange County case study provides an overview of the challenges faced in implementing this water reuse application.

Orange County Case Study

In Orange County, the implementation of new wastewater reuse technology was driven by the prediction of potable water supply shortages by 2020, the need to augment the seawater intrusion barrier in the groundwater basin, long term reduction of salinity and the opportunity to eliminate the need for a wastewater outfall (CH2M Hill, 2004).

A joint project with the Orange County Water District and the Orange County Sanitation District was developed to inject highly treated wastewater into groundwater aquifers to address the above concerns. This is the largest indirect potable water reuse project of its kind in the world.

Wastewater is treated at the Orange County Sanitation District and subsequently flows to another treatment facility to undergo a more sophisticated treatment process that brings water to a quality that exceeds all drinking water quality standards (Trojan UV, 2010). The water is then pumped to two different locations. Each day approximately half of the water treated is injected to create a seawater intrusion barrier to the potable water supply. The other half is pumped to the Orange County Water District's percolation basin in Anaheim where water naturally filters through sand and gravel into the deep groundwater aquifers (GWRS, 2004).

The public interest in this project was a significant concern for implementation, and the public education efforts continue. A number of steps were taken in order to effectively address these issues. Outreach to the public, politicians, and community leaders was undertaken; identification of demographic sources of potential opposition was part of the strategic efforts. The main approach to develop support was addressing the "yuck factor" and explaining the technologies and process. Emphasis is placed on the demonstrated need for the project, and on reliability of the system (CH2M Hill, 2004).

The United States Department of the Interior Bureau of Reclamation has released the "Successful Public Information and Education Strategies Technical Memorandum" (2004) to help other states manage the issues related to public resistance and education.

While the situation in Alberta does not currently require treated wastewater effluent as a water supply, public perception is a barrier. Municipal water reuse projects will likely require public consultation prior to construction. This can create extended periods of regulatory consideration and review and may result in the development of costly over conservative monitoring programs to appease public concern. Thus, public education and acceptance of water reuse is a key challenge to address. Addressing it concurrent to the development of water reuse legislation and system implementation may reduce the future costs of a reuse system.

5.4.3 Australia

The Australian National Environmental Protection Council also has extensive policy and regulations around water reuse. In 2006, the Australian federal government developed *National Guidelines for Water Recycling: Managing Health and Environmental Risks*. The guidelines offer a risk management framework, similar to the approach adopted by the Health Canada (2010). They do not deal with recycling of industrial and commercial sources, but the approach can be applied to these sources. The guidelines also do not address the issue of allocations and

return flows. These guidelines represent an effort to create a consistent framework for water reuse applications; some states had developed their own regulations and guidelines prior to these guidelines, and there was a need to develop uniformity in applications.

The existing guidelines for general water recycling, and specific guidelines for three separate uses, are available as follows:

- *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks* (2006);
- *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2): Augmentation of Drinking Water Supplies* (2008);
- *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2): Stormwater Harvesting and Reuse* (2009); and
- *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2): Managed Aquifer Recharge* (2008).

Based on these guidelines, water reuse is being undertaken in a number of sectors, which are outlined in Table 8.

Table 8: Existing uses currently undertaken and considered in the Australian Guidelines for Water Recycling (2006)

Category of use	Examples
Agricultural uses	• Horticulture, trees/woodlots, pasture/ fodder, dairy pasture, lucerne, cotton, flowers, orchard, nursery, vegetables, viticulture, hydroponics, turf farm, cane fields, and grain cropping
Fire Control Uses	• Controlling fires • Testing and maintenance of fire control • Systems • Training facilities for fire fighting
Managed Aquifer Recharge	• In a number of schemes, stormwater is collected, stored in aquifers and then extracted for use for municipal irrigation. • Aquifers could also be used to store treated sewage as part of recycling schemes.
Municipal Uses	• Irrigation of public parks and gardens, roadsides, sporting facilities (including golf courses) • Road making and dust control • Street cleaning
Residential and Commercial Property Use	• In-building (toilet flushing) • Garden watering, car washing • Water features and systems (ponds, fountains, cascades) • Utility washing (paths, vehicles, fences, etc.)
Industrial and Commercial Use	• Cooling water • Process water • Washdown water
Environmental Uses	• Streams and creeks • Rivers • Lakes and dams

In summary, compared to the work being undertaken in other jurisdictions in Canada and around the world, Alberta has adopted fewer Provincial specific regulations and standards for water reuse. More comprehensive

regulations including quality requirements for specific uses might ensure a consistent and rigorous planning and implementation process of water reuse programs that prioritizes the health and safety of the public. The process of regulation development and implementation has varied among jurisdictions and provides an opportunity to learn from their challenges and successes. Further investigation into the work conducted as part of the 2012 USEPA *Water Reuse Guidelines* and other documentation of regulatory challenges and successes might inform a more effective process for implementation in Alberta.

5.5 Policy Issues

According to findings of the participant interviews, there is a perception that legislation and regulatory limitations remain one of the largest barriers to implementation of water reuse initiatives in Alberta. Some progress has been made on a national level with the 2010 updates to the *National Building Code*, the publication of the *CSA B128.1-06/B128.2-06 (R2011) Design and Installation of Non-Potable Water Systems/Maintenance and Field Testing of Non-Potable Water Systems*, and the publication of the 2010 *Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing*. However, the *National Plumbing Code* only allows the use of non-potable water for flush toilets, urinals and subsurface irrigation systems. It does not allow for closed loop greywater use applications within buildings.

The Alberta Municipal Affairs fact sheet described above references the National Building Code, and the Health Canada Guidelines. However, to our knowledge, these documents have not been used in Alberta to develop provincial water reuse policies and regulations.

Based on the review of the current Alberta legislative framework and on interviews with stakeholders throughout the Province reported earlier in this report, this may be due to a number of different issues. Experiences related to these perspectives are provided later in the report.

- The Alberta government has not yet updated their own guidelines and regulations to reflect nationally accepted practices.
- There does not appear to be a comprehensive definition of water reuse within the Alberta legislative and regulatory context.
- Regulators continue to struggle with the challenging issue of trading off the benefits of water reuse with the impacts on return flows and subsequent possible impacts on the ecosystem.
- Government regulators at the local level continue to operate within the current regulations and in some cases do not appear flexible on approving local water reuse projects, despite the high level policy support for such initiatives.

The above findings may change based on the recently published fact sheet on water reuse approval requirements. For example, although the fact sheet does not represent new Alberta legislation and regulation, it references nationally accepted practices as a requirement for obtaining this variance in Alberta. The factsheet may also provide more clarity for local government regulators, and therefore, municipalities and developers may have more positive experiences with these regulators. However, the implementation of such systems is dependent on local authorities, and approval from ESRD for the use of specific source waters (e.g. raw water, non-potable water, stormwater, etc.). Due to the complexity of issues such as ownership and return flow, it is expected that ESRD will not issue water reuse related approvals in the near future.

The process of regulation development and implementation has varied among jurisdictions in Canada and around the world and provides an opportunity to learn from their challenges and successes. Further investigation into these regulations might inform a more effective process for implementation in Alberta.

The Province has stated there is a need for more detailed water quality and technical standards and guidelines, as well as risk management frameworks and processes to ensure the safe use of non-potable water. The planned development of an Alberta management framework for water reuse by the Alberta Reclaimed Water Working Group would address these challenges; however the timeline for its development and issuance is not publicly available. This framework will be a large step towards more effective and sustainable water management for Alberta, and therefore the acceleration of its delivery is necessary for the safe and efficient implementation of pending reuse initiatives.

6.0 REGIONAL PERSPECTIVES

The following sections outline a summary of findings from interviews with municipal, industry, and regulatory leaders on water availability and use in each land use region of the Province. The interviews were conducted with the purpose of developing insight on the following:

- Areas experiencing barriers to development based on a lack of water supply;
- Successful water management practices;
- Potential avenues for the improvement of water management;
- Successes and challenges in implementing innovative water reuse initiatives; and,
- The impact of policy and legislation on the above.

Each land use region is unique in terms of existing use, water availability and future water demand and development. Provincial solutions will need to address local challenges. Therefore, perspectives from each region were invaluable for understanding priority needs, long term concerns, current barriers to addressing these needs, and how to capitalize on water conservation and management opportunities to create more economic development in each region.

6.1 South Saskatchewan Region

6.1.1 Background

"This region aligns with the South Saskatchewan Region in the Land Use Framework, and includes the Oldman River basin, the South Saskatchewan River basin, the Milk River basin, and the Bow River basin with the exception of areas that reside in Banff National Park, which are included in the North Saskatchewan Region" (Alberta WaterSMART, 2008a).

Since 2006, upon issuance of the *South Saskatchewan River Water Management Plan*, new water licenses are no longer issued for the Bow, Oldman, and South Saskatchewan river basins. This has placed urgency on improved water management to mitigate challenges related to population growth, current water allocation and license trading processes, and annual variations in water flows.

The SSR accounts for about 73 percent of all estimated water use in the Province (Alberta WaterSMART, 2008a). In the region, the majority of water allocations are for the irrigation-agriculture sector and the municipal sector, representing 79 percent (Government of Alberta, 2009) and 14 percent of allocated water, respectively. This represents virtually all of the Province's water allocations for irrigation and approximately 68 percent of all municipal water allocations in Alberta. Approximately 56 to 72 percent of the average annual flow is allocated, and about 25 to 32 percent is being consumed (Alberta WaterSMART, 2008a).

Approximately 89 percent of water consumed for municipal purposes within the region is from populations currently residing in cities and towns. Specifically, 80 percent of people in this region live in the Calgary metropolitan area. Population growth in urban centers is expected to continue growing at a rapid rate, with an estimated increase of two million people by 2076, of which 1.6 million are expected to reside in the Calgary metropolitan area (Government of Alberta, 2009).

Based on the high ratio of gross domestic product to water used by the municipal and commercial sector, short and long term water management for residential development in the major urban centers in this region is a key component to sustained economic growth for the region and the Province.

Recreational use of water adds significantly to the quality of life in this region and makes it Alberta's most popular tourism and recreation destination. However, maintaining this level of popularity will remain a challenge in an area that continues to increase in population.

Interviews with some individuals in this region highlighted numerous supply driven challenges facing municipalities. Other individuals shared that the public perception over the lack of water may be restricting growth in areas that are in fact not experiencing water shortages. Interviews with industry representatives indicated the potential growth in the energy sector in this region, specifically for development of tight oil and shale gas resources, may require a more delicate balance of water resource management and governance.

6.1.2 Regional Water Supply and Reuse Experience

The planning and implementation of water reuse projects in this region has grown in recent years, though experience remains limited. Some experiences are common among municipalities, while perceptions, approaches, and goals related to water reuse vary substantially. Experiences and perspectives from this region were collected from four municipal leaders, one residential developer, two individuals connected to economic development agencies, and one individual from the energy sector.

Although the south central area of this region experiences the least amount of rainfall, recent studies have indicated that based on existing river data, the existing water allocation and licensing is sufficient to support residential development until 2050 without significant changes to the current management practices. More work is being conducted in this region in order to fully understand the impacts of commercial and industrial development on the river system.

Based on this initial data, two interviewees felt that there is a strong and far reaching perception that there is insufficient water to support new opportunities in rural communities, villages and towns in some areas of the region. This public perception may be fuelled by a lack of public awareness and education, and could be contributing to slower economic development than might otherwise occur. To the knowledge of the individuals interviewed, many smaller communities in this area have not yet considered water reuse as an alternative source of water.

In other areas of the region, implementation of water reuse projects has also been limited. Perspectives on the limited planning and implementation of water reuse projects have been summarized in Table 9 with respect to consistent themes identified during the interview process.

Many of these perspectives were developed by individuals who have attempted to implement water reuse initiatives with varying degrees of success, or otherwise support the concept and development of water reuse systems.

Certain areas of the region have more urgent needs with respect to water supply for economic development, and have therefore acknowledged water reuse as a necessity. Two areas with the greatest immediate needs are the Town of Okotoks and Rocky View County. Development has already been restricted in these areas due to availability of water licenses.

Table 9: Perspectives on water reuse implementation limitations in the South Saskatchewan Region

Theme	Perspectives
Business case/cost of implementing	• The demand for reuse is just starting now. • Water needs to be treated for purpose. • It is cheaper to treat and reuse water than to source new water. • Reusing water is complicated and expensive. • The technology is available but the business case is not. • There are large costs associated with retrofitting existing infrastructure to accommodate or support reuse.
Limited use of available technology	• There is currently limited use of available technology to better manage water quantity.
Lack of long term planning for reuse	• Current systems were built prior to the system being constrained and were therefore not built for a constrained system.
Limited leadership on issues concerning governance of water and regional initiative	• There is a lack of regional water management perspective, regional dialogue, understanding, cooperation and solutions. • Reuse opportunities need to be viewed in the context of the watershed. • Management decisions need to be at the basin level. • There is no regional group that has legislative standing. • Initial government support for innovation does not translate into government support for implementation. • There is a need for a paradigm shift from: water coming from one place to: using it again once it has been removed from the system. • There is a need for a paradigm shift from: a constrained water supply is a constraint to: a constrained water system is both a constraint and an opportunity. • Discussion should not be solely on a system need, should also discuss system opportunity.
Lack of and inconsistent government and legislative support	• There is a disconnection between different levels of the provincial government on requirements of water reuse systems. • Legislation has not caught up with current technology. • The benefit of return flow requirements to the river is not legislatively supported consistently between the municipal and energy sectors. • Water reused and water returned to the River must be balanced and impacts understood. • Reuse options should be placed-based.

The Town of Okotoks (Okotoks) Case Study outlines their experience over the last two decades. It represents a significant need with respect to water supply for economic development. While Okotoks has made incredible sustainability efforts to minimize cumulative impacts on the environment and provide a healthy and active place to live, they have continually experienced challenges in ensuring secure water supplies for continued development. The lack of legislation related to water reuse to support the Town's proposed total watershed management strategy, and the significant difficulty in transferring water licenses has had severe impacts on growth, which are expected to continue into the future.

Town of Okotoks Case Study

Fourteen years ago, Okotoks became "one of the first communities in the world to make a conscious decision to limit growth based on an established environmental carrying capacity" (Town of Okotoks, 2009a). With limitations set for the Sheep River for both consumption and return by ESRD, Okotoks had to limit the number of residents despite expected increases in population (in 2006 there were just over 17,000 residents and almost 25,000 in 2011) (Ramsay, 2012).

In an effort to balance water needs of residents with environmental impacts such as droughts and floods while also considering groundwater protection, quality of sewage treatment, etc., the community committed to the 2002 *Okotoks Water Management Plan*. The ultimate purpose of this plan was "to ensure provision of quality potable water to residents, institutions and businesses" (Town of Okotoks, 2002).

License transfer agreements and alternative water supply options were already implemented and explored respectively, before the recent removal of the population cap in September, 2012. Other options and strategies included: a study determining the feasibility of regional pipelines from the Bow and Highwood rivers; negotiations with more senior license holders and ESRD to pursue additional water licenses through sustainable management practices, as well as a harmonization of regulations and legislation.

Other measures such as ASR, and the "beneficial reuse of reclaimed wastewater and stormwater for non-potable uses" are a priority in Okotoks' Water Management Plan. Expanding this plan to find additional creative means of conservation is a critical path for Okotoks, especially in a constrained water management context without the population cap.

Due to legislation restrictions, the only option for the Town is to obtain water licenses through transfer. However, the current license system does not allow the transfer of water licenses from a location downstream to a location upstream. Based on Okotoks' geographical location, there are few eligible licenses available for transfer to them.

However, over the past three years Okotoks has negotiated the transfer of parts of three licenses, totalling 250 acre feet of water. A portion of the licenses transferred were from an oil and gas sector license holder. Thus, the transfer from a highly consumptive user (oil and gas) to a traditionally non-consumptive user (the municipality) would mean more water is returned to the river. The Town proposed to the government to receive "credit" for flows they returned to the river which would otherwise be lost from the system under the previous license. However, there is no provision in the 1999 *Water Act* to allow this; the government indicated that the policy group at ESRD is looking into governance issues around return flow.

The Town is currently looking into longer term options of developing a sub-regional system for water supply. The process of developing this system could take more than a decade. However, they would like to ensure the water supply impacts of other regional options are fully understood before committing to a system that may be expensive and not sustainable in the future.

In at least two municipalities in this region, developers are asked to provide their own license for water supply and discharge, as the municipality and County are not able to guarantee a short or long term supply of water. This has had a significant impact on residential development. Due to the high upfront cost of servicing infrastructure, the financial net benefit for developers is typically dependent on revenue from the final phases of development.

Municipalities are supporting developers to come up with innovative solutions to manage stormwater and wastewater in order to meet this challenge. However, developers have shared that in their view the existing regulatory framework does not support water reuse initiatives. In some instances, municipal leaders feel that initial government support for innovation does not translate into government support for implementation. Developers have indicated that support from Alberta Health, Municipal Affairs and the more senior individuals at ESRD is not necessarily enough to convince local ESRD that water reuse projects should move forward. Therefore, at least one municipality is asking for ESRD to provide clear upfront support that they are able to follow up on. This would reduce costs of regulatory processes associated with water reuse projects.

The WID and Rocky View County case study illustrates how the lack of water in this region has created the need for large water transfers. Currently, water transfers are the only opportunity for municipalities and developers in this region to support large economic development projects that require significant amounts of water.

Due in part to the proximity of these areas to the Calgary metropolitan area, and a lack of existing support from Calgary for water supply to rural residential areas, there is considerable tension throughout the region with respect to water licensing and allocation, and regional solutions. Although many towns and municipalities are members of the CRP, tension around water continues to increase.

WID and Rocky View County Case Study

Since the closure of the South Saskatchewan Basin occurred, one of the major license transfers in southern Alberta was between Rocky View County and the WID. Since 2005, the County's mission has been to achieve its own water servicing abilities. With the closure of Basin, and growth expecting to continue in the near and long term, this has been a challenge for the County.

The business community of Balzac and specifically Cross Iron Mills, the largest shopping mall in the region, struggled through significant water sourcing challenges. The mall and surrounding developments represent a significant opportunity for economic development to the region and the province. With dozens of businesses in the area and the Cross Iron Mills mall, over 4,000 fulltime jobs have been created in the area. This number is expected to grow. The construction of the water treatment facility to supply water to these facilities itself attracted hundreds of millions of dollars in construction value (McGuire, 2011).

However, these benefits were almost lost to the availability of a water supply. It was not until the developer of the mega-mall had started construction that planners realised a water supply had not been established. It is possible that this development may not have occurred if the lack of water supply was known at the onset. As a result, numerous sourcing options were developed during construction. Among them were a pipeline from the Red Deer River that was deemed prohibitively expensive and politically unacceptable to the County of Red Deer, and acquiring a license or diversion from Calgary that was also politically unacceptable.

Ultimately, Rocky View County paid 15 million dollars to the WID to acquire water rights for the Balzac community. This equates to a cost of $6,000 per decameter ($6 per cubic meter) of water transferred (Sandor et. al, 2010).

Cross Iron Mills does not use potable water to irrigate exterior landscaping, but uses the 1.4 million square foot roof to harvest rainwater. Three cisterns exist under the parking lot to store one million litres of harvested rainwater.

The oil and gas sector will also be affected by the lack of water supply in this region, where industry has indicated there is emergent growth in hydraulic fracturing. These hydraulic fracturing facilities can be developed by large, medium and small scale oil and gas companies due to their relative size compared to other energy facilities. They also typically require more volumes of water than conventional operations over a shorter period of time. Industry recognizes that the incremental demands of high value water use in this region has the potential create conflict.

Competition for water supply across every sector in this region may grow in the near future. The existing water market in Alberta also creates a scenario where oil and gas companies may have the upper hand, with the ability to purchase water at a higher cost. The way in which senior license holders work with each sector to meet their current and future water supply demands in this region will have a significant impact on how development proceeds in this region.

Another example points to the need to plan for water reuse. A major challenge for at least one municipality investigating the use of wastewater effluent has been the location of existing wastewater treatment plants relative to potential demand and the costs associated with system upgrades. All treatment plants are located at the bottom of the watershed, while potential demand is located at higher elevations where pumping of water would be required for delivery. Where the quality of water is required to be at a higher standard than current wastewater treatment facilities can provide, costly retrofits to existing facilities may also be necessary.

While integration into existing systems may be challenging, there were competing perspectives on the cost of technology and infrastructure required for reuse, versus the long term savings. Some individuals felt that reusing water is complicated and expensive, while others felt there were cost savings in treating and reusing water as opposed to sourcing new water. In addition, while current regulations and public perception may not allow certain applications of water, some participants in this region and other regions felt that planning to be “reuse ready” would reduce long term costs.

Costs related to water reuse projects include initial capital costs, licensing and regulatory requirements, and ongoing monitoring costs. Ongoing financial returns should also be considered when analyzing costs. Initial capital costs will include infrastructure associated with withdrawing and supplying water to the treatment process, the treatment process itself, and the distribution and conveyance system.

One perception denotes that water reuse is not economic due to the very low price of potable water in Alberta, and Canada; the cost of treating water for reuse applications is currently more than supplying potable water for those applications. Only until the cost of potable water surpasses the cost of reclaimed water, will water reuse become economical. When considering the costs of retrofitting an existing system, this individual felt that most wastewater facilities already meet standards for some reuse applications. For example, some biological nutrient removal (BNR) facilities exceed standard requirements for toilet and urinal flushing. Thus, the individual saw major costs coming from the conveyance system and the assurance of public health and safety.

The opposing perception indicates there is a need to closely identify the economic efficiency of capital investments at a more broad scale of cost impact. There is a belief that redeveloping effluent into new water sources will lead to cost savings throughout the entire Province rather than cost savings for just a single industry.

Others may argue that the cost of water reuse is very site specific, and therefore, both perceptions may reflect some truth. A number of factors come into the comparison of costs, especially if a triple-bottom-line cost analysis is conducted. A more detailed review of potential costs of installing water reuse systems in various regions throughout Alberta may provide greater context for this discussion.

6.1.3 Opportunities

There has been progress with water reuse applications in this region. Calgary has implemented numerous water conservation initiatives over the past decade, and has implemented water reuse applications as part of this effort. Water analysts in Calgary's planning department have determined that water reuse will likely need to account for 8 to 10 percent of their 30 percent water reduction objective by 2030. The way in which they will achieve this amount of water reuse is not yet determined.

Final approvals are waiting for the development of the Shepard Energy Centre, which will be the largest reuse project Calgary has undertaken. Calgary has a contractual arrangement with Enmax to provide treated effluent for cooling water at the facility. This will enable the development of Calgary's first purple piping system for non-potable water. In addition, the Calgary views stormwater management and beneficial use as a key part of achieving their water reduction objective. They have made significant progress in using stormwater in place of potable water that would normally be used for parks and golf course irrigation, and street washing. Developments with stormwater harvesting and use for toilet and urinal flushing and irrigation on larger scales have also proven successful.

While ESRD may not traditionally support such a project, the City garnered support by searching out examples of similar water reuse applications from abroad and negotiating with ESRD on the effective implementation of the system. The City has also looked abroad to understand the challenges and risk mitigation of greywater reuse systems.

For municipalities and industry with sufficient financial resources, this likely creates a slow and inefficient implementation process. For smaller organizations wishing to reduce water use in order to save on capital and operational costs, the investigatory process may seem too daunting, or might not be feasible to undertake. As a result, one participant indicated that some water reuse projects might be operating illegally due to the frustration created by the current approval system.

There has also been some discussion in this region around the potential for ASR. However, as noted previously the public perception challenges can become a major barrier to implementation of this practice, as was the experience in Orange County, California.

In other locations in this region, the government has required the installation of water treatment plants that have no net losses of water. Thus, closed loop reuse systems within treatment plants have been installed. There are many examples throughout the region where wastewater effluent is used for irrigation. However, irrigation is limited to sub-surface irrigation or irrigation that is typically 60 meters away from occupied dwellings.

6.2 North Saskatchewan Region

6.2.1 Background

"This region aligns with the South-Central Region in the Land Use Framework, and includes the North Saskatchewan River Basin and Battle River Basin. In contrast to the South Saskatchewan Region, this region accounts for only 9 percent of total estimated water use in the Province, and most of the region's water allocation (82 percent) is assumed to be returned back to rivers and lakes after use." (Alberta WaterSMART, 2008a)

This region accounts for 37 percent of all active water licenses, 29 percent of all the provincial allocated water volumes, and 88 percent of all industrial water allocations in the Province (Alberta WaterSMART, 2008a). The Alberta Industrial Heartland accounts for the majority of water allocations.

Edmonton is projected to grow by about 60 percent to 1.6 million people by 2040. This will correspond with significant growth in residential, commercial and industrial sectors. However, it is clear from the Edmonton MDP that the City is focusing on water reuse in the industrial sector to reduce the total amount of water diverted from the natural water systems in the region.

The overarching challenge in this region is the cumulative loading of contaminants that cause excessive nutrient loading on the region's rivers and groundwater. Water quality objectives outlined in the Apportionment Agreements with Saskatchewan are exceeded about five percent of the time (Alberta WaterSMART, 2008a).

6.2.2 Regional Water Supply and Reuse Experience

Due in part to the inextricable link between quality and quantity, short and long term planning for reuse is happening in this region at the municipal, industrial, energy, and cross-sector levels. Experiences and perspectives from this region were collected from one individual representing the municipal sector, as well as documented management and growth plans, and research studies from these sectors.

The perspectives from this region with respect to water reuse implementation are outlined in Table 10 and represent the opinions of the municipal representative only.

Table 10: Perspectives on water reuse implementation limitations in the North Saskatchewan Region

Theme	Perspectives
Business case/cost of implementing	Water reuse will only become economic when price of potable water or other alternative increases.
Technology availability	Technology is much further ahead than legislation. The government wants a precedent in order to make future decisions.
Policy and governance support	Policy direction is there but could be stronger.
Inconsistent government and legislative support	Main issue is legislation and regulatory capacity to approve projects. Due to the discretionary nature of applications, it is a case-by-case basis, which requires review. There is a lack of resources and experiences for ESRD to focus on reuse.

Based on the information and opinions shared by this individual, as well as information and policies outlined in the 2010 Edmonton MDP and the *Water Management Framework for the Industrial Heartland and Capital Region,* it is clear that support for water reuse exists for the development of all sectors in this region.

The MDP indicates the support for various water management and reuse applications, especially as they relate to the development of industry in the short and long term. The following policies are outlined within the MDP:

- Collaborate with stakeholders to support the adoption and enforcement of regulations and guidelines that reduce the consumption of Edmonton's water resources;
- Design, arrange and locate new infrastructure and buildings to mitigate impacts upon the water system;
- Encourage designs and standards that accommodate the exchange of waste and grey water between various businesses and industry in business and industrial areas; and,
- Support eco-industrial relationships by facilitating cooperation between businesses on site and design, shared facilities and services and interchanges of energy and products.

Consistent with themes in other regions, the lack of legislative support for municipal reuse applications has apparently limited the ability of the Edmonton region to implement strategies which they believe can more effectively reduce the consumption of water resources and support development in their region. Therefore, the City is calling for collaboration to develop these guidelines and standards so they can move forward.

The MDP indicates Edmonton has recognized that the way in which they have traditionally planned for capital infrastructure is unsustainable. Infrastructure that has a life cycle of approximately 50 years needs to be planned such that new development can effectively be integrated and investments are maximized. Combined with this, by recognizing the need for new infrastructure planning to consider impacts on the water system, planning for improved water reuse options in the long term may be one strategy aligned with this policy.

The last two policies reference the implementation of eco-industrial development. Eco-industrial relationships are exercised when the waste of one business is used as the input to another. Ideally the full net of relationships creates a closed loop system where zero waste is discharged from the system. This is the basis behind the *Water Management Framework for the Industrial Heartland Region,* discussed in more detail below. On this topic, the MDP also indicates the following:

"Edmonton will promote sustainability and innovation through adoption of eco-industrial standards and approaches to land and property development and business operations. The Northeast Edmonton Industrial Development Strategy will focus on creation of a chemical industry cluster employing business-to-business eco-industrial relationships."

The Alberta government has recognized that proper water management in the Industrial Heartland is integral to successful implementation of upcoming development for economic growth. The *Water Management Framework for the Industrial Heartland and Capital Region* was developed in 2007 by the ESRD Water Committee for the Industrial Heartland and Capital Region to address the water quantity and quality issues surrounding the use of the North Saskatchewan. It is meant to provide an integrated water management system within the North Saskatchewan River to sustainably support the environment, and social and economic development in the area by incorporating wastewater reuse. In addition to providing a phased approach to development as it relates to water management, it provides potential management tools for meeting water quality targets in the North Saskatchewan River. It recognizes the role of water quantity in providing the ability to assimilate contaminants. It sites options to improve or increase river flow that include the following:

- Release more water or store and release water;
- Reduce license allocations;
- Reduce water withdrawal rates during critical periods and/or; and,
- Limit some or all new water withdrawals.

Further, to reduce contaminant release into the river, options include the following:

- Increase quality of return flow by regulation;
- Mandate the reuse of wastewater;
- Reduce the concentration of wastewater at area of release (to allow for better mixing); and,
- Limit all or some of wastewater release.

Wastewater effluent use for industrial purposes is not explicitly supported by existing ESRD legislation; however, based on the discretionary nature of regulations with respect to effluent use, the Director has approved this

application for projects in this region. With the majority of water in the region used for industrial purposes, significant opportunity for wastewater effluent reuse exists.

However, in addition to industrial growth, a total of nine bitumen upgraders were planned in Upgrader Alley of the Industrial Heartland between 2015 and 2020. In 2008, one was operating and being expanded, two were under construction, one had been approved and four were in the application phases (Griffiths & Dyer, 2008). To date, four of the upgraders are active, three have been deferred and one has been withdrawn (Alberta's Industrial Heartland Association, 2012)

The majority of water used for industrial cooling is typically returned to the river with minimal losses; however a significant amount of water used in the bitumen upgrading process is consumed by the process and removed from the watershed. In 2008 it was expected that development of the eight upgraders would reduce return flow to the river by 1 percent. The continued growth of the oil and gas industry in this area will require further investment to manage water in order to maintain healthy ecosystems.

6.2.3 Opportunities

The EPCOR and Suncor (formerly Petro-Canada) joint venture has shown how a collaborative water reuse application has provided economic benefits in terms of municipal costs and industry operations. This is just one example of an eco-industrial relationship, which can open up potable water supply for other areas of development, while providing benefits to both partners. Further discussions on the implementation of similar partnerships for supply of treated wastewater for the upcoming bitumen upgraders continue.

EPCOR and Suncor Joint Venture Case Study

Suncor, Edmonton, and Strathcona County worked together to develop a solution that would avoid withdrawing additional water from the North Saskatchewan River. The use of wastewater effluent from Edmonton's Gold Bar wastewater treatment plant for the Suncor refinery boiler feed water system was the first major industrial application of membrane treatment technology using municipal wastewater in Canada (General Electric Company, 2006). Based on this new application of wastewater reuse, Suncor was able to change to a different type of cooling system. This system, reducing water requirements by half, coupled with the water received from the City meant that Suncor did not have to build their own treatment plant.

The Suncor refinery boiler feed water treatment system came online in October 2008. Since then, plans have been developed to implement a similar system with the Alberta Capital Region Waste Water Commission (ACRWWC) to supply reclaimed wastewater for process water at the proposed Fort Hills Sturgeon Upgrader. The effluent would then be sent back to the ACRWWC for further treatment and redistribution. This project is currently deferred, and the timeline has not been made public.

The key challenge raised throughout the development of the *Water Management Framework for the Industrial Heartland and Capital Region* was the question of the 'ownership' of the treated effluent emerging from the Goldbar treatment plant. This issue is similar to that of return flows in the closed South Saskatchewan basin. Edmonton considered the treated effluent as a potential economic advantage to them in supplying waste water to the proposed upgraders. The proponents of the upgraders considered the cost of the pipelines to ship the treated effluent from Goldbar to their facilities downstream as unnecessary, since the river was able to efficiently move the water to the proposed facilities. However, once the treated water enters the river, it is now under the

jurisdiction of the Province according to the *Water Act*. No economic benefit would then accrue to Edmonton. As noted previously, clearer definitions of water and water reuse will help to clear up these issues of ownership.

There are other regions of economic activity in the North Saskatchewan Region that have positive experiences with water reuse. Drayton Valley provides an excellent example.

Town of Drayton Valley Case Study

In June 2011 the Town of Drayton Valley achieved one of its Water Conservation Strategy goals of replacing a portion of oil field potable water use with treated wastewater from the Town's wastewater treatment plant.

The Town's existing license required that municipal effluent be returned to the river. The Town approached ESRD to request an amendment to their license. Although the Town was under the impression that this would be against the *Water Act*, due to the discretionary nature and case by case review of amendment requests, the ESRD was able to approve the request.

Prior to supplying effluent to oil and gas companies in the area, the Town was selling potable water to them. The Town did their research and contacted oil companies to gauge interest in receiving lower quality water for their operations. Oil companies received this well and agreed to the change. With this new development, the wastewater is sold at a lower rate, and reduces the pressure for upgrades to the Town's existing water treatment plant (Whalen, 2011).

There are a few examples of other wastewater effluent reuse projects in this region. One example is the on-site wastewater treatment and reuse project at the Northern Alberta Institute of Technology, where a biological nutrient reactor wastewater facility will treat sewage from the school and use the effluent for toilet and urinal flushing. The project has been verbally vetted by the government; however, implementation is apparently held up by the unresolved warranties and assurances of the technology and process.

6.3 Red Deer Region

6.3.1 Background

"The Red Deer Region includes the vast majority of the Red Deer River basin, which forms the largest sub-basin of the SSRB. It includes 57 urban municipalities, 17 rural or regional municipalities and one First Nation. Farms in the Red Deer River Basin cover nearly 12 million acres or about 97 percent of the basin (Alberta WaterSMART, 2008a).

Alberta's LUF recognizes that while the Red Deer Region will be considered a distinct region for land use purposes, watershed management policy for the region will continue to be aligned and set within the context of the *South Saskatchewan River Basin Water Management Plan*. This is an important consideration, and allows for greater flexibility when considering future intra-basin water transfers between the Red Deer sub-basin and other SSRB sub-basins" (Alberta WaterSMART, 2008a).

By comparison to other rivers in the SSRB the Red Deer River has fewer water allocations as a percentage of natural flow, and therefore less stress on river environments. While ESRD is still accepting applications for new water allocations, the region remains under a water watch alert.

In 2005, 20 percent of average annual water supply was allocated with an estimate 12 percent consumed. The region is limited by legal obligations in the Apportionment Agreement to provide 50 percent of natural water flows

to Saskatchewan. Major water allocations sectors included agriculture (29 percent), municipalities (19 percent), oil and gas (13 percent) and flood control and habitat management (31 percent).

Gas and petrochemical plants account for 74 percent of allocations in the region and, because of high utilization of groundwater allocations, they accounted for 98 percent of consumptive use in the region's oil and gas sector. Four surface water licenses for cooling purposes, used for power generation, account for over 98 percent of the industrial water allocations (Alberta WaterSMART, 2008a).

In a 2006 comparison of 16 municipalities, Red Deer had the fourth lowest water price rates in Alberta. In an area made up of numerous small communities, the development of regional systems has become an interest to many. The population of Red Deer in 2011 was approximately 92,000 people (City of Red Deer, 2011), and projections for the 2031 population have been estimated to be 185,000 people (Schollie, 2006).

6.3.2 Regional Water Supply and Reuse Experience

The MDP indicates that the greatest concern with respect to water for Red Deer is quality; the watershed protection policy indicates a key objective is to maintain water quality in the Red Deer River. The Red Deer River Alliance has also focused their efforts on the development of an integrated watershed management plan, as well as draft water quality objectives for the River. No publications on water quantity were available on their website.

Another policy related to water use in the MDP is planning for eco-industrial parks in industrial areas, as discussed in the North Saskatchewan Region. However, the way in which water reuse may be used in the development of eco-industrial parks within this Region is not identified.

Red Deer has developed a water conservation strategy to ensure water demands from future growth do not exceed annual flows, and in stream water quality objectives are maintained. The plan recognizes that although quantity is not an issue now, the forecasted climate models indicate lower precipitation rates, higher evaporative losses, and lower summer river flows may reduce water availability in the future.

One of the recommended water conservation initiatives is to reduce unnecessary use of high quality water. They indicate potential costs as staff time, potential infrastructure and equipment upgrades, budgetary constraints, and overcoming the "yuck factor". Benefits outlined include decreasing the use of potable water where high quality water is not necessary, and potential increase in the number of people served within the existing allocation. Implementation of this requires investigation of opportunities for water recycling and/or raw water use, and the possibility of diverting treated wastewater to fill stations for roads/public works uses, firefighting training center, and irrigation. In addition, the strategy recommends investigation of replacing golf course irrigation and industrial cooling water applications with wastewater effluent in order to extend the life of existing allocations.

Lastly, the strategy recommends investigation of incorporating water sensitive urban design into review of new development applications, including the consideration of stormwater storage options and grey and/or raw water reuse.

According to the conservation plan, one recreation center already uses recycled shower water to flush toilets and urinals, and they recommended implementing this at another community center.

Based on the context of proposed initiatives, the strategy shows significant support of water reuse in this Region; however, a lack of knowledge and understanding about the requirements to undertake these projects prevails. While it appears that water reuse has just begun at the municipal level, the water conservation strategy

requirement for investigation into the proposed water reuse initiatives warrants support from the provincial government. Many of the proposed initiatives align with existing programs in Calgary.

6.4 Lower Athabasca Region

6.4.1 Background

"This region aligns with the Lower Athabasca Region in the Land Use Framework. It includes the Regional Municipality of Wood Buffalo (Fort McMurray), Lac La Biche County and the M.D. of Cold Lake, and reflects the downstream portion of the Athabasca River Basin, and the Beaver River Basin. Oil sands industry expansion is a major driver of economic activity in the Lower Athabasca Region" (Alberta WaterSMART, 2008a).

In the Regional Municipality of Wood Buffalo (RMWB), population is expected to more than double in the next 20 years and Fort McMurray is expected to be the third largest urban area in Alberta. The RMWB is currently the home of approximately 104,000 residents, of which 77,000 live in Fort McMurray, and the remaining live within the nine rural communities spread throughout the RMWB. Continual increases in oil and gas development expected to contribute $1 trillion into the Canadian economy.

The Canadian Association of Petroleum Producers reports that currently the oil sands industry contributes 48 percent of the region's employment and 96 percent of investment. In 2009 in the Athabasca River Basin, industry and oil sands development accounted almost two thirds of total water allocated (CAPP, 2010). Although this industry will continue to grow, diversified economic growth through development of service and private sector business and retail is expected and promoted in the Lower Athabasca Regional Plan. Together, the hope of government leaders is that this growth will lead to improved financial, educational and social services which will improve the quality of life in this region. The RMWB is encouraging permanent residency, and is developing plans to accommodate this (RMWB, 2011).

Water allocations are not typically a challenge or restriction on development in this region. In 2011, approximately 4.2 percent of annual average natural supply was allocated to license holders (RMWB, 2011). The main challenges are water quality and the management of winter flows.

In terms of water supply, water use is expected to increase due to the growth of industry. It is estimated that between 2005 and 2020, water use will grow by 188% (Alberta WaterSMART, 2008a). In addition, some rural communities are becoming limited in their ability to produce potable water onsite.

6.4.2 Regional Water Supply and Reuse Experience

Experiences and perspectives from this region were collected from two industry representatives and one municipal representative.

Current regulations outlined in the *Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River* limit water diversion from the Athabasca River based on natural flows in the river at specific times of year. These limits were developed based on water quality concerns, the highly variable annual flows in the river, and the limited return flows to the river due to the nature of water use in the region. The first phase of the management framework was developed in 2007 and recognized that current licensing has allowed for operations to cumulatively exceed the in stream flow needs of the river, and that water sharing and other integrated water management options will be required to meet Phase 1 limits.

Industry typically refers to this as "political scarcity" of water. Although the perception is that water is physically available, regulations have limited river withdrawal volumes and increased recycling requirements.

Water withdrawn from rivers for oil field injection is ultimately removed from the watershed completely. Therefore, a significant portion of return flow is made up of municipal wastewater effluent. However, domestic wastewater effluent has increasingly become a resource for the energy sector. Similar to wastewater effluent use in the Industrial Heartland, treated process affected water from the mining operations can be piped to SAGD facilities for use as makeup water for the extraction processes. The GoA supports the implementation of such systems as a policy objective. However, one participant indicated that the much anticipated update on the existing oilfield injection policy (assumed to be the *Water Conservation and Allocation Guideline for Oilfield Injection*) has not yet been released, where it is anticipated that the definition of water will be refined to accommodate these regional water management schemes. The date of release of the update has not been made public. As of this time, the use of fresh water is being strongly discouraged, regardless of the source, through the ERCB draft directive to increase recycle rates in SAGD operations.

Industry is investigating a number of new technologies and processes to reduce freshwater use in their operations. Although certain processes allow them to reuse more water, the regulatory focus has been to consider the net environmental cost and benefit. While some investigations have compared water reuse with increased energy use and therefore carbon dioxide emissions, one industry representative felt that a greater understanding of this relationship would help to inform policy related to water reuse for this sector.

Based on government requirements for limiting net environmental impacts, a different industry representative has found that industrial wastewater effluent is the best alternative water supply option in comparison to saline, or other non-saline sources. The use of industrial wastewater effluent for SAGD operations will likely continue to grow with increased generation of wastewater effluent and increased demand for low net environmental impact inputs into SAGD operations.

According to an ESRD regulator, an example of policy that limits the beneficial use of produced water is with coal bed methane development. During the process of gas extraction, water is removed from the earth. Although the water could potentially be treated for a beneficial use in a water scarce area, existing regulations require the re-injection of this produced water back into the formation. Regulatory experts in Alberta believe the impact of this policy may be unintended, and review of policies around water use for this type of development could potentially benefit water scarce areas.

6.4.3 Opportunities

Municipal and industry leaders in this region have recognized the need to take an integrated approach to water management in the future. With upcoming residential, commercial and energy sector growth, they must appropriately manage water supply to enable sustainable development of each sector for the long term. Their approach considers using all waste resources and inputs to other systems, by taking an eco-industrial approach to cross-sector development.

In addition to industrial wastewater effluent reuse, long term plans for the RMWB consider the use of snow melting facilities in large urban centers to provide make-up water to SAGD operations. In addition, they are considering the opportunity to collect waste heat from sewage as part of a district energy facility that will provide heat for various commercial applications.

Feasibility studies for water reuse in residential and commercial developments in the region are also underway. The region has identified the potential for potable water savings in commercial districts that use a significant amount of water for construction operations and truck cleaning, for which the use of potable water seems wasteful. The region is also proactively searching for existing non-potable standards in Alberta and abroad to

understand what design standards will meet the approval of the Alberta Government for these, and other wastewater effluent reuse applications.

If municipal effluent and snow melt recovery and use are implemented in this region, while maintaining existing allocation and use by industry and oil recovery practices, water returned to the river will continue to decrease.

For industry, the "political scarcity" of water has led to significant increases in water reuse over the history of natural resource extraction. However, in addition to tailings management, some companies are considering the potentially negative long term impacts of water reuse on the environment. As water is continually recycled throughout the extraction process, the quality of water continually reduces, and must be treated to a certain standard prior to additional recycling. There is some concern that this will create an accumulation of salt and thus, a long term liability for handling of the salt and the risks associated with its potential release back into the environment.

6.5 Upper Peace and Upper Athabasca Regions

6.5.1 Background

"This region aligns with the Upper Peace and Upper Athabasca Regions in the Land Use Framework, and reflects the western portions of the Athabasca and Peace/Slave River Basins. The annual river flows throughout the Athabasca Basin are one of the few remaining natural flows not currently being managed by reservoirs used for hydro-electricity generation. However, the Peace River has a substantial reservoir and hydro-electricity generation facility located upstream of the Alberta-B.C. border" (Alberta WaterSMART, 2008a).

The region includes the head waters of both the Athabasca River and Peace River, and as such, preservation of these watersheds is critical to water management plans and oil sand operations downstream. Land uses in the region include forestry, resource exploration and extraction, and recreation. Water use in the region includes industrial, oil and gas extraction, water and habitat management, waste assimilation, and some agriculture.

Overall, the region accounts for 6 percent of provincial water allocations, and for 7 percent of all estimated water use in the Province. In 2008, water allocations accounted for one percent of the annual natural flow of the Peace River. About 59 percent of the estimated water use in the region is for water and habitat management, 14 percent for oil sands mining and thermal/injection operations in the upstream petroleum sector and 9 percent for the forestry sector (Alberta WaterSMART, 2008a).

6.5.2 Regional Water Supply and Reuse Experience

The Upper Athabasca Region has similar water issues to the Lower Athabasca Region with respect to the upstream petroleum sector and oil sands operations, and variability in seasonal flow. Less long term planning with respect to water use for energy applications has occurred in this region, likely due to the concentration of oil and gas development currently located in the Lower Athabasca.

Although discussions with individuals from the Upper Athabasca Region did not occur, individuals from the Upper Peace Region were able to share their perspective. Experiences and perspectives from this region were collected from two municipal representatives in this region.
Some of the perceptions shared from this region were as follows:

- Water reuse could reduce the size of anticipated infrastructure, and therefore costs to the communities.
- Partnerships with oil and gas companies with respect to water use could be mutually beneficial.

In the Upper Peace Region, the largest municipality is the City of Grand Prairie. Grand Prairie currently withdraws water from the Wapati River, which has significantly lower flows that the Peace River. Due to the low flows and current withdraws from the river, the license for the City is required to return 100 percent of flows diverted from the river during low flows periods in the winter months. Thus, an alternative water supply and associated infrastructure will be required to accommodate future growth. In the long term it is expected that diversion of water from the Peace River will be required. In an area with little river water management infrastructure and large seasonal flows, this will require significant raw water storage facilities, and approximately 50 to 60 kilometers of pipelines.

In addition, there are increasing concerns of groundwater quality in this area. Rural communities primarily access water from aquifers in the area. Numerous complaints of drinking water odour have initiated discussions about alternative water sources for these communities. One option is to develop a regional water distribution network, which would necessitate the installation of significant lengths of pipeline.

6.5.3 Opportunities

Although limited, some consideration has been given to the implementation of water reuse in this region. According to the understanding of participants interviewed, long term plans for integrated water management have not been developed in this area. However, the water and wastewater utility, Aquatera, has initiated investigations on opportunities for supplying wastewater effluent to industry.

With 95 percent of the Provincial forestry sector located in this region, horticultural irrigation is a unique opportunity (Alberta WaterSMART, 2008a). Plans for a poplar tree farm irrigated with wastewater effluent have been developed. The project is currently on hold due to unknown reasons.

7.0 CHALLENGES AND OPPORTUNITIES

Based on the above discussion, a number of key challenges and opportunities were identified, and are summarized in Table 11.

Table 11: Key challenges and opportunities for water reuse

Challenge	Opportunity	Recommendations for Government
Water supply challenges—resulting from increasing water demand, water governance restrictions, and allocation system provisions—are limiting community development and economic growth.	Water reuse practices offer an opportunity to address the water supply challenges in the province.	❑ Support and develop water reuse legislation or regulations that are environmentally, economically and socially sustainable.
Water policy and legislation does not provide a clear definition of water reuse or its sources, thus creating confusion over who has the rights to reused water—the province or the license holder.	Establishing a clear definition for water reuse and identifying water reuse sources would promote more efficient discussions between stakeholders and help them identify who receives the economic benefit of water reuse.	❑ Develop a new regulatory framework that includes clear definitions of water reuse, including but not limited to municipal wastewater, grey water, and industrial water (such as boiler water, cooling water and process affected water).
The current regulatory framework is trailing behind the interest of communities to develop water reuse projects, thus hampering innovative solutions to water challenges.	Although water issues in each region differ, municipal and industry leaders from across Alberta have a great interest in developing water reuse projects if given the ability through legislation.	❑ Develop water reuse policy, regulations and standards as soon as possible.
Alberta appears to be lagging behind other jurisdictions in Canada and around the world in providing a legislative framework to support water reuse.	Legislative frameworks have been developed in British Columbia, the United States and Australia, amongst others, which in turn, can provide guidance for Alberta in updating its regulatory framework.	❑ Undertake a review of existing water reuse regulations in other jurisdictions to inform a new water reuse regulatory framework in Alberta.
Each land use region has unique water challenges and potential reuse opportunities.	Flexibility in regulations to accommodate regional needs will promote more sustainable economic growth across the province.	❑ Develop a new regulatory framework for Alberta that is sufficiently flexible to accommodate regional needs across the Province.
The relationship between water reuse and return flows is not well understood.	Return flow and water reuse are inextricably linked. A better understanding of this relationship can be developed with more modelling and analysis, as well as a review of how other jurisdictions are handling this issue.	❑ Undertake modelling and analysis of return flow in the South Saskatchewan River Basin, and undertake a review of how other jurisdictions manage return flow requirements, to inform the development of water reuse policy, regulations and standards.

Challenge	Opportunity	Recommendations for Government
Legislation has not kept up with advances in water reuse technology.	Water treatment technologies have advanced significantly over the last several decades, providing more opportunities for safe and cost effective reuse.	❑ Consider existing and future technological advancements when developing Alberta's new regulatory framework.
The economic drivers for implementing water reuse are not clear in all cases.	Further investigation into the cost-benefit and cost allocation of the investment in water reuse is required to convince stakeholders of economic viability. Understanding the true value of water will help support this economic case.	❑ Conduct analyses of cost-benefits and cost allocation to clearly identify the economic benefits of water reuse for various stakeholders.
People are concerned about the safety of water reuse systems, potential impacts on their health, and the security of the system.	Parallel government efforts on development of regulations and public education initiatives early in water reuse implementation phases will improve efficiency of adoption.	❑ Initiate the development of public education initiatives on water reuse to enhance the efficiency of water reuse implementation.

8.0 NEXT STEPS

The information in this report provides a basis for future work that will be conducted under Phase 2 of the project. A number of issues around water supply and the implementation of water reuse were identified, and some solutions were suggested as part of the key observations from study findings. Additional work is required to understand how challenges have been overcome and opportunities used in other local, national and global contexts, to ensure the Province moves towards implementation of effective water reuse guidelines, regulations and programs. Phase 2 of the project will include the following work:

- Explore possible solutions on a local, national and global level;
- Examine national and global solutions being implemented throughout the world; and,
- Develop a set of alternative solutions, addressing the economic impact of each alternative.

Each of these issues present potential costs and benefits to the government and its economy. These should be more thoroughly understood as the Province moves towards a formal and comprehensive water reuse framework.

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Appendix A: Interview guide and questionnaires

The following are the documents provided to study participants. There were two questionnaires developed for municipal and development sector and industry sector representatives. While the municipal sector questionnaire was provided to the non-sector representatives, they shared perspectives on issues related to water reuse they felt were specifically important to address. Questionnaires are provided in the following order:

- Municipal/development sector
- Industry sector

Municipal/Development Sector

Alberta Economic Development Authority: Water Reuse Project
Backgrounder

Water availability is emerging as one of Alberta's primary resource issues. However, there is significant and growing opportunity to address our water supply challenges. Proper management and the acceptance of new technologies may enable the Province to deal with the inevitable increased demand on resources while maintaining a competitive and sustainable economy.

Alberta WaterSMART is undertaking a study for the Alberta Economic Development Authority (AEDA) to explore and identify potential water management opportunities and challenges, including water reuse, at the municipal, regional and provincial levels. Part of this study will include collecting perspectives and experiences on water availability and use in each land use area of the Province. We will be conducting interviews in order to develop insight on the following:

- areas experiencing or anticipating barriers to development based on a lack of water supply;
- successful water reuse practices;
- successes and challenges in implementing innovative water reuse initiatives; and
- potential avenues for the improvement of water reuse project implementation

Each land use area is unique in terms of existing use, water availability and future water demand and development. Provincial solutions will need to address local challenges. Therefore, perspectives from each region are invaluable for informing strategies to address priority needs and long term concerns, and to capitalize on water conservation and management opportunities. Statements and opinions of individual contributors will be made without attribution in the documentation of study findings.

Interview Guide

Land Use Area:
Organization:
Contact:

1. Please describe your current water situation (potable, stormwater, effluent and grey water). What is working well? What is not working as well as you would like?

2. Do you anticipate residential, industrial and/or commercial development in the future**?** If yes, please describe.

3. How do you think this anticipated development might impact (negatively or positively) your water situation**?** Do you think future development will be influenced by water supply? If yes, how?

4. Have you undertaken a formal water needs assessment? If yes, is this assessment available to the public? Do you have a water management strategy in place? If yes, is this strategy available to the public? Do you have structures and processes in place to operationalize your strategy? If yes, what are they?

5. How would you define water reuse?

6. What is your current experience with water reuse? Are you currently reusing water? If yes, in what ways? What has been your experience in implementing a reuse initiative?

7. Are there water reuse opportunities you are planning to explore? If yes, what are they? What benefits would these opportunities provide? Do you envision there will be challenges in implementing these reuse opportunities? If yes, what are they?

Industry Sector

Alberta Economic Development Authority: Water Reuse Project
Backgrounder

Water availability is emerging as one of Alberta's primary resource issues. However, there is significant and growing opportunity to address our water supply challenges. Proper management and the acceptance of new technologies may enable the Province to deal with the inevitable increased demand on resources while maintaining a competitive and sustainable economy.

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Interview Guide

Land Use Area:
Organization:
Contact:

1. Please describe your experience with water management in your area of work; with respect to water supply, potable water, wastewater, stormwater and/or process water.

2. How do you think anticipated development might impact (negatively or positively) the water situation in your industry or region? Do you think future development will be influenced by water supply? If yes, how?

3. Do you have a water management strategy in place? If yes, is this strategy available to the public? Do you have structures and processes in place to operationalize your strategy? If yes, what are they?

4. How would you define water reuse?

5. What is your current experience with water reuse? Are you currently reusing water? If yes, in what ways? What has been your experience in implementing reuse initiatives?

6. Can you provide any examples of water reuse projects that you have heard of and/or been involved in? Were they successful? If yes, why? If no, why not?

8. Are there water reuse opportunities you are planning to explore? If yes, what are they? What benefits would these opportunities provide? Do you envision there will be challenges in implementing these reuse opportunities? If yes, what are they?

9. What challenges and opportunities do you foresee with respect to implementing more water reuse projects in the Province in the short term? In the long term? How will this impact development in your region?

Appendix B: Review of water allocation and return flow

A review of the allocation system was conducted by the Government of Alberta in order to allow government, communities, industry and the public to explore options to better meet future water needs, and support the regional outcomes developed across Alberta as part of the implementation of the Land Use Framework under the *Alberta Land Stewardship Act*. This appendix provides a summary of the current discussions and recommendations around the existing water allocation and transfer system, and the role of return flow management within the recommendations. Based on this information, it is clear that further research on impacts of water reuse on return flow are required to move water reuse forward in Alberta.

Three different reports were developed and published in 2009 by independent institutions in order to inform discussions and offer recommendations for the Water Allocation and Transfer System Review. An additional document was released around the same time and was also considered by the Government. The four documents are as follows:

- The Minister's Advisory Group
  Recommendations for Improving Alberta's Water Management and Allocation
- Alberta Water Council
  Recommendations for Improving Alberta's Water Allocation Transfer System
- The Alberta Water Research Institute (Alberta Innovates - Energy and Environment Solutions) *Towards Sustainability: Phase 1 – Ideas and Opportunities for Improving Water Allocation and Management in Alberta*
- Water Matters and Ecojustice
  Share the Water: Building a Secure Water Future for Alberta

The first two documents focus on the Alberta context, while the third investigated water allocation policies and practices in the western U.S. and Australia where the water challenges are similar to Alberta's, and developed recommendations in the context of the Alberta system. The Government of Alberta is working on building upon this work; however, changes to policy and legislation have not been released to date.

An outline of each of the documents is provided, with a brief description of return flow management integration into recommendations of each report. Return flow management is generally recommended within each document as part of a strategy to ensure water conservation objectives of each river basin are met. In addition, the reports indicate the lack of existing legislative requirement within water licenses and the enforcement of return flows in the current allocation and licensing system.

The Minister's Advisory Group report provides a detailed description of the issues developed by a lack of governance around return flow, and offers specific recommendations for improving the license and transfer system to address this. This report specifically considers impacts of return flow in the context of protecting water resources for environmental purposes and downstream users. A summary of advice with recommendations for the allocation system, and the specific recommendation (#5) that addresses return are provided below. Recommendation 5 of this report provides the greatest detail and consideration of return flow among all of the reports presented in this Appendix.

The Alberta Water Council report identifies the need to quantify and define return flow as part of a recommendation to develop a strategy to minimize risk to water conservation objective licenses. It identifies return flow management, where licences permit or terms are negotiated, as a potential mitigative measure.

The Alberta Water Research Institute (Alberta Innovates - Energy and Environment Solutions) report addresses return flow as one of the proposed strategies to address the Alberta *Water for Life* goal of water for people and communities, in the context of ensuring availability for downstream users. It also addresses water reuse as part of the strategies to address the Alberta *Water for Life* goal of Water for the Economy by recommending examination of opportunities to treat produced water and wastewater effluent so that these resources can be used for other purposes. It also states that the government should assure that water for economic development can only be achieved once the issues related to water for communities and water for nature have also been addressed, which includes return flow.

The Water Matters and Ecojustice report proposes a new type of "share" allocation system which recognizes variable annual and inter-annual river flows above the water conservation objective. The shares would entitle the holder to a portion of water available at specific time periods on a seasonal basis up to a specified maximum volume limit, as opposed to a fixed volume at any time regardless of the current flow conditions. In addition, return flows would be defined and enforceable as a percentage of the withdrawal. In this type of a system, monitoring, data collection, interpretation, and forecasting tools play a major role in determining the allowable seasonal withdrawals. On this basis the importance of return flows is more significant. The report suggests that the combination of real time monitoring and metering of water diverted and returned to the river will provide information required to provide real time watershed management decisions. Water licenses would therefore address more functional needs of the system at particular times of the year and climatic cycle.

The system would also recognize societal priorities for water use as identified in water management plans. Priorities would start with reservation of water for environmental purposes, water to meet Aboriginal rights obligations, and water required to meet apportionment obligations to other jurisdictions. After these priorities have been met, the issuance of shares must consider the balance between domestic, agricultural, industrial, and other uses identified in the water management plan for each basin. In order to accommodate these priorities, the report suggests the establishment of shares within three "pools of use, namely "domestic", "agricultural", and "industrial, commercial and other". The introduction to the report is provided below, which identifies the key recommendations.

Based on the observations and recommendations in all of the reports, it is clear that the definition and better management of return flow is necessary in order to implement a more effective allocation and transfer system that recognizes the needs for other users, namely, the environment and communities. Thus, the willingness and technical feasibility of water reuse application must be coupled with changes to legislation that directly affect water and wastewater use, but also to policy that considers the needs of the watershed. This will require a better understanding of how different water reuse applications will impact the volumes of water in the river at a specific time and location.

Recommendations on how to improve Alberta's water management and allocation system.
Minster's Advisory Group on Water Management and Allocation
August, 2009

The Minster's Advisory Group on Water Management and Allocation is pleased to provide its recommendations on how to improve Alberta's water management and allocation system. The Advisory Group (see Appendix A for list of members) was established in March 2009 and was tasked with:

1) *understanding the current water management and allocation system in Alberta,*
2) *understanding the current and future pressures and issues on the system provincially and specifically for each of the seven major basins as defined in the* Water Act*, and*
3) *making recommendations in a report to the Minister of Environment on how to improve the system to meet such pressures and issues.*

The Advisory Group was directed by the Minister to provide high-level observations and conclusions leading to strategic recommendations. It was recognized that the Advisory Group had a limited time to consider these complex issues and that it would provide broad guidance on directions for change without considering detailed questions of implementation. On that basis, the Group's report is attached for your consideration.

Summary of Advice
There is an urgent need to:

- *Establish levels of Protected Water for the purpose of protecting the environment and aquatic ecosystems in all major river basins in the Province. The government should not allocate water for consumptive uses where allocations would reduce Protected Water below the stipulated levels. Where existing licences prevent the stipulated levels of Protected Water from being met, the government should establish and implement a plan to achieve legal protection for the stipulated levels within a reasonable period. [Recommendations #1, 2, 3]*
- *Invigorate the current process for transferring existing water allocations. The goal is to allow water to be transferred to its most highly valued uses, while ensuring that transfers protect or enhance the environment and respect the rights of other water users. [Recommendations #4, 5, 6, 7, 8, 9]*

Alberta's water management and allocation system must achieve a number of more particular goals. In order to address the identified urgent needs, the Group recognised that it is necessary to:

- *Provide an expedited process for establishing Protected Water and in particular for setting interim Water Conservation Objectives in those basins that do not already have them. [Recommendations # 2, 3]*
- *Remove barriers to the transfer of water allocations except those that are genuinely required to protect the environment and the rights of other water users. [Recommendations #4, 5, 6, 7, 9]*
- *Facilitate participation in the process for transferring water allocations. [Recommendations #7, 9]*
- *Establish clear roles for regional and local stakeholder and advisory groups, such as Watershed Planning and Advisory Councils, and clear relationships between water allocation decisions, Water Management Plans and the Land-use Framework. [Recommendations #12, 13, 14]*
- *Increase the strategic use of existing and new storage as a beneficial tool in water management and allocation. [Recommendation #10]*

- *Take into account the inter-connection of groundwater and surface water, allowing the integrated, systematic management of groundwater and surface water. [Recommendation #11]*

The Advisory Group urges the consideration of longer term issues identified but not dealt with in this report, including:

- *Assessing additional mechanisms for unlocking existing unused water allocations.*
- *Examining alternative innovative regional governance approaches, including the use of basin commissions or authorities.*
- *Examining the relationship between irrigation districts, irrigation farmers and the transfer system by engaging in consultation with the Minister of Agriculture and Rural Development.*
- *Investigating whether the Province could accept money or other benefits in a transfer rather than simply holding back 10% of the water. This could be a consideration in cases where the monetary value of the water could be applied to improve instream flow conditions with significantly greater benefit to the river system than the 10% holdback provided for in the Water Act. [Recommendation #15]*

Overall, the Advisory Group believes that the current system as outlined in the Water Act*, including the system of prior allocation (commonly called first-in-time, first-in-right or FITFIR), continues to be a reasonable basis for allocating and reallocating water in Alberta at this time. The Water Act contains tools that if used more completely or with relatively straightforward changes would enable transfers to happen more quickly, easily and transparently in all major basins. This would allow water to move to more highly valued uses and permit licencees to better manage risk. The group concluded that more study would be required to determine whether the province should move away from the prior allocation system.*

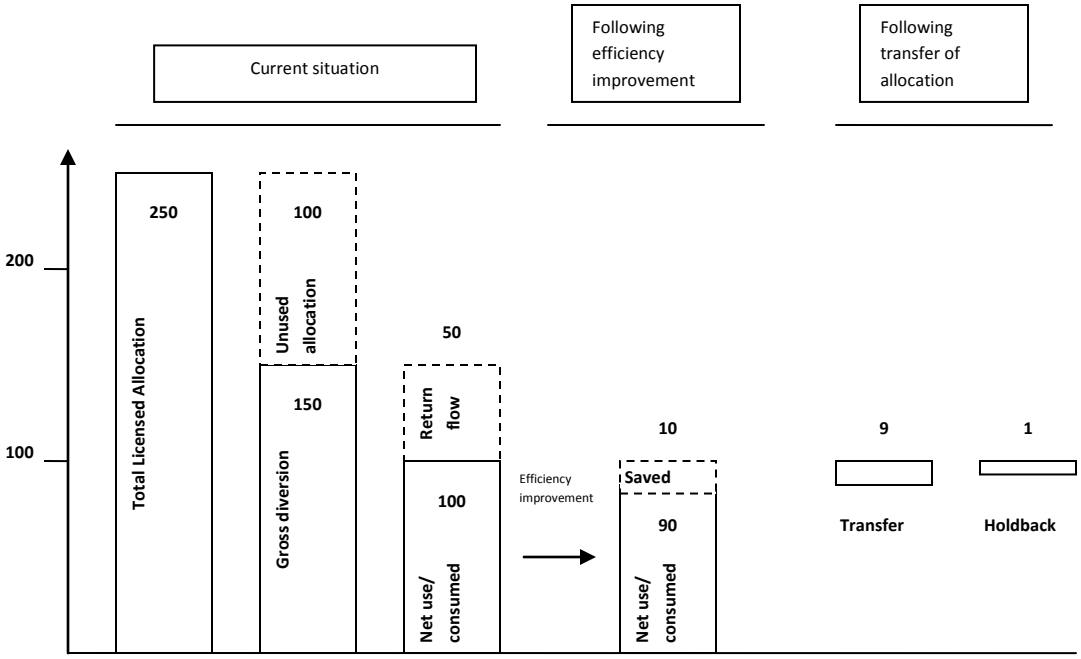
The Advisory Group's recommendations do not limit the ability of the Province to implement future changes in these areas.

Recommendation #5 –The Minister must clarify the amount of water the licencee is entitled to transfer. The Water Act does not deal clearly with this and it must ultimately be resolved for the transfer system to achieve its full potential.

The Minister must decide three issues relating to the nature of a licensee's entitlement to water. First, are licensees entitled to the gross amount of water stipulated in their license or only to the net amount of water that they consume under the terms of the licence? Secondly, are licencees entitled to hold the amounts of water stipulated in their licences even where those amounts exceed their foreseeable future needs or should the excess water or unused allocation be unlocked and made available to others? Third, while savings should be encouraged, when savings have been made by a licencee through increased efficiency in water use, should the licencee be allowed to retain (and transfer) all or only a portion of the saved water?

The operation of the transfer system in the SSRB has raised all three questions. The first asks whether licencees are entitled to transfer water that would normally return to the river as return flow, or whether the licencee must continue to allow normal return flow to go back into the river. The second asks whether the entitlement of a licencee is limited to the amount of water which it is likely to put to use in the foreseeable future. The third is controversial when the increase in efficiency has occurred in part through investments paid for by the government.

These situations can best be described by reference to an irrigation example (see diagram below).



The first situation deals with the important issue of return flow. Suppose that an irrigation district generally diverts 150,000 acre-feet [gross diversion] of its licenced allocation, but it never consumes more than 100,000 acre-feet in a given year [net use]. It returns a minimum of 50,000 acre-feet to the river in the form of return flow.

The issue for the Minister is whether the irrigation district is legally entitled to transfer up to 150,000 acre-feet to a new user [its gross diversion] or whether it can transfer only 100,000 acre-feet [the amount of its net use]. If licencees are entitled to transfer their gross diversion, the flow of the river will gradually diminish because of reduced amounts of return flow.

The Water Act *addresses this problem in two ways. Generally, it allows the Director to consider the effect of a transfer on the aquatic environment. More specifically, it allows the Director to take into account the amount of water historically diverted by the licencee. This allows the Director to ensure that the licencee does not transfer more than the amount of water it has historically diverted, but it does not prevent the licencee from transferring more water than it has historically used.*

If transfers are to be more widely employed, it is important to decide whether licencees are entitled to transfer amounts up to their net use or up to their gross diversion.

The second and the third situations both relate to unused water. The second situation occurs where licences are for amounts of water significantly in excess of the licencee's foreseeable future needs [unused allocation]. The third situation arises where there are water savings made by a licencee through investments in increased efficiency in water use.

The problem of unused water, whether resulting from an excess over foreseeable future needs or from savings made by the licencee, must be addressed on the basis of the following principles:

- *Any change to the existing rules must be fair and transparent.*

- *Changes should create incentives for existing licencees to make unused water available to others, rather than requiring unused water to be taken away against the wishes of the licencee.*
- *Changes must not penalise licencees whose investments in efficiency have created water that is surplus to their immediate needs. Water that has been saved since 1999 through the licencee's own investment should remain with the licencee and be available for transfer by the licencee. The Minister must decide whether the same principle applies when the saved water has been created wholly or partly through government investments.*
- *Changes must not cause significant harm or compromise Protected Water, as described above.*
- *If statutory changes are required to alter the rights of existing licencees to unused water, they should be implemented by a single statutory amendment to avoid continued uncertainty in the market.*
- *Any statutory change must provide the opportunity for existing licencees to demonstrate their need for the unused water before it is made available to others.*

The Advisory Group acknowledges that the responses to these questions will require careful consideration and further study. However, they must be resolved in order for the transfer system to work effectively.

Recommendations for Improving Alberta's Water Allocation Transfer System
Alberta Water Council
August 2009

In support of achieving the three goals of Water for Life, the Alberta Water Council established the Water Allocation Transfer System Upgrade Project Team with the mandate to "recommend improvements to better utilize and enhance Alberta's water allocation transfer system." As per their Terms of Reference, the team kept their work within the confines of existing legislation, specifically the Water Act. Currently, there are a number of projects focused on water allocation in Alberta and this work serves as one of several inputs to the Government of Alberta. After a year of examining Alberta's current water allocation transfer system, the Alberta Water Council is pleased to make a number of recommendations. If implemented, these improvements will greatly strengthen the water allocation transfer system. They will also ensure the system meets the social and economic needs of all Albertans, while still safeguarding the environment, now and in the future. The Council identified six areas for improvement and made a number of recommendations within each area that can be briefly summarized as follows:

1) Protected Water: *Before a water allocation transfer system can function effectively, an amount of water must be set aside for environmental and non‐consumptive purposes as determined in the public interest by the process established for creating a water management plan. This Protected Water will not be traded in the water allocation transfer market. This step is the foundation of, and contributes to certainty in, the water allocation transfer system. Setting the amount of Protected Water as a Water Conservation Objective for each of Alberta's seven major basins; developing Approved Water Management Plans; and regularly reviewing and improving such plans are additional activities required to*
ensure our water sources remain healthy and sustainable for future generations.

2) A Water Allocation Transfer Market: *A robust market must be established to incent the transfer of all or a portion of a water allocation between users. An active water allocation transfer market must be fair to all participants. It must be transparent and administratively efficient with clear objectives, principles and criteria. Once*

transfers are approved for use in a basin, all existing water allocation licence-holders 'in good standing' can participate in a market subject to conditions or requirements around participation, specific to each basin.

3) Unused Water for the Market: *Certainty about the amount of water available for transfer is also a foundational requirement of the water allocation transfer system. Unused water or water gains made through conservation and efficiency can be made available to meet the needs of new users. Although there are acceptable reasons to hold unused water in a licence, criteria need to be developed to clarify such situations. In addition, a decision tree is proposed for determining if an existing licence is transferable. The principles of 'in good standing' and 'reasonable prospect of use' are used to guide decision-making. Every potential transfer must be assessed to ensure it satisfies the 'does no significant harm' principle.*

4) Conserving Water: *Water conservation is a cornerstone of the Water for Life strategy. Improved conservation efforts will make more water available to meet ecosystem and economic goals of the province. Hence, an improved water allocation transfer system should promote water conservation, efficiency and productivity and should not be at cross purposes to such initiatives. Additionally, to manage their risk, all water licence-holders should be prepared for, and develop, a Water Shortage Response Plan.*

5) Applying for a Transfer: *The water allocation transfer system requires an effective application and approval process. To facilitate this, three classes of applications are proposed based on the level of risk to society and the level of discretion to be exercised by the Director in the public interest. Simple transfers will be processed relatively quickly; transfers that are more complex will come under increasing scrutiny by the Director, by directly affected parties, and those who may achieve public interest standing.*

6) Data and Information Platforms: *An improved water allocation transfer system will require solid data and sound information to inform decision-making. An information platform must be accessible to all participants such that available volumes, prices and other pertinent information are known to both parties in a transaction. In general, the Alberta Water Council found that with the improvements recommended in this report, the water allocation transfer system can continue to serve the province well. For the most part, there was agreement regarding where improvements were needed and what actions were required. However, despite sincere commitment and extensive discussion in the available time, consensus was not reached on some items. Out of a total of 23 recommendations in this report, there are two recommendations that do not have unanimous support. Of the 15 member groups represented on the council's Water Allocation Transfer System Upgrade Project Team, two member groups do not support Recommendation 16 and one member group does not support Recommendation 19. In addition, there are two recommendations that are supported by all team members, but are felt by some to not go far enough; specifically, two member groups believe that Recommendations 1 and 8 do not go far enough. Hence, for 21 of the 23 recommendations there is consensus support. It will take a concerted effort and time to implement an improved and robust water allocation transfer system in Alberta. This system must be adaptive and should have performance indicators and periodic review and assessment built into it. However, as the province begins closing its basins to new allocations, time is of the essence. Unless otherwise noted, all recommendations in this report are directed to the Government of Alberta.*

Towards Sustainability: Phase I
Ideas and Opportunities for Improving Water Allocation and Management in Alberta,
Alberta Water Research Institute
November, 2009

The Alberta Water Research Institute (AWRI) was established in the spring 2007 to coordinate world class and leading edge research to support Alberta's provincial water strategy, Water for Life: A Strategy for Sustainability.

This report was developed based on an assessment of North American and Australian allocation and licensing systems. "These regions appear to have had similar approaches to water laws, governance and practice to that of Alberta. The goal of the review was to examine the underpinnings of water allocation and management in those regions, identify the range of successes and failures, and compare this experience to the Alberta situation."

Alberta's historic water legislation and its accompanying licensing system have provided the security needed to support much of Alberta's economic growth, especially in southern Alberta. However, with increasing recognition of the need to develop a more deliberate and integrated approach to water management to address a multitude of uses with a watershed context, the effectiveness of allocation legislation and policy must be revisited. The Alberta Water Research Institute has recently examined water allocation practices and legislation in various jurisdictions around the world to identify lessons, ideas and opportunities that may be applicable to Alberta. These opportunities are presented below in terms of the three major objectives in Alberta's Water for Life *strategy.*

Water for People and Communities

With the population of many communities expected continue to grow rapidly for the foreseeable future, will there be sufficient quality water to support this growth? Current Alberta legislation sees municipal water use being like every other, with priority during dry conditions assigned to uses with the oldest licences, regardless of purpose. There is growing concern that this system of priorities may no longer be appropriate and that critical human needs may be the most important priority during times of drought. What steps can Alberta take to ensure adequate water for people and communities?

- *Develop criteria for defining critical human uses that should receive priority during extreme shortages*
- *Explore how current municipal licences could be shared as part of a regional approach to address drought*
- *Re-evaluate and "right size" municipal licences to reflect current and expected water use*
- *Make water use reporting mandatory and provide the public with access to the information*
- *Improve management of return flows to ensure that treated wastewater and stormwater are returned to streams and are available to downstream users.*
- *Ask – should municipal users be exempt from requiring a diversion licence as long as they return as much water after use as they diverted in the first place?*

Water for Nature (Healthy Aquatic Ecosystems)

There are increasing concerns about the adequacy and priority of water allocations for nature, especially in those basins where much of the flow has been allocated for consumptive use. Fortunately, Alberta's obligations under the Master Agreement on Apportionment, which restrict us to using only half the flow east flowing rivers, mean that our rivers are healthier that in many other jurisdictions where nearly all of the flows have been allocated for

consumptive purposes. However, there still concerns that the Water Conservation Objectives for southern rivers are not currently being met, resulting in deteriorating aquatic health, and that there are no WCOs for rivers elsewhere in the province. What steps can Alberta take to ensure adequate water for nature?

- *Establish interim WCOs for reaches of streams and tributaries in the South Saskatchewan River Basin and for watersheds that are not yet fully allocated*
- *Undertake pilot projects to determine the extent to which water management infrastructure, which is owned by a combination of government and private interests, could be managed in concert to meet multiple objectives without detracting from current licensed allocations*
- *Allow organizations other than government to secure and hold water for environmental purposes*

Water for the Economy

The key economic drivers in Alberta – agriculture in the south and energy development in the north – are highly reliant on water, and future economic growth will require additional water that simply may not be available in some part of the province. While industry continues to identify and adopt technology and innovation that has resulted in reduced intensity of water use, total water requirements for the economy will continue to increase. In other jurisdictions, industry has been able to secure water by purchasing water rights from other users, resulting in water being reallocated to "high value" purposes, such as higher value horticultural crops rather than irrigation of forages. Most jurisdictions are investigating opportunities to streamline the functioning of their water markets to facilitate the reallocation of water to support economic growth. What steps can Alberta take to ensure adequate water for the economy?

- *Require better reporting of actual water use by agriculture and industry to support water management and provide clarity on the nature of water use entitlements that can be traded*
- *Use grant money to irrigation districts and other water users to promote increased water use efficiency, with the government retaining the rights to some of the saved water.*
- *Examine collective opportunities for securing sufficient water for oil sands development, rather than require individual operators to individually address their own water requirements*
- *Examine opportunities for treating produced water and municipal effluent so that these resources can be used for other purposes.*
- *Develop administrative procedures for water licences transfers that protect third party interests but do not represent significant barriers to the buying and selling of water licences.*
- *Assure water for economic development can only be achieved once the issues related to water for communities and water for nature have also been addressed.*

In conclusion, it appears that, on "paper", many of Alberta's short to medium term (three to 10 years) water management objectives can be attained under the current provisions of Alberta's first-in-time, first-in-right (FIT FIR) system. This assumes, however, that government, licensees, water users and other stakeholders commit to meeting the long terms needs of water for people and communities and improve the practice of assuring water for nature. By strategically dealing with these foundational issues, creative solutions can be found to meeting the changing needs of water in Alberta's economy.

Phase II of this work will explore a number of future oriented development scenarios against which to evaluate ideas, opportunities and solutions. In 2010, AWRI will convene a number of workshops with key water stakeholders and develop a suite of logical scenarios along with their respective range of solutions.

Share the Water: Building a Secure Water Future for Alberta; Introduction
Water Matters and Ecojustice
September, 2009

When it comes to water, Alberta is at a crossroads. In the twenty-first century, Alberta faces new challenges. We now know that Alberta's water supplies are not limitless. In fact, they are decreasing. Over the past three decades, Albertans, along with the rest of the world, have come to recognize the environmental values associated with natural watercourses, aquatic ecosystems, fisheries, and wildlife. The Government of Alberta has passed laws to protect water quality from industrial pollutants, but laws to protect instream water quantity have not kept pace.

For the first time in 12 years, the Alberta government is considering whether to update their water allocation system. Increasingly, it has become apparent that there are more and more demands for a resource that is dwindling. By the close of 2005, Alberta had allocated more than 9.5 billion cubic metres of water annually for various uses throughout the province. Today, the South Saskatchewan River is over-allocated and there are strong arguments that the North Saskatchewan River is headed in the same direction.

Alberta's current system to allocate water among all users is no longer able to fully respond to population growth, opportunities for industrial growth, reduced water flows, and the coming challenges of climate change. Without significant changes, the current water allocation system will produce winners and losers without any rational consideration of how we want water to be used for the benefit of Albertans.

Specific recommendations include the following:

1. *Legally enforceable water management plans for each basin, developed using the best available scientific evidence;*
2. *Legally enforceable objectives that protect instream flow needs for each basin;*
3. *Water entitlements based on water "shares" allocating a percentage of the water available in excess of the water left instream. Water volumes allocated to each share are to be adjusted seasonally, and more often if needed, in response to predicted flows in the basin;*
4. *Provided water is secured for people and the environment, establish a water allocation and share trading system that facilitates the re-allocation of water from one use to another;*
5. *The ability of the public to hold water shares for instream purposes;*
6. *The use of incentives to encourage water conservation and the efficient use of water; and*
7. *The inclusion of groundwater in the water management system.*

The purpose of this paper is to inspire Albertans to participate in the discussion about Alberta's water future in an informed manner. The Government of Alberta has provided its citizens with the opportunity to reform the water allocation system. Albertans should participate in defining a new water future for Alberta.

Appendix C: United States environmental protection agency water reuse applications category definitions

The following is a list of water reuse application categories as they relate to specific state regulations and guidelines (USEPA, 2004).

- Unrestricted urban reuse – irrigation of areas in which public access is not restricted, such as parks, playgrounds, school yards, and residences; toilet flushing, air conditioning, fire protection, construction, ornamental fountains, and aesthetic impoundments.
- Restricted urban reuse – irrigation of areas in which public access can be controlled, such as golf courses, cemeteries, and highway medians.
- Agricultural reuse on food crops – irrigation of food crops which are intended for direct human consumption, often further classified as to whether the food crop is to be processed or consumed raw.
- Agricultural reuse on non-food crops – irrigation of fodder, fiber, and seed crops, pasture land, commercial nurseries, and sod farms.
- Unrestricted recreational reuse – an impoundment of water in which no limitations are imposed on body-contact water recreation activities.
- Restricted recreational reuse – an impoundment of reclaimed water in which recreation is limited to fishing, boating, and other non-contact recreational activities.
- Environmental reuse – reclaimed water used to create manmade wetlands, enhance natural wetlands, and sustain or augment stream flows.
- Industrial reuse – reclaimed water used in industrial facilities primarily for cooling system make-up water, boiler-feed water, process water, and general washdown.
- Groundwater recharge – using either infiltration basins, percolation ponds, or injection wells to recharge aquifers.
- Indirect potable reuse – the intentional discharge of highly treated reclaimed water into surface waters or groundwater that are or will be used as a source of potable water.

States with regulations or guidelines pertaining to the use of reclaimed water for the following unrestricted urban reuse categories are:

- Toilet Flushing – Arizona, California, Florida, Hawaii, Massachusetts, New Jersey, North Carolina, Texas, Utah, and Washington
- Fire Protection – Arizona, California, Florida, Hawaii, New Jersey, North Carolina, Texas, Utah, and Washington
- Construction Purposes – Arizona, California, Florida, Hawaii, New Jersey, North Carolina, Oregon, Utah, and Washington
- Landscape or Aesthetic Impoundments – Arizona, California, Colorado, Florida, Hawaii, Nevada, New Jersey, North Carolina, Oregon, Texas, and Washington
- Street Cleaning – Arizona, California, Florida, Hawaii, North Carolina, and Washington