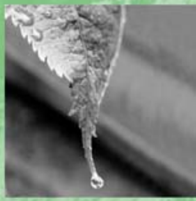
water for life



reliable, quality water supplies
for a sustainable economy

current and future water use in alberta

> november 2007

Alberta

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CURRENT AND FUTURE WATER USE IN ALBERTA

Prepared for
Alberta Environment
Edmonton, Alberta

Prepared by
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Edmonton, Alberta

March 2007

FOREWORD

This report was commissioned by Alberta Environment (AENV) to begin to answer some of the fundamental underlying questions raised in *Water for Life*. In particular, one of the key outcomes is "Reliable, quality water supplies for a sustainable economy". In measuring progress toward achieving our outcomes, some reasonable definitions and appropriate benchmarks need to be established. How does one define "reliable"? Reliability depends on many factors, but water management relies fundamentally on two concepts: supply and demand. "Reliable" can then defined by the relationship between the two, and whether there is now or in the future a fundamental gap - where it is, how big, and how it is changing.

While our knowledge of surface water supply is the province is generally in good shape (climate change uncertainty and groundwater resources notwithstanding), our understanding of actual water use, patterns and trends is limited. This lack of data was proving to be a critical limitation in many baseline assessments and planning exercises. The *a priori* assumption is that Alberta is booming, population and industry will need more water, and water is increasingly scarce. But where are these needs located? How much growth in demand is expected? Can we accommodate future needs by improving conservation and efficiency within existing uses or should we look at more radical solutions? To begin to answer these questions, AENV this study to provide an overview f current water use in Alberta with an outlook to the future.

For readers to fully understand the contents of this report, it is important that they first understand the scope, **and the limitations**, of this assessment.

AENV's vision for this document is to provide a baseline; a starting point; a frame of reference. It has been completed at a provincial overview level and is intended primarily for planning purposes but also to highlight gaps in our existing data and knowledge. In the numerous instances where actual data is missing, estimates are used. **Undoubtedly better information will emerge over time and assumptions made herein will be tested.** For that reason, the reader should bear in mind the context in which the assessment was done: this is not the final say on the matter; rather, it is only a first step in a process of information gathering and analysis.

Results are presented by sector and by major river basin. One of the reasons this format was chosen was so that Watershed Planning and Advisory Councils (WPACs) could relatively easily take the information in a compartmentalized fashion (their "chapter", plus the foreword, methodology and executive and Alberta summaries) and have a foundation upon which to prioritize and identify key issues at a regional scale. Just as the river basins of Alberta have diverse issues related to water use, supply and pressures, so too will individual river basins, especially as they are broken down at increasingly smaller scales. Therefore, the refinement of data and assumptions is expected to be an ongoing process as AENV, WPACs and others are able to tighten their focus over time and improve our understanding overall. **This report highlights the need for the collection of actual water use information if we are to make the best possible decisions about this critical resource.**

Alberta Environment
July 2007

EXECUTIVE SUMMARY

Purpose

Alberta's *Water for Life* strategy, released in 2003, confirmed that Albertans want a safe, secure drinking water supply, healthy aquatic ecosystems and reliable, quality water supplies for a sustainable economy, and established a series of research priorities and action that will ensure that these goals are attained. Information and knowledge of water resources was identified as the most critical element in being able to manage water efficiently. A starting point in effective water management is to understand the extent to which water resources have already been committed to human and economic activity. How much water has been allocated? How much is currently being used? Within this context, Alberta Environment (AENV) commissioned AMEC Earth & Environmental (AMEC) to undertake a study to determine current water allocations and use and water use forecasts for Alberta's 12 river basins: Milk, Oldman, Bow, South Saskatchewan, Red Deer, North Saskatchewan, Battle (includes Sounding Creek), Beaver, Athabasca, Peace/Slave (includes Lake Athabasca, Great Slave Lake, and Buffalo), Hay and Liard.

Scope and Methodology

The assessment differentiates between water allocations, which represent the amount of water that licensees are entitled to take from surface or groundwater sources, and licensed water use, which is component of the licence that is expected to be consumed or lost. The difference between water allocation and water use consists of return flow, which is available for reuse. Water licence information was provided by AENV in October 2006. The assessment included surface water and groundwater use and focussed on six sectors: municipal and residential, agricultural, commercial, petroleum, industrial and other. Each sector is divided into a number of activities.

The assessment also differentiates between licensed water use and actual water use. Municipal water use for 2005 was determined based on a review of water use information available from AENV and Environment Canada and Census 2001 data, which was also used to describe demographic and economic characteristics and trends in the basin. Agricultural water use was estimated based on discussions with AENV and through a review of Census of Agriculture data. Petroleum water use was estimated based on Alberta Energy and Utilities Board (EUB) data provided by Geowa Information Technologies, Ltd. and data obtained from AENV. Industrial water use was estimated based on data available in the AENV's electronic Water Use Reporting System database (WURS) and data provided by the major licence holders. As WURS contains no actual water use information for the commercial or other sectors and reviewing the paper files for water use information was beyond the scope of this study, water use for these sectors was assumed to be as specified in the licences.

Water use forecasts were prepared for five-year intervals up to 2025 using 2005 as the base year. Forecasts were based on expected changes in populations and economic activity, as described using available projections provided by provincial government agencies and the private sector. These forecasts represent "business-as-usual" predictions of water use in that no allowance is made for any significant changes in efficiency or productivity that are likely to result from initiatives under Alberta's *Water for Life* strategy.

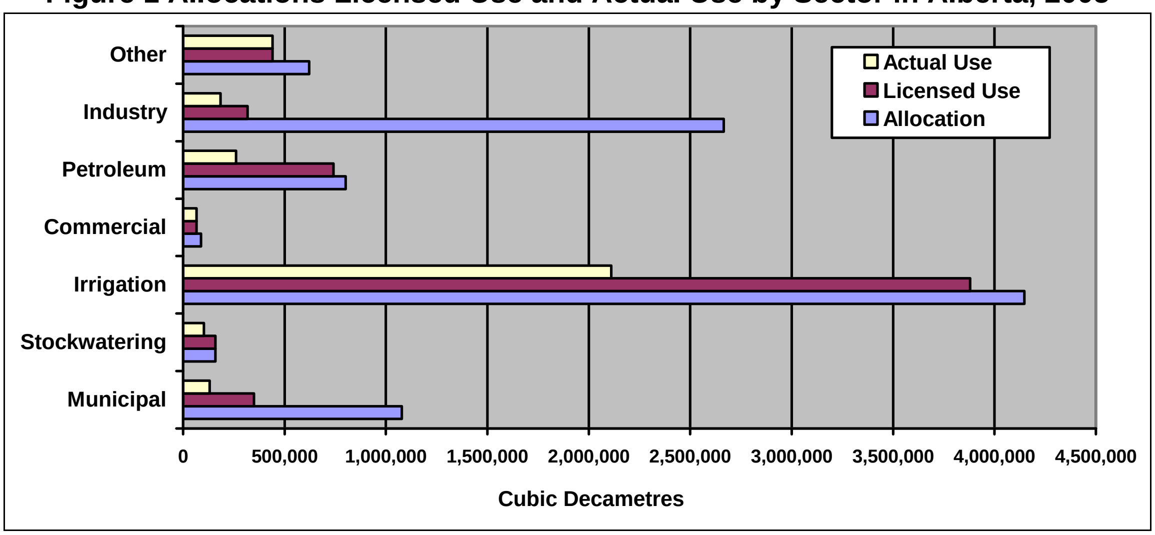
Summary of Results by Sector

Allocation, licensed use and actual use for the 12 basins are shown in Figure 1. As of December 2005, licences and registrations issued in Alberta allocated 9,563,218 dam^3 of water for various purposes. Of this, 9,254,931 dam^3 was for surface water and 308,287 dam^3 was for groundwater. The irrigation sector accounts for 43 percent of the total water allocations. The industrial sector accounts for 28 percent of allocations followed by the municipal (11 percent), petroleum (eight percent), other (seven percent), stockwatering (two percent), and commercial sectors (one percent).

Licensed use, which represents the amount of water that can be consumed or lost under the terms of existing licences and registrations, was estimated to be about 5,955,594 dam^3, or 62 percent of allocations. Figure 1 shows the difference between allocations and licensed use for each of the major sectors. The largest differences are for the municipal and industrial sectors, which have large return flow allowances in their licences. Thermal power plants, for example, are expected to consume only 10 percent of their allocations while licences issued to municipalities assume that 68 percent of withdrawals are returned, although actual returns may be even greater.

Based on available water use information for 2005 and discussions with both government and industry sources, it is estimated that 3,297,876 dam^3 (55 percent of licensed use) was actually used in Alberta. The largest water user in Alberta was the irrigation sector (63 percent) followed by the other sector (13 percent), and the petroleum sector (eight percent). The remaining activities account for a relatively small amount of estimated water use.

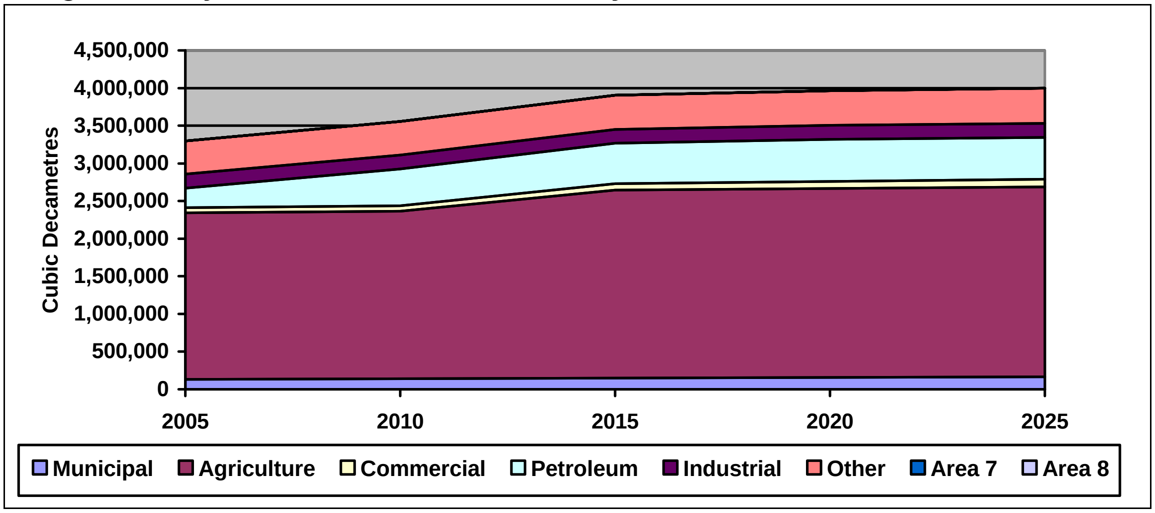
Figure 1 Allocations Licensed Use and Actual Use by Sector in Alberta, 2005



Forecasts of future water use were developed for each of the major water use sectors under the Low, Medium and High Growth scenarios. The net result of these forecasts is that water use in Alberta is predicted to increase to over 3,998,600 dam^3 by 2025 which is a 21 percent increase from current use (Figure 2). The majority of increased demand is expected to come from the petroleum sector for the period to 2010 as additional oilsands mines begin operation and

upgraders are constructed to process bitumen. Between 2010 and 2015, the irrigation sector is expected to account for the largest increase in water use, but this will stabilize once the irrigation districts are operating at maximum capacity. While water use in the other sector is also expected to increase, these changes will be fairly small compared to changes expected for the irrigation and industrial sectors.

Figure 2 Projected Water Use in Alberta by Sector, Medium Growth, 2005-2025

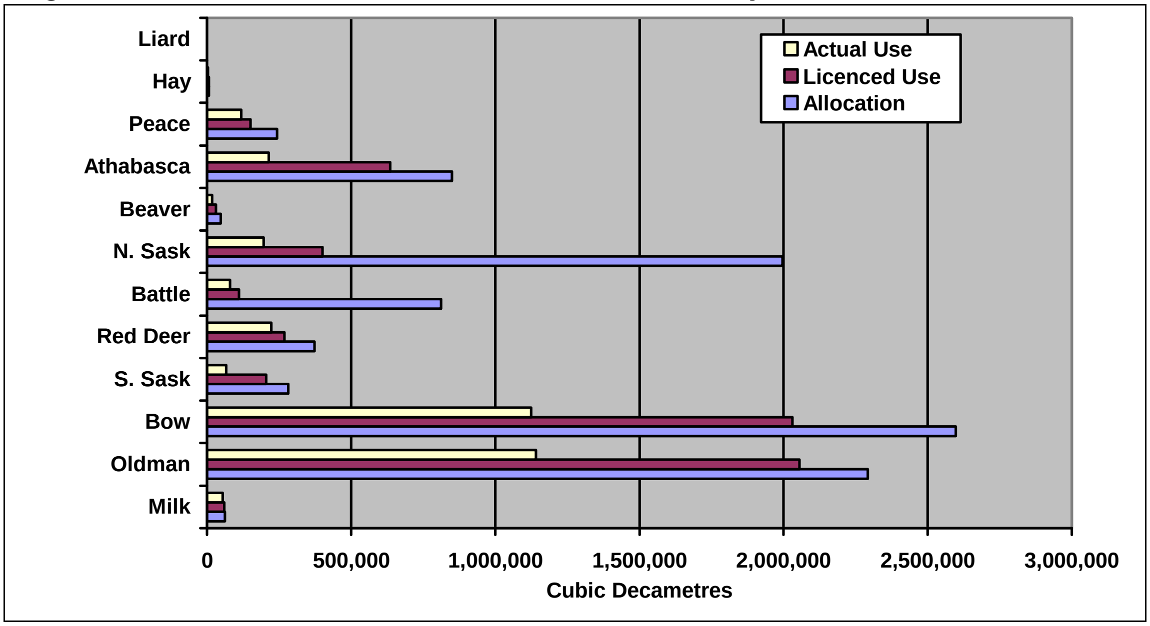


Summary of Results by River Basin

Water allocation, licensed use and actual use vary substantially across Alberta's 12 major river basins. Almost 75 percent of the province's water allocations have been issued in the Bow, Oldman and North Saskatchewan river basins. As of December 2005, licences and registrations issued in Alberta allocated 2,597,894 dam^3 of water in the Bow, 2,292,401 dam^3 in the Oldman and 1,996,839 dam^3 in the North Saskatchewan. These large allocations are associated with the irrigation districts in the southern basins and thermal power plants in the North Saskatchewan River Basin.

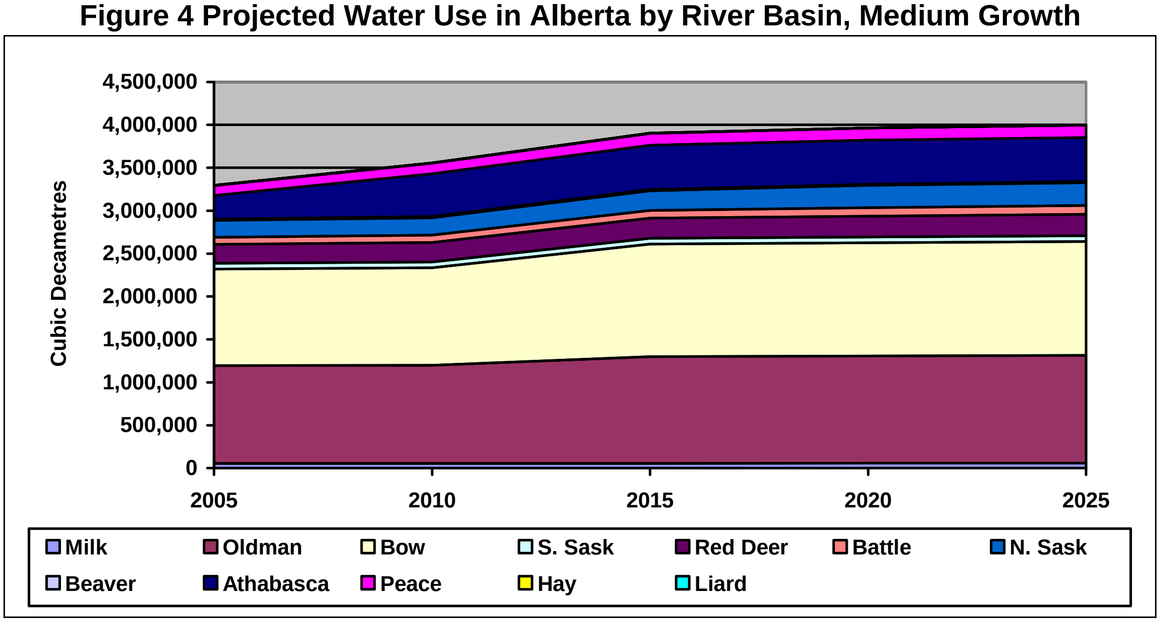
The Bow and the Oldman river basins are also estimated to account for the majority (67 percent) of estimated water use in the province in 2005 (2,265,078 dam^3 combined). The Athabasca basin is estimated to have had the third largest water use (eight percent), primarily because of water use by the petroleum sector, oilsands mines in particular. Other basins that accounted for relatively large amounts of water use in 2005 include the Red Deer basin (seven percent), North Saskatchewan (six percent), and the Peace (four percent). A relatively small amount of water was estimated to be used in the remaining six basins. Figure 3 shows the difference between allocations, licensed use and estimated actual use for 2005.

Figure 3 Allocations, Licensed Use and Actual Use by River Basin, Alberta, 2005



Projections of future water use in Alberta under the Medium Growth scenario are provided in Figure 4 for each of the river basins. It shows that, in the near future, most of the increases in water use will occur in the Athabasca River Basin as a number of oilsands mines become fully operational. Between 2010 and 2015 water use in the Bow and Oldman river basins is expected to increase due to irrigation. However, after 2015, water use is expected to level off as general population-based increases in water use are offset by continuing decreases in water use for injection purposes and as various industries improve their operating efficiencies.

Figure 4 Projected Water Use in Alberta by River Basin, Medium Growth



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1.0 INTRODUCTION

Alberta's *Water for Life* strategy, released in 2003, created a new agenda for water management in Alberta. The strategy confirmed that Albertans want a safe, secure drinking water supply, healthy aquatic ecosystems and reliable, quality water supplies for a sustainable economy, and established a series of research priorities and action that will ensure that these goals are attained. One of the key directions in the strategy was Knowledge and Research: Albertans will have the knowledge needed to achieve safe drinking water, efficient water use and healthy watersheds. Information and knowledge of provincial water resources was identified as the most critical element in being able to manage water efficiently.

A starting point in effective water management is to understand the extent to which Alberta's water resources have already been committed to human and economic activity. How much water has been allocated? How much is currently being used? The answers to these questions are fundamental to the calculation of natural flows, which are used as the basis for determining healthy ecosystems, and as the basis for developing management plans for each of the province's watershed. Understanding current water use is also necessary for developing and assessing the effects of water conservation and productivity plans. And, by examining recent trends in water use, forecasts of water use can be developed to assist water managers in identifying potential problems before they occur.

In recognition of the need for a better understanding of current and future water use, Alberta Environment commissioned a study to determine current water allocations and use by each of the major types of water use in each of the province's 17 basins. AMEC Earth and Environmental (AMEC) was retained to complete this study and a summary of its findings are presented in this report.

1.1 APPROACH

This assessment of water demand in Alberta involves four major tasks:

1. Establishing current water use patterns in the basin by examining the maximum amounts of water that can be withdrawn, consumed or lost under the terms of all existing and cancelled surface and groundwater licences and registrations. This use pattern was derived based on the review of the database of licences and registration information maintained by Alberta Environment (EMS database).

2. Determining actual water withdrawals and use through a review of Water Use Reporting System (WURS) plus any applicable available information.

3. Developing socioeconomic profiles for each basin.

4. Identifying water use major trends and factors and preparing water demand forecasts up to 2025, using 5-year intervals from 2005.

This analysis of water demand relies predominantly on historic and existing information available in electronic databases.

1.2 RIVER BASINS OF ALBERTA

Although the *Water Act* defines Alberta as having seven major river basins for purposes of administering the legislation, some of these basins are recognized as consisting of a number of significant sub-basins. For example, the South Saskatchewan River Basin consists of the Red Deer, Bow, Oldman and South Saskatchewan sub-basins. Overall, there are 17 commonly-referenced river basins in Alberta. These 17 river basins are shown in Figure 1.2-1. Some of these are very large and warrant individual attention. However, some are quite small and have limited water use. In order to provide a more meaningful and accurate assessment of water demand, this study reports water use in 12 river basins, modified from the 17 basins listed in Figure 1-1. These 12 basins include:

1. Milk
2. Oldman
3. Bow
4. South Saskatchewan
5. Red Deer
6. Battle (includes Sounding Creek)
7. North Saskatchewan
8. Beaver
9. Athabasca
10. Peace/Slave (includes Lake Athabasca, Great Slave Lake, and Buffalo)
11. Hay
12. Liard

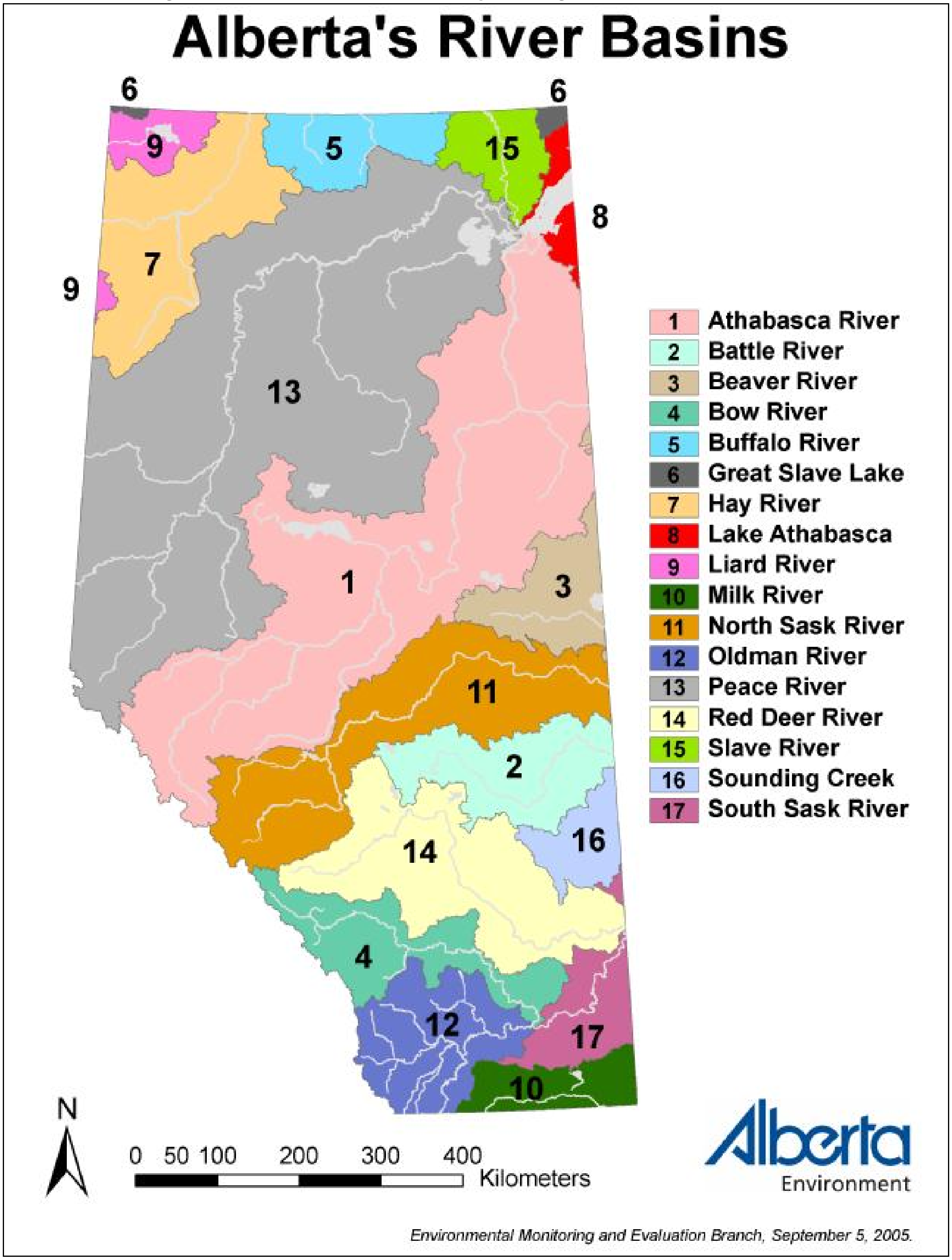
Sounding Creek was included in the Battle River Basin. Some of the small northern basins that contain little or no water use activity were included in the Peace/Slave Basin. Mean annual natural flows of Alberta's major rivers are shown in Table 1-1. Volumes are expressed in terms of cubic decametres (dam^3). The difference between inflow and outflow consists of surface run-off generated within the Province of Alberta.

Table 1-1 Mean Natural Annual Flow of Alberta Rivers

River Basin	Mean Annual Inflow into Alberta (dam^3)	Mean Annual Outflow from Alberta (dam^3)
Athabasca	2,290,000	
Battle		278,000
Beaver		613,000
Bow		Included in S. Sask
Hay	697,000	3,564,000
Liard		952,000
Milk	102,000	160,000
North Saskatchewan		7,277,000
Oldman	1,558,000	Included in S. Sask
Peace/Slave	65,580,000	109,053,000
Red Deer		1,837,000
South Saskatchewan		7,425,000
Total	**70,227,000**	**131,159,000**

Source: Alberta Environment (2005)

Figure 1-1 Alberta's commonly Recognized 17 River Basins



1.3 WATER USE CATEGORIES

Residents and businesses in Alberta draw water from surface and groundwater sources. Under the Alberta *Water Act* there are four ways in which a person can legally use water:

1. Household purposes – People owning or occupying land adjacent to surface water or under which groundwater exist can use up to 1,250 m^3 per year without requiring a licence.

2. Traditional agricultural use – Farmers owning land adjacent to surface water or under which groundwater exists could register to use up to 6,250 m^3 per year with priority based on date when water was first used. Applications for registrations had to be submitted prior to December 31, 2001 (within three years of the proclamation of the *Water Act*).

3. All other uses – A licence is required for all other diversions and the priority is based on the date the complete application was received.

4. Exempted agricultural use – The *Water Act* allows farmers who own land adjacent to surface water or under which groundwater exists and who used water for raising animals or applying pesticides prior to 1999, to use up to 6,250 m^3 per year without having to acquire a licence. This use has no priority.

Based on available information, this assessment focuses on traditional agricultural users (registrations) and all licensed water uses.

1.4 TERMS AND DEFINITIONS

NSRB North Saskatchewan River Basin

SSRB South Saskatchewan River Basin

Water allocation refers to the amount of water that can be diverted for use, as set out in water licences or the *Water Act*. These allocations include maximum amounts of water that can be withdrawn as well as the rate of withdrawal. An allocation is generally based on the maximum amount of water that an applicant expects will be required over the licensing period.

Water diversion (or withdrawal) describes the amount of water being removed from a surface or groundwater source, either permanently or temporarily. Water diversions are typically less than water allocations because the full licensed amount is often not used.

Water consumption is the amount of water that is used for the intended purpose (*e.g.,* crop production, oilfield injection) and is not available for reuse.

Losses refers to water that is withdrawn for a particular use but is lost, either due to evaporation or seepage, and is not available for immediate reuse.

Return flow is water that is returned to surface water sources after use and is available for reuse, although the water quality characteristics may have changed during use. Typical return flows include discharges from sewage treatment plants, run-off from irrigated fields, and water discharged from cooling ponds.

Water use is considered to be the combination of consumption and losses or, alternatively represents the difference between the amount of water diverted and the return flow.

A graphical representation of these terms and their definitions are provided in Figure 1.2. This report uses metric units of measurements. Imperial units of measure can be calculated using the conversion factors provided in Table 1.2.

Figure 1-2 Key Water use Concepts and Terms

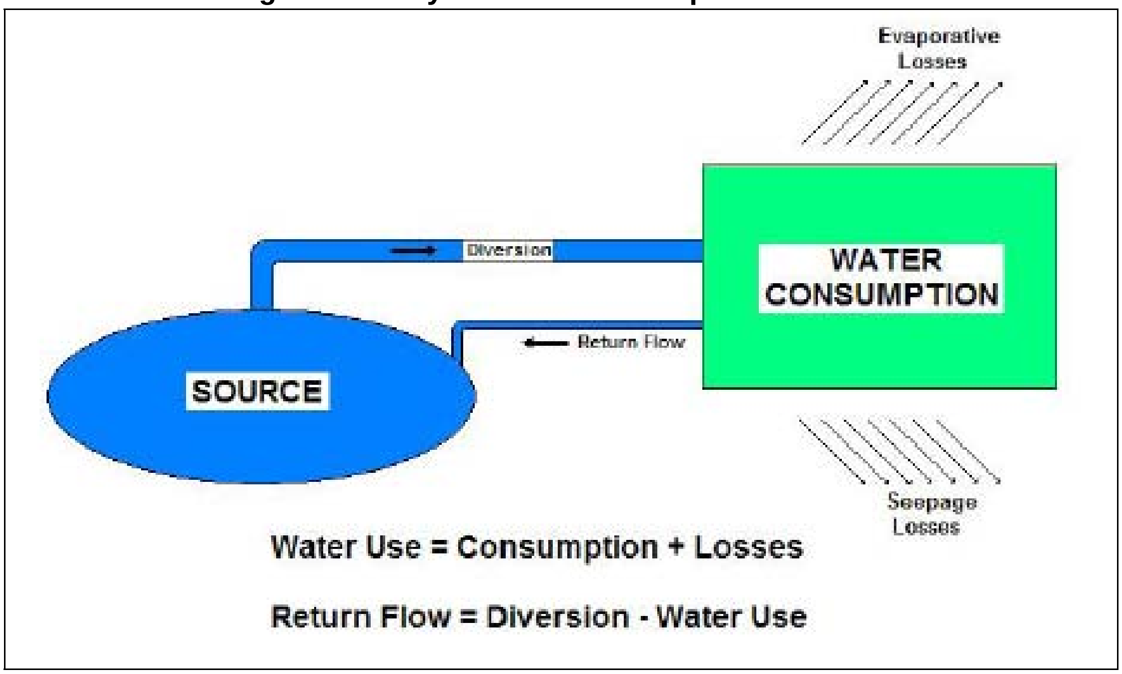


Table 1-2 Unit Conversion Factors

	Metric Units	Imperial Units
Length	1.0 millimetre (mm) 1.0 metre (m) 1.0 kilometres (km)	= 0.039 inches (in) = 3.281 feet (ft) = 0.621 miles (mi)
Area	1.0 hectare (ha) 1.0 square kilometre (km^2)	= 2.471 acres (ac) = 0.386 square miles (mi^2)
Volume	1.0 litre (l) = 0.001 cubic metre (m^3) 1.0 cubic metre (m^3) 1.0 cubic decametre (dam^3) = 1,000 m^3	= 0.0353 cubic feet = 0.21998 gallons = 35.315 cubic feet (ft^3) = 220.1 gallons = 0.811 acre-feet (ac.ft.)

2.0 METHODOLOGY

The methodology for the study consists of three components: understanding the allocations, current water use and preparing water use forecasts.

2.1 WATER ALLOCATIONS

In Alberta, water is allocated under the *Water Act* in terms of licences and registrations. A complete list of ground and surface water licences and registrations, as recorded in the Environmental Management System (EMS), was provided by Alberta Environment in October 2006. The EMS database includes a list of all active, cancelled, and expired water licences (approximately 32,000). The EMS database also includes approximately 90,000 registrations. The analysis of current water demand only considered active water licences (approximately 26,000), although cancelled and expired were used to determine historical trends. In addition, licences that did not contain allocations were excluded from the analysis. This report uses 2005 as the base year for the analysis. A minor error was discovered in the licence date assignation after the analysis was complete for the municipal sector. The result of this error that only 99.5 percent of the actual municipal allocations were included in the analysis, however, there was no significant variability in error distribution among the basins. The error was within one percent for all basins, with the exception of Oldman Basin, for which the analysis was based on an allocation two percent below the actual municipal allocation.

Three water use factors are considered in issuing water allocations. Allocations reflect the amount of water that the licensee is expected to consume, plus losses due to seepage or evaporation, and a possible allowance for returning water back to rivers and lakes after use. In this assessment, the term “licensed water use” reflects those components of the allocation that are expected to be consumed or lost. In determining what percentage of allocations is currently being used, actual water use is compared to licensed water use. While understanding the return flow allowance is important because return flows represent water that can be available for

use by other licensees, the allowances only form part of the overall allocation and are not enforceable.

The main objective in reviewing water allocations was to organize the licence data into specific water use sectors that could then be used for preparing water use forecasts for each river basin. The licence information for each sector was then aggregated to produce estimates of the maximum water volumes that could be diverted, maximum consumption, losses and return flows identified in the terms of these licences. The water use sectors developed for this assessment were determined in consultation with Alberta Environment and reflect a refinement of the “Activity” and “”Specific Activity” classifications currently used in the EMS database. These refinements are necessary because some of the categories in EMS are so broad that it is not currently possible to differentiate among water used in oil sands plants from water used in coal mining or chemical plants. In addition, variations in licensing practices among Alberta Environment offices has meant that some uses currently identified as “Commercial” are also classified as “Industrial”, so it was necessary to reclassify licences to improve overall consistency and to align with the economic sectors used for water use forecasting.

Overall, six general water use sectors are used in this assessment. These six sectors, and the individual water uses contained in each sector are described in Table 2-1. The classification of water licences into the six sectors involved looking at the original classification in EMS, examining the name of the approval holder, and sometimes even checking against the original licence document, using the priority number as the reference. Reclassification of licences for the oilsands was done in cooperation with staff from Alberta Environment.

A number of problems and challenges arose during the process of classifying licences into appropriate sectors and/or basins:

- Although priority numbers are supposed to be unique, there were a number of situations where licences had the same number. In these cases, information from both licences were included the analysis, but the details were forwarded to Alberta Environment for further investigation.
- The database contains some licences that are shown as having expired. Where it appears that these licences are in the process of being renewed, they have been considered to be active because Alberta environment allows a one-year grace period after the posted expiry date.
- Licences that are not currently being used because the licensee or the project for which the licence was issued may actually no longer exist.
- The river basin classifications does not always correspond to the location information (latitude and longitude) provided in the EMS. However, since it was undetermined whether it was the location or the basin classification information that was incorrect, no corrections were made for this discrepancy so river basin classifications in EMS were used in data analysis. This discrepancy is minor, affecting about one percent of the total allocation at the provincial scale, although at the basin level this discrepancy is higher but is not likely to appreciably change the overall results and conclusions contained in the report.

Table 2-1 Current and Revised Water Use Sectors and Components

Sector	Current Environmental Management System (EMS)			Revised Water Use Classifications
	Activity	Specific	Specific Activity Name	
Municipal and Residential	WDMUN	URBAN	Urban, villages, summer villages, towns, cities, hamlets	Municipal
		SUBVDIVID	Subdivisions	
		CONDOD	Condominium/townhouses/mobile homes/complexes, hotels, motels	
		COOPD	Cooperatives, farmsteads, single-multi homes, colonies	
		CAMPS	Camps	Municipal Institutional/Other
		INSTITUT	Institution, senior/correctional centres, nursing/children's homes, hospitals	
		SCHOOLS	Schools, training centres	
		MOTHER	Other (fire protection)	
Agricultural	WDAGR	FEEDLT	Feedlots	Agriculture – Feedlot
		STCKWT	Stockwatering	Agriculture – Crops & Stockwatering
	WDIRR		Crops	Agriculture – Irrigation
	WDREG	REGISTRY	Traditional Agriculture User Registration	Agriculture – Traditional use
Commercial	WDCOM	GRDN	Gardening, market gardens, sod and tree farms	Commercial – Gardening & Sod
		GLFCRS	Golf courses	Commercial – Golf Courses
		PRK	Parks	Commercial – Parks & Recreation
	WDREC	RCRTN	Recreation	
	WDCOM	AGGWSH	Aggregate washing	Commercial – Gravel Mining & Washing
		CNSTRCT	Construction	Commercial – Construction
		BTTLNG	Bottling	Commercial - Bottling
		GWHAULING	Groundwater well – water hauling	Commercial – Water Hauling
		SWHAULING	Surface water – water hauling	
		OTHR	Other (dust controls, abattoirs, bridge washing, hydroseeding)	Commercial – Other
Petroleum	WDIND	INJECTN	Oilfield injection	Industrial- Oil & Gas – Injection
		GAS/PTRO	Gas/petrochemical plants	Industrial – Oil & Gas Plants
	WDCOM	OIL/GAS	Drilling (developing oil/gas wells	Industrial – Oil & Gas Drilling
	NEW			Industrial – Oil and Gas Thermal
				Industrial – Oil Sand Mining
Industrial	NEW			Industrial – Forestry
				Industrial – Chemical Plants
				Industrial – Fertilizer Plants
	WDPOWER	HYDRPWR	Hydro-power	Industrial – Hydropower/ Non-thermal
	WDCOM	COOLING	Cooling	Industrial –Cooling
	NEW			Industrial – Mining - Coal
				Industrial – Mining - Other
Other	WDDEWAT	DRAINAGE	Drainage (gravel pits, mines)	Other – Water Management
		REMEDIA	Remediation	
		FLOODCNT	Flood control	
	WDWMNGT	STBLZTN	Stabilization (lake level)	
	WDFISH	FISHERY	Fish, fish farms/hatcheries	Other – Fish, Wildlife & Enhancement
	WDWILD	SRWILD	Storage reservoir for wildlife	
	WDHBTENH	WTLANDS	Wetlands	
	WDOTHER	SOTHER	Specified by the Director	Other –Specified Use
	WDWCO	WDC	Water conservation holdback	Other – Water Conservation Objective

The assessment and presentation of licence allocations in this report is based on the Maximum Allowable Diversion (MAD) as stated in each licence or registration. During the course of the study, it was determined that the MAD for multiple licences having the same Approval ID or the same Approval Holder may not in all cases be separate allocations but the same allocation spread among several licences. For example, two licences with the same Approval ID for the same Approval Holder, each with a MAD of 15 dam^3, would potentially only allow the licensee to draw 15 dam^3 over those licences, rather than 30 dam^3 (the sum of the two MAD values). In a worst-case scenario, if all licences with the same Approval ID and Approval Holder were in fact single allocations, but were counted as separate allocations, it would lead to an overestimate of provincial MAD of 4.7 percent. Confirmation of the prevalence of this issue would require analyzing 1191 duplicate sets of hardcopy licences, and this was beyond the scope of this study.

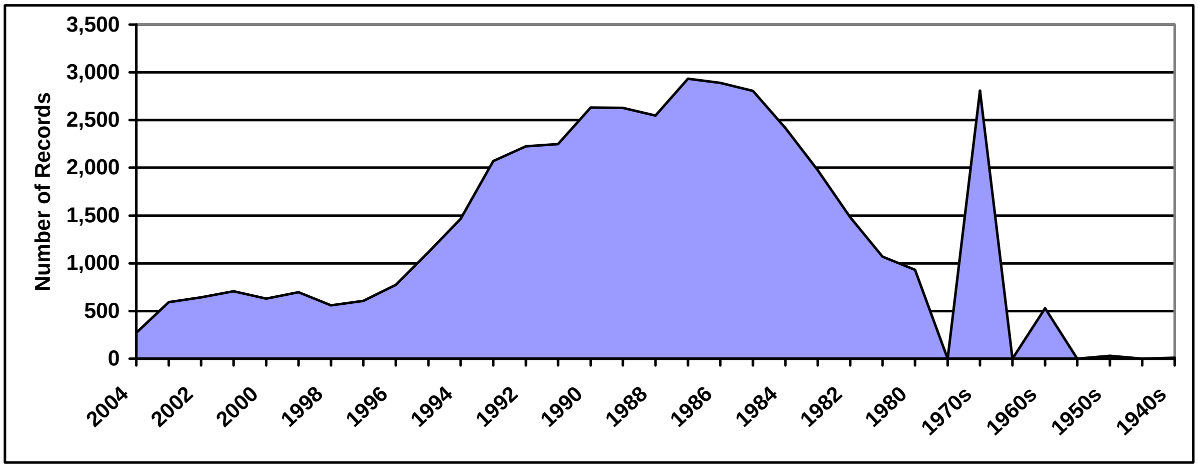
2.2 CURRENT WATER USE

This assessment of water use differentiates between licensed allocations, which represents the maximum amounts that licences are entitled to withdraw, and actual water use, which is based on actual levels of water use. Actual water use reflects the fact that licensees may not actually withdraw the maximum amount of their entitlement and that net consumption must also consider the difference between what they withdraw and what they put back (return flow).

The main source of information for determining water use was AENV's Water Use Reporting System (WURS). The WURS database contains information on annual and monthly water withdrawals as submitted by licensees. WURS is a very new database and contains information for only a few years for a small percentage of licensed water users. Reporting to WURS is voluntary at this time, and the information contained in this database is not representative of all water use data that has been submitted to AENV. Requirements to submit annual paper reports are included in the terms and conditions of some licences, but AENV has only focused on collecting water use information from major licensees. Reviewing these paper records to assess actual water use was beyond the scope of this study.

To assist in interpreting water use, AENV also provided the archived records of past water use reports submitted by water users prior to the creation of WURS. In total, some 65,535 water use records were contained in the historical base. However, assessment showed that about 35 percent of these records could not be traced back to specific licences (i.e. no or incomplete priority numbers). The remaining records are very dated, with some having been for reported water use in the 1940s. As shown in Figure 2-1, the majority of water use records are for the 1980s. The most recent water use records was for 2004 but, with individual records providing monthly data, the 300 records for 2004 only provides annual information for about 25 licensees. Furthermore, most historical water use data were for injection purposes and it was determined that there were better source of recent water use information for this sector. The sources used to estimate current water use are described below for each sector.

Figure 2-1 Number of Historical Water Records by Date of Water Use Information



Until such time as all licensees are submitting water user reports and these reports are consistently assessed and archived, determining accurate water use will remain a time consuming and complex exercise and estimates of water use, such as contained in this report, will be subject to errors and interpretation.

2.2.1 Municipal and Residential Sector

For most basins in Alberta, the water diversion, return and use information within the provincial Water Use Reporting System (WURS) is very limited. In order to make defensible municipal water use estimates, it is necessary to use additional information regarding municipal water flows. Environment Canada's Municipal Use Database (MUD) contains water diversion data for most urban and several rural municipalities with 2001 populations over 1000 people. It also has return flow information for 26 municipalities. A ratio of diversions and returns was calculated for these communities and this ratio was used to estimate actual water diversions and use for those communities for which no other water diversion and/or use information was available.

MUD contains no actual water use information for rural communities, which includes licences issued for condominiums/townhouses/mobile homes/complexes, hotels/motels, cooperatives, farmsteads, single-multi homes, colonies and subdivisions and other municipal uses (camps, institutions, senior/correctional centres, nursing/children's homes, hospitals, fire protection). For purposes of estimating actual withdrawals in 2005, the ratio of diversions to allocations determined for urban municipalities was assumed to be the same as the ratio for rural users, unless there was enough information available within WURS for a particular basin to determine the ratio. Only a few of the licences issued to rural communities have return flow requirements and, for these licences, actual return flows were calculated by multiplying estimated withdrawals by the ratio of licensed return flows to licensed allocations. For those rural communities that have no return flow requirements in their licences, it was assumed that all water withdrawn was used.

The resulting estimates of actual diversions and water use must be interpreted with caution.

Water use estimates for Alberta and for those basins where the majority of the population resides in large urban centres are generally considered to be reliable because there is MUD data for the larger communities and any errors in the estimation process for the rural communities will have a relatively small effect on the overall water use estimates. However, this may be problematic in that MUD and WURS data do not distinguish between municipal water used for residential purposes and water used by commercial enterprises and industries that draw their water from a municipality and, in this regard, each larger community may be unique. For example, the City of Medicine Hat has a municipal urban water allocation several times higher than cities of comparable size because its power plant does not have a separate industrial licence. There is a greater potential for error for those basins with a larger rural population.

With respect to estimating return flows, there is some uncertainty because MUD does not track whether the source and return flows are in the same river basin. There are a number of communities where water may be withdrawn from one basin and returned to another basin, especially in southern Alberta where communities obtain their water through the works or irrigation districts. Similarly, groundwater that is withdrawn, used and returned can wind up as surface water. Additionally, municipal water and wastewater facilities may give/receive water to/from multiple users separate from the municipality. Determining the extent of inter-basin transfers, groundwater-surface water transfers, and transfers in and out of municipal systems was beyond the scope of this analysis. However, the potential for such inaccuracies must be considered in interpreting the water use estimates for individual basins.

Given that the estimates of actual water use can be found in a number of different sources, a comparative analysis of information from these sources was undertaken to determine whether the information was consistent. Water use data from WURS, MUD and hardcopy intake and wastewater flow reports held at AENV regional offices were compared for those communities where water use information was available for all three sources. Since MUD was most recently published in 2001, the water use estimates were adjusted to 2005 based on reported municipal population changes from 2001 to 2005. AENV regional office hardcopy reports were for 2005. The analysis showed that MUD and the hardcopy reports housed at AENV regional offices are consistent and comparable in value with each other in terms of estimated diversion. With respect to actual use and return flow, a number of municipalities in 2005 had greater returns than withdrawals but this was possible due to heavy precipitation and flooding conditions during the summer of 2005. The estimates of diversions reported in WURS were determined to be 20 to 25 percent lower than the diversions estimated from MUD or as reported in hardcopy reports in regional offices. There is also much greater variability in WURS estimates in relation to MUD and regional-office reported estimates. As a consequence this analysis relied more on the population-adjusted MUD information than on the municipal information contained in WURS.

It should be noted that this analysis focuses only on licensed municipal water use. As noted in Section 1.3, people owning or occupying land adjacent to surface water or under which groundwater exists can use up to 1.25 dam^3 without having to obtain a licence. The number of such people and their use of water for household purposes are unknown. Household use of groundwater in some basins could be relatively important. However, without the benefit of

specific studies that have determine the number of people who are drawing water for household purposes, all water use estimates based only on licensed water use must be considered incomplete.

2.2.2 Agricultural Sector

Different methods were used to estimate the three major components of agricultural water use: district irrigation, private irrigation and stockwatering.

For irrigation, high quality information on actual diversions, the mix of crops being irrigated, the technology being used, and return flows for the 13 irrigation districts is available from Alberta Agriculture, Food and Rural Development (AAFRD), AENV, and the districts themselves. Since irrigation districts account for such a large amount of water use in southern Alberta, their patterns of use are well known and documented. Consequently, water use estimates drawn from these sources are considered to be highly reliable. It should be noted however, that using 2005 as a base year for the analysis does not present a true picture of typical irrigation water use. A review of historical records show that 2005 was a naturally wet year and total diversions by the districts in 2005 (1,494,916 dam^3) was 30 percent less than average diversions (2,156,101 dam^3) and 48 percent less than the peak withdrawals that occurred in 2000, which was a very dry year.

Although private irrigation allocations are issued to farmers for crop irrigation throughout Alberta, very little is known about their actual use of water. According to other sources (Watrecon, 2005), it is believed that most private irrigators use water to grow forage for livestock and that, in the absence of better information, it is reasonable to assume that private irrigators are using all of their entitlement. Thus, estimates of actual water use reflect the maximum amount of water that can be used under the terms of the licences issued for private irrigation. This likely overstates actual water use in 2005 which, as noted above, was a wet year. However, over the longer term, this assumption is probably realistic. Given the relative size of this sector, any inaccuracies in the estimation method are not likely to affect overall water use estimates for most of the basins.

Farmers can acquire water for livestock through licences and registrations, but can also obtain small amounts of water for livestock as part of domestic use or as an exempted water user which allows them to use up to 6.250 dam^3 of water per year without having to acquire a licence or registration (see Section 1.3). This analysis of stockwatering focused only water allocations for livestock through licences and registrations. There is no information on actual use for stockwatering and past water demand studies have simply assumed that the full amount of water allocations were being withdrawn and used. A recent study (Watrecon, 2005) attempted to corroborate this assumption by calculating livestock use by combining known livestock populations based on the 2001 Census of Agriculture, with information on average daily livestock consumption as provided by AENV to assist farmers in determining their water requirements. The resulting calculations showed that, after adjusting for evaporative losses, the resulting estimates of actual consumption very closely matched allocations for the Battle River basin. This report employs the same approach to estimate actual water use for stockwatering.

2.2.3 Commercial Sector

There is no information on actual water used for parks and recreation activities, golf courses, aggregate washing or gardening. Estimates of actual water use are based on the assumption that licensees are using the amounts that they are licence to use.

Food processing activities include abattoirs, dairy processing plants and malting operations. There is limited actual use information for food processing activity. The analysis of WURS data showed that the actual water consumption ranged from less than one percent to 100 percent. Although the licence information shows a theoretical return flow of about 20 percent, lack of data precluded verifying that return rate. Based on the scarcity of information for this activity, it was assumed that water use was equivalent to licensed use.

2.2.4 Petroleum Sector

Estimates of actual water use by the petroleum sector for 2005 are based on data provided by government agencies and/or the major licence holders. Water used for oilfield injection and thermal extraction is reported to the Alberta Energy and Utilities Board (EUB) and Geowa Information Technologies Ltd. (Geowa) reviewed the EUB database and provided a summary of actual water use based on activity, basin and water source. Data on water used for oilsands mining were obtained from AENV and from a recent report that examined water use in the Lower Athabasca River Reach (CEMA, 2005). Gas and petrochemical plant water use information was drawn from the WURS database provided by Alberta Environment. No data were available for drilling or other petroleum activities. A couple of companies, including Imperial Oil and Syncrude, directly provided their 2005 water use data.

Actual water use in 2005 was reported where available. However, actual water use information was not available for many licences. For those water use activities where information was reported by a high percentage of licensees and the activity represents a large share of petroleum water allocations, total water use for all licensees was calculated by applying sample information to all licences. For those activities for which there was very little data or no data at all, it was assumed that licence holders were using 100 percent of their licensed consumption.

2.2.5 Industrial Sector

Estimates of actual water use by the industrial sector for 2005 are based on data available in the WURS database and data provided by the major licence holders. Cooling data are a combination of the water use information available in WURS and data provided by TransAlta, EPCOR, ATCO Electric, University of Alberta, University of Calgary and Milner Power Inc. Forestry data for pulp mills were also taken from WURS and 2004 use data provided by the Alberta Forest Products Association. Other forestry activities were assumed to use 100 percent of their licensed consumption. Water use for chemical plants, fertilizer plants, and mining (other than coal) was based on information in the WURS database, with the assumption that licensees were using all of the water that they are entitled to use. No data were available for

manufacturing, coal mining, or hydroelectricity. These three activities are allocated only a small amount of water and are therefore assumed to use the full capacity of their licensed water use.

Actual water use data for 2005 were reported where available. However, for those industrial activities where use information was reported for a large proportion of the licences representing a large share of the water allocations, the total water use for all licences was calculated by applying water use characteristics for the sample to the entire population of licences. For those activities that have very little data or no data at all, licence holders were assumed to use 100 percent of their licensed consumption.

2.2.6 Other Sector

Little to no data were available for water use by the “other” sector. Estimates were based on the assumption that licensees were using all of the water that they were entitled to use. While this may exaggerate water use by this sector, the resulting inaccuracies are likely not significant for the water use estimates for individual basins because total allocations to the other sector are relatively small.

2.3 FUTURE WATER USE FORECASTS

One of the goals of Water for Life is for a 30 percent increase in water use efficiency and productivity in 2015 compared to 2005. At the time of writing, the Alberta Water Council is determining how this goal is to be attained for individual water use sectors and river basins. In the absence of clear direction on what programs and policies will be established to encourage water conservation, the water use forecasts prepared in this analysis reflect a “business-as-usual” case that ties water use to economic and population growth and assumes that companies will improve their operating efficiencies as they have done in the recent past.

2.3.1 Municipal and Residential Sector

Future water use in the municipal and residential sector was estimated using the population growth rates. The rates used in this analysis reflect the most recent population projections provided by Alberta Finance (2004). Although other population projections have been made for various jurisdictions within Alberta, the Alberta Finance projections were chosen because they cover the province and are officially recognized by the provincial government. Population projections for individual river basins were calculated by adjusting the rates for individual Census Divisions (CD) based on the percentage of falling within each basin. To ensure that the rural populations were appropriately distributed among basins, CD data were spatially adjusted to reflect road network densities in each basin, on the assumption that rural population density is directly related to road network density. Canada Census 2001 census division populations were used as the population baseline to make the projections.

There was some concern that using population growth rates for CDs, which include both urban and regional populations, may not be appropriate for basins that had large urban populations and that it might be necessary to develop separate population growth rates for urban and rural

communities. This was assessed by comparing population growth rates for the City of Edmonton and the City of Calgary with the rates for CD 11 and CD 6, respectively. The analysis showed that, for Edmonton, the population growth rates were similar enough not to require preparation of separate urban and rural population growth rates. Population growth rates for the City of Calgary were found to be 0.24% per year higher rate than predicted for CD 6, but this difference was not considered to be significant. As the population growth rates for the two major cities tend to match the growth rates for the two CDs, which together comprise 2/3 of the provincial population, it was decided that it was not necessary to prepare separate urban and rural population forecasts.

The municipal water use forecast also considered trends in per capita water consumption. Historic information on per capita municipal water diversions from 1990 to 2004 was taken from a recent study by Seneka (2006) and a best-fit linear trend of per capita water diversions was calculated to determine recent trends in per capita use. The resulting analysis found that there was too much variation in the per capita use information to statistically determine any clear trends. Consequently, the municipal water use forecasts assume that per capita water use for each basin in 2005 remains constant throughout the forecast period.

The high, medium and low basin population projections based on Alberta Finance projections were then multiplied by projected basin per capita diversions to estimate future annual basin municipal diversions. Estimates of actual use and return flows were calculated using the ratios of actual diversions to licensed diversions and actual use to actual diversions as calculated for 2005. This approach ensure that the estimates are internally consistent, but may not be entirely correct as a result of the assumptions used in calculated actual municipal water use in 2005 (see Section 2.2.1).

2.3.2 Agricultural Sector

With over 99 percent of water source for the district irrigation coming from the Oldman and Bow river basins, the projections of future water use by irrigation district focused on these two basins. While the *1991 South Saskatchewan River Basin Allocation Regulation* established a cap on the amount of land that could be used for district irrigation (531,434 hectares) based on a licensed allocation of 3.6 million dam^3, recent changes to the *Irrigation Districts Act* allow expansion beyond the cap on irrigated area subject to approval by water users in each district and as long withdrawals do not exceed allocations. Thus, there is some potential for expansion of district irrigation in southern Alberta. The potential for expansion was examined in a recent study undertaken as part of developing the plan for the SSRB (Irrigation Water Management Study Committee, 2002), and the projections of future irrigation water use are based on that study. The study examined potential changes in cropping patterns and on-farm water use, and analyzed a number of current and future irrigation scenarios.

Three scenarios from that study are employed in this analysis:

- S1: (Base Case – actual 1999 conditions) refers to the modelled demand using current crop mixes, irrigation efficiencies and management practices.

- S3: (Expansion to 1991 *Regulation* Limits) – refers to the modelled demand using 1999 crop mix but improved irrigation efficiencies and management practices.

- S9: (Expansion to 10 percent beyond *Regulation* Limits) – refers to modelled demand using future crop mix with improved irrigation efficiencies and management practices.

Two of these scenarios model irrigation based on the limits set in the Regulation, while the third examines expansion beyond these limits and include improved irrigation efficiencies and different crop mixes.

Forecasts of future water use by private irrigator are based on the assumption that their use of water will be tied directly future changes in livestock populations in each basin because, as noted earlier, most private irrigation in Alberta is used to raise supplemental forages to feed livestock. A description of the method used to predict future livestock populations is provided below. However, the 1991 *Regulation* also has caps on the amount of water that can be used to support increased private irrigation in the Red Deer, Bow and Oldman basins. Based on discussions with AENV, about 0.2 million dam^3 is available for expansion of private irrigation in these three basins.

The key factor affecting future livestock water demand will be changes in the cattle populations in each basin, as cattle account for the vast majority of livestock water demand. Predictions of future cattle populations at this point in time are highly speculative given the recent uncertainty in world and North American cattle markets due to the discovery of several cases of Bovine Spongiform Encephalopathy (BSE) over the last few years and the changing trade rules that have resulted. Although the export market, the mainstay of Alberta's beef industry has begun to rebound, there is still volatility of prices in the cattle markets, the average annual price in 2005 ($ 84.98/CWT) was still below the level found prior to BSE discovery. As a result, cattle sales have dropped and inventories have increased with the result that there are concerns that there could be a significant over supply of slaughter weight cattle in Alberta.

The effects of these lower prices and reduced sales volumes are not reflected in the agricultural statistics presented for each basin, which are based primarily on the 2001 Census of Agriculture. According to AAFRD, the provincial herd has increased in size relative to pre-BSE levels could be partially attributed to BSE as producers held cattle on farms due to the lack of export markets for live cattle.[1] The current description of cattle populations in Alberta is provided in Figure 2-2. This figure shows that, between 1986 and 2005, the number of cattle on Alberta farms grew steadily from about 3.75 million to 6.50 million animals. This represents about a 75 percent increase, or an annual increase of 3.7 percent. There was a decrease of six percent in cattle numbers in 2003 but populations started to increase due to continued restriction of the export market over the last few years.

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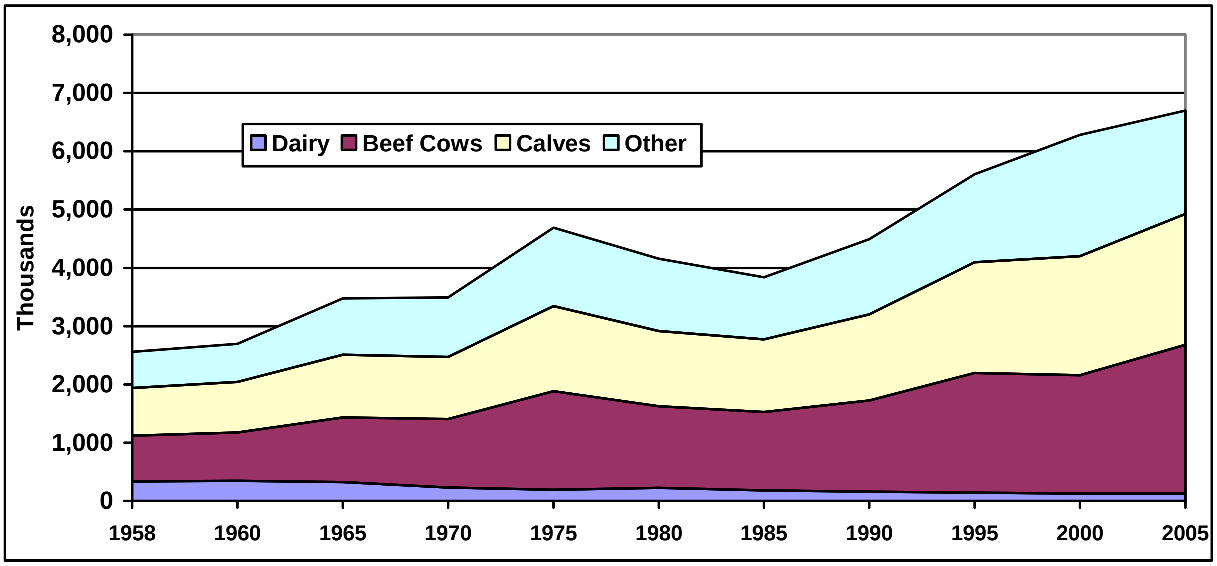
[1] AAFRD, 2005. "Livestock". Available at http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sdd10294#cattle

Figure 2-2 Cattle and Calves on Alberta Farms, 1958 to 2005



A second factor affecting livestock expansion in Alberta is changes in the regulatory system as a result of the *Agricultural Operation Practices Act (AOPA)*. *AOPA*, effective January 2002, requires that farmers wanting to develop new livestock operations or expand their annual populations above a certain size threshold must first obtain permission from the Natural Resources Conservation Board (NRCB). For the cattle and dairy operations, the animal population thresholds are outlined in Table 2.2. To obtain this permission, farmers must submit an application that demonstrates how their operations would meet the legislated requirements for manure storage and management. Farmers must also demonstrate that they have or can obtain the rights to sufficient water to support livestock. The NRCB must deny any applications that fail to meet the requirements for manure management, setbacks from neighbours, access to water, or any of the other requirements of the legislation.

Table 2-2 AOPA Requirements for Cattle Operations

Type of Livestock	Registration Required	Approval Required
Beef cows/finishers (900+ lbs)	150-349	350+
Beef Feeders (<900 lbs)	200-499	500+
Dairy (milking cows including replacements and dries)	50-199	200+

Given these factors, and when combined with lack of livestock forecasts published on a provincial or a regional basis, prediction of future livestock water demand is difficult. Toma and Bouma (1997) utilized scenario planning to determine the growth rate required for the Alberta agri-food sector to become a $20 billion manufacturing industry and a $10 billion production sector by 2005. This scenario features a doubling of beef feedlot population, a tripling of the hog population and other livestock sectors following historical growth rates and assumes a strong export market, especially to the US and to Asia. Since the study, there have been

significant changes in export conditions due to the discovery of BSE. Further, the study does not outline how growth in livestock activity might be distributed within the province.

In order to assess the potential suitability of livestock operations, Alberta Agriculture, in the late 1990s, undertook a study that examined the potential for expansion of the beef industry in Alberta. With respect to the possible development of feedlots, AAFRD identified five criteria for evaluating the potential for expansion:[2]

1. **Manure odour and population densities** - Manure odours were considered the most limiting factor in selecting sites for new feedlots, in that feedlots can only be located beyond specific distances from neighbouring residences in order to minimize odour impacts.[3] Thus, feedlot development is more likely in areas with low population densities.

2. **Local silage supplies –** Adequate quantities of silage can only be economically produced in some parts of Alberta. Alberta Agriculture identified areas where sufficient silage could be grown within six miles of the feedlot so that hauling would be economical.

3. **Water supply –** The availability of groundwater was the second most important factor in selecting potential feedlot sites. It is estimated that a 5,000-head backgrounding operation would require 50 dam^3 of water per year while a 20,000-head finishing operation would require 300 dam^3. Consequently the study identified areas where sufficient water was available and could reliably be supplied using more than one source (four wells). Surface water sources must be permanently flowing to provide a reliable water supply for feedlots.

4. **Landscape characteristics** – The preferred locations for feedlots are areas with well developed natural drainage to ensure that pens stay dry and drain completely. Suitable areas were identified using slope information from the Soil Landscapes of Canada.

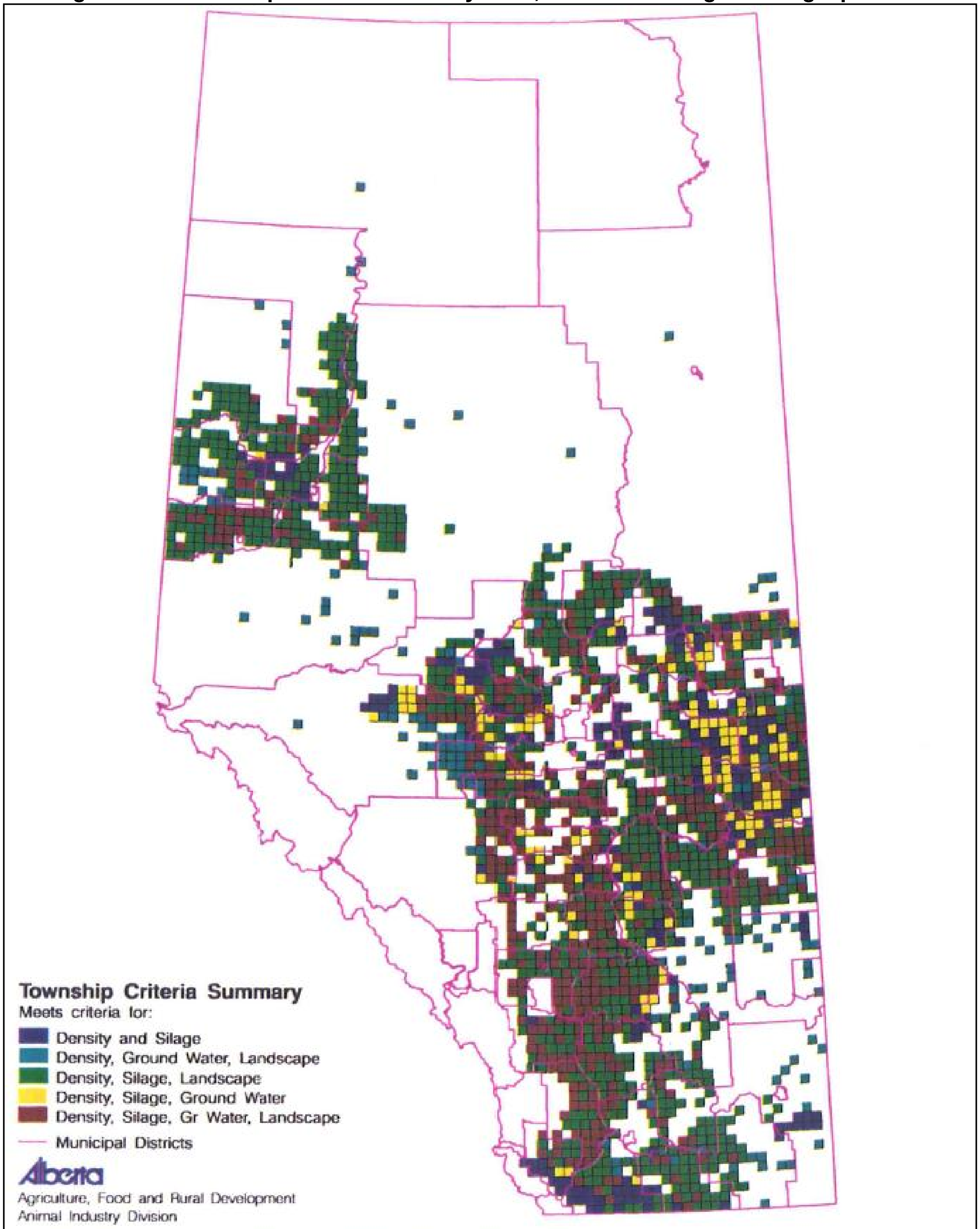
5. **Land for manure spreading** – Extensive lands are required for spreading of manure and are similar to land requirements for barley silage. Land requirements for manure spreading are now identified in the *Agricultural Operation Practices Act* but Alberta Agriculture determined that about 5.5 sections are required for a 20,000-head feedlot.

Using these selection criteria, AAFRD was able to identify townships where development of a 5,000 head backgrounding operation (Figure 2-3) or a 20,000 head finishing feedlot was possible (Figure 2-4). These figures are used to provide some guidance in forecasting future livestock conditions in Alberta.

[2] Some of these criteria are specified in the *AOPA*

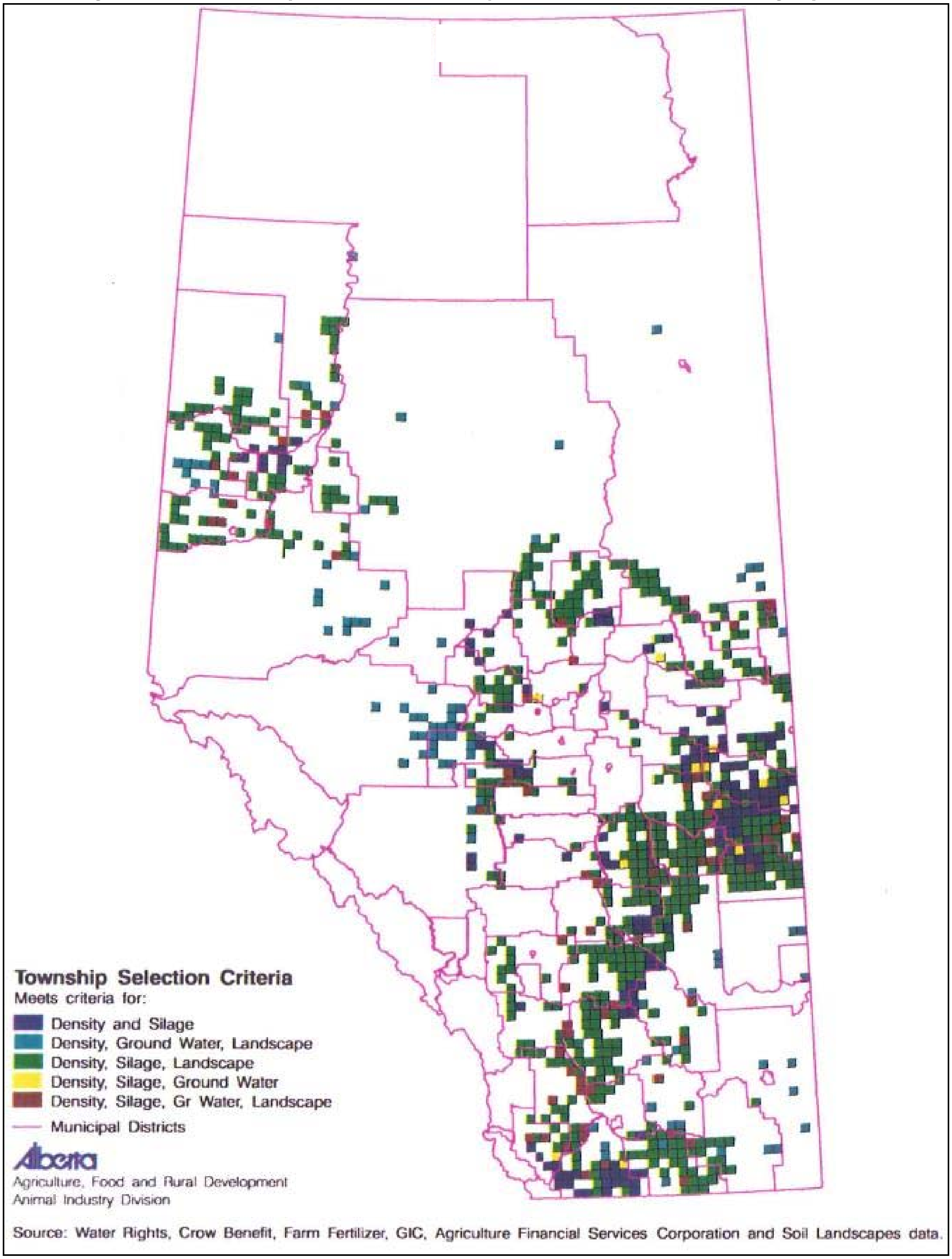
[3] In the 1990s these distances were contained in a Code of Practice but setback distances are now specified in the regulations for the *Agricultural Operation Practices Act*.

Figure 2-3 Township Criteria Summary for 5,000-Head Backgrounding Operation



Source: Water Rights, Crow Benefit, Farm Fertilizer, GIC, Agriculture Financial Services Corporation and Soil Landscapes data.

Figure 2-4 Township Criteria Summary for 20,000-Head Finishing Operations



2.3.3 Commercial Sector

Estimates of future water use for parks and recreation are based on the assumption that demand for these facilities will increase in accordance with population growth. Thus, the annual growth rates in water use for parks and recreation areas reflect the population growth rates in each basin.

With respect to future water use for golf courses, historical trends in Alberta household participation in golfing since 1981 show that demand for golfing has climbed steadily, reaching a peak in 2000. This trend, combined with a growing interest in golfing explains why there has been a proliferation of golf course development. The demand for new golf courses or course expansions is expected to continue as the population continues to grow and an ageing population has more leisure time. With respect to water allocation, licence data indicate that currently there are 180 golf courses that hold 264 licences. Approximately 30 percent of these licences have been issued since 2000. A review of licence data suggest that average water demands for golf courses amount to about eight dam^3 per hole. The average water requirement tends to be higher in the southern basins than in the northern basins. Future water demand for golf courses has been estimated using the approach outlined in Watrecon (2005) which uses population growth to estimate the increased numbers of new golf course holes required to maintain the current availability of golf facilities for a growing population. Water use estimates for each basin were developed using this approach, the appropriate population forecasts, and the average water requirement per hole for that basin. It was assumed that the proportion of surface and groundwater use would not change over the forecast period and that as compared to 2005.

Future water use for food processing is based on the assumption that demands will increase by somewhere in the range of 0.5 to 2.5 percent annually and that mix of surface and groundwater use will remain unchanged over the forecast period.

Future water use for aggregate washing and gardening has been estimated based on expected changes in the economic activity in Alberta. Forecasts are based on anticipated GDP growth rate of 1.2, 2.2 and 3.2 percent annually.

2.3.4 Petroleum Sector

Forecasts of future water use by the petroleum sector were based on consultations with large licence holders and estimates provided by government agencies. Oilfield injection, thermal, and oilsands forecasts are based on the outlooks of EUB (2006) and the Canadian Association of Petroleum Producers (2006). Gas and petrochemical plant forecasts focused on potential bitumen upgraders as these facilities are likely to be the largest driver of future water demand in the province. Upgrader forecasts were based on current known proposals (Stringham, 2006) and discussions with EUB and Alberta Environment. In the absence of information about drilling and other petroleum activities, it is assumed that water used for these purposes will remain constant for the forecast period.

It is likely that, with the adoption in 2006 of the *Water Conservation and Allocation Policy for Oilfield Injection*, there will be less use of potable water and increasing reliance on saline water or other techniques for enhanced oil recovery. However, it is too soon to be able to gauge the effects of this policy. It is expected that the effects of the policy will be most noticeable in the water short areas of Alberta (essentially parts of the South Saskatchewan, Milk and Battle river basins), where applicants who wish to use potable water for oilfield injection will face the most stringent application requirements.

2.3.5 Industrial Sector

Forecasts of future water use by the industrial sector are based on consultation with large licence holders, and information provided by government agencies. Since water required for cooling purposes accounts for the vast majority of industrial water allocations in Alberta, forecasts of future industrial water use focused on water use by electrical power plants. The forecast considered information in the EMS database regarding scheduled licence expiries, new water licences for 2006, and list of applications in process. It also incorporated information on power generation forecasts (AMEC Americas Ltd, 2005; AMEC Americas Ltd. 2006), water use estimates from Environment Canada (1996), a list of proposed electricity facilities/upgrades in Alberta (Department of Energy, 2007), and discussions with large water licence holders (including TransAlta, ATCO Electric, University of Alberta, University of Calgary and Milner Power Inc).

Forestry forecasts are based on discussions with Alberta Forest Products Association. In the absence of information about chemical plants, fertilizer plants, manufacturing, mining (other than coal), coal mining, hydroelectricity and other industrial activities, it is assumed that water used for these purposes will remain constant for the forecast period. While economic activity will likely trigger some additional water use for these activities, this additional water use is difficult to predict but will be relatively small, given that these activities currently account for less than three percent of all water allocations in Alberta,

2.3.6 Other Sector

Forecasts of future water use by the other sector were based on consultations with the largest licence holders. Neither Ducks Unlimited nor Alberta Environment has formal forecasts of their future water needs. The number of projects that Ducks Unlimited will implement depends on a number of factors such as their budget, the state of the economy, and environment objectives. It is anticipated that there will be an increased emphasis on restoring drained wetlands to pre-drainage or natural conditions. These types of projects will not require new water licences. In terms of new water licences, Ducks Unlimited foresees an increase of about eight new water licences for about 300 dam^3 per year each (Randy Cummer). The emphasis will likely be on the Battle and the North Saskatchewan basins with one project in another basin. There are also discussions of a larger water licence in the magnitude of 600 dam^3 for the Red Deer River Basin. Based on discussions with AENV, water use for projects licensed to AENV for other purposes is not expected to change over the forecast period.

Milk River Basin

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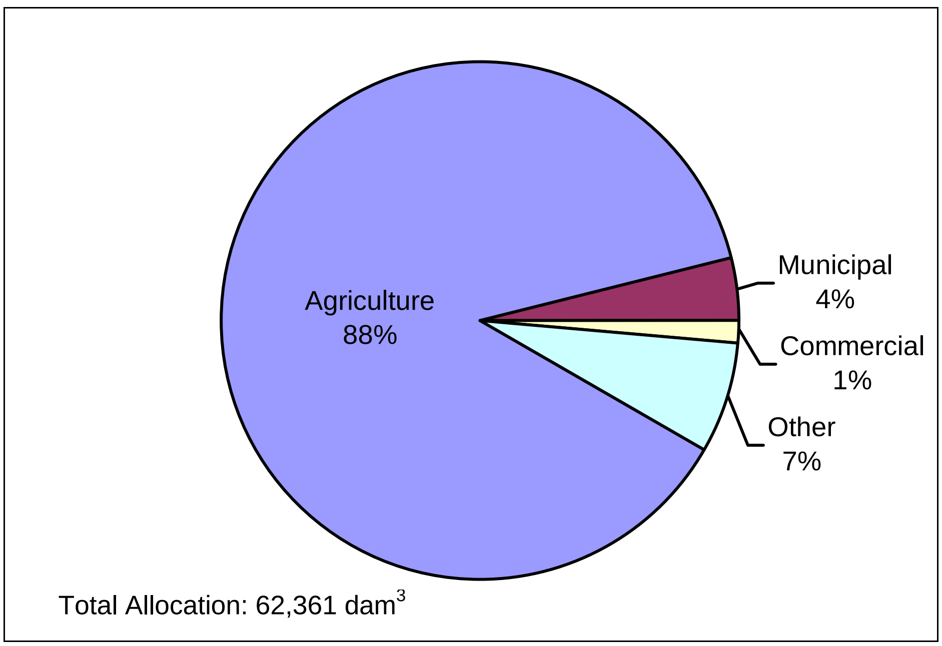
3.0 MILK RIVER BASIN

The Milk Basin is about 11,860 km^2 in area, which represents 2.0 percent of Alberta. The mean annual natural river discharge of the Milk River is 160,000 dam^3 and it eventually drains into the Mississippi River. In 2001, the Basin had a population of only 11,500 people, or 0.4 percent of the provincial population, resulting in a population density of 1.0 person per square kilometer. The Milk Basin is comprised of all or parts of the counties of Cardston, Forty Mile No. 8. Lethbridge, and Cypress. Major urban centres include the towns of Milk River and Raymond and the villages of Coutts, Stirling and Warner. There are no Aboriginal Reserves or Métis Settlements within the Milk River Basin.

An overview of surface and groundwater allocations existing is provided in Figure 3-1. It shows that agriculture, including registrations, accounts for 88 percent of total allocations, which totaled 58,440 dam^3 in 2005. The other 18 percent of water allocations consisted mainly of other and municipal uses.

Figure 3-1 Distribution of Active Water Allocation in the Milk Basin



Detailed descriptions of current allocations and actual water use for each of the water use sectors are provided below.

Figures 3.2 and 3.3 show the location of all active surface and groundwater licences in Milk Basin classified in terms of total allocation and water sector. Figure 3-4 shows the location of all registrations issued for the Milk River Basin.

3.1 MUNICIPAL AND RESIDENTIAL SECTOR

3.1.1 Population

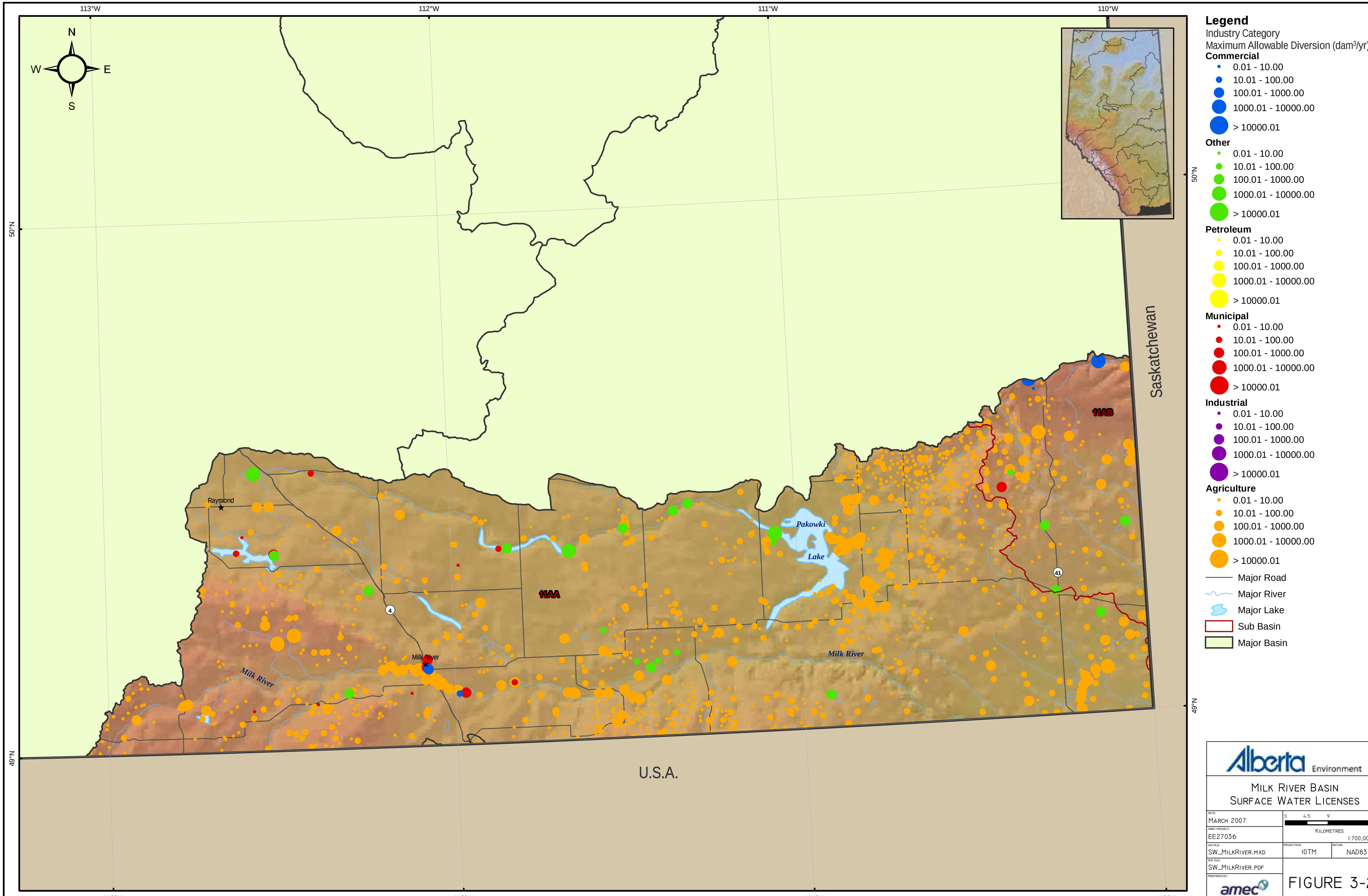
The population of the Milk River Basin is split nearly evenly between urban centres and rural areas. As shown in Table 3.1, residents of towns and villages accounted for 49.7 percent of the Basin population, and the number of urban residents grew very little (0.6 percent) between 1996 and 2001. Major population centres included the towns of Raymond (3,200 residents) and Milk River (879) and the villages of Coutts (364), Stirling (877) and Warner (379). In the rural areas, the population grew by 4.4 percent during the same period. The majority of the rural population resided in the County of Warner (3,395 residents), with the balance being in the County of Forty Mile No. 8 (1,239), Cypress County (566), Cardston County (566), and the County of Lethbridge (126).

Table 3-1 Population Distribution and Growth in Milk River Basin, 2001

	2001		1996	1996 to 2001 Population Change
	Population	Percent	Population	Percent
Urban Municipality	5,699	49.7%	5,666	0.6%
Rural or Regional Municipality	5,778	50.3%	5,535	4.4%
First Nations and Métis Settlements	0	0.0%	0	0.0%
Total	**11,477**	**100%**	**11,201**	**2.5%**

3.1.2 Allocations

In 2005, there were 15 active municipal water licences for 13 licensees in Milk Basin (AENV EMS Database, 2006). The allocation for these licensees is 2,539 dam^3. Municipal water allocations account for 5.7 percent of licensed water allocations in Milk Basin. Municipal uses in the Milk Basin include water for camps; cooperatives, farmsteads, single- and multi-homes and Hutterite colonies and urban municipalities including villages, summer villages, towns, cities and hamlets. The highest MAD is assigned to cooperatives, farmsteads, single- and multi-homes and Hutterite colonies accounting for 72 percent of MAD. This is followed by urban municipalities (28 percent of MAD). This is different from other Alberta basins where urban allocations account for the majority of municipal sector allocations.


113°W
112°W
111°W
110°W
50°N
49°N
N
W
E
S
Raymond
Milk River
Milk River
Milk River
Pakowki
Lake
11AA
11AB
4
41
Saskatchewan
U.S.A.
Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
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Other
0.01 - 10.00
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Petroleum
0.01 - 10.00
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> 10000.01
Municipal
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Industrial
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Agriculture
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10.01 - 100.00
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1000.01 - 10000.00
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Major Road
Major River
Major Lake
Sub Basin
Major Basin
Alberta Environment
Milk River Basin
Surface Water Licenses
March 2007
EE27036
SW_MilkRiver.mxd
SW_MilkRiver.pdf
0 4.5 9 18
Kilometres
1:700,000
10TM
NAD83
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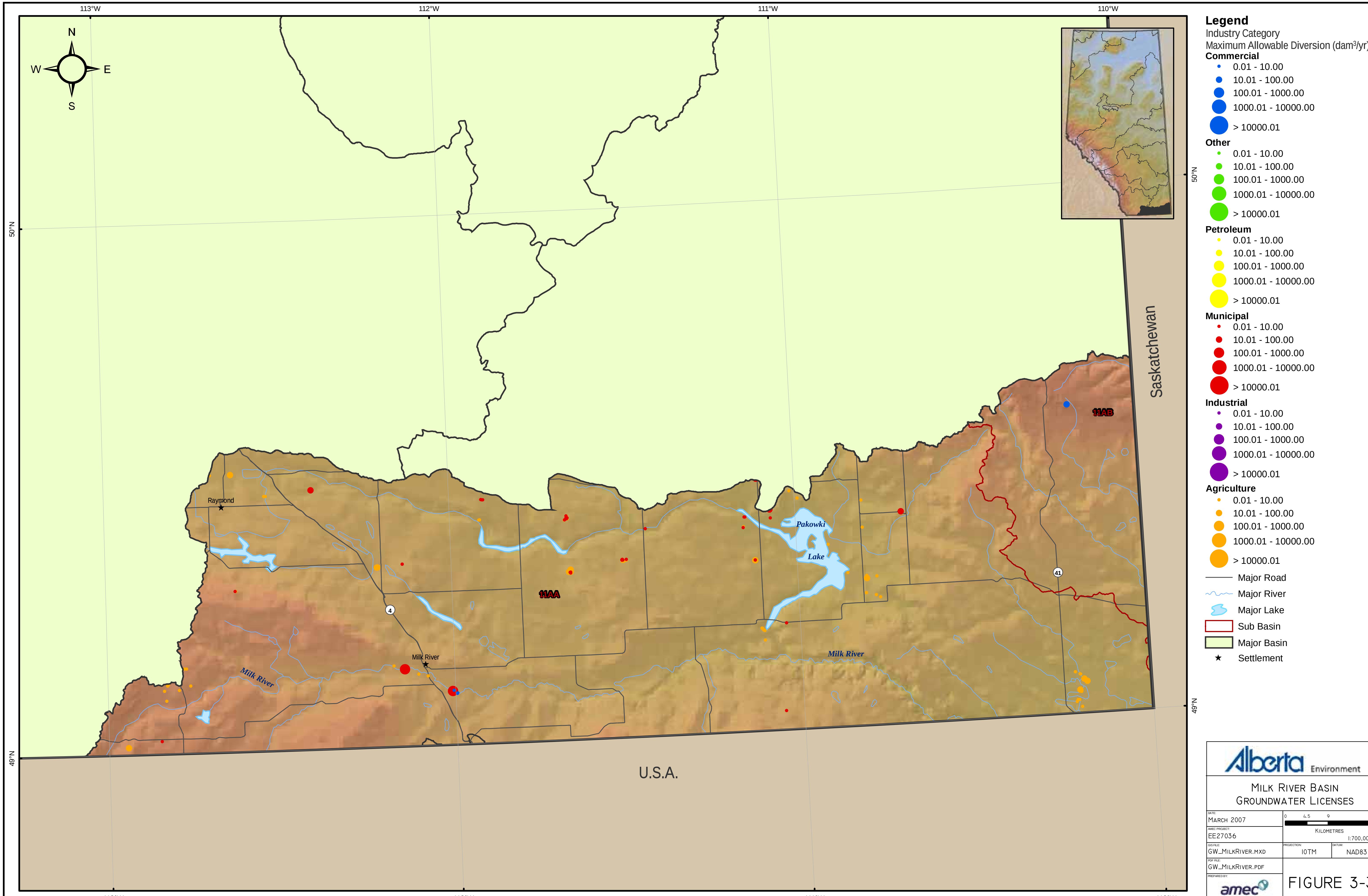
FIGURE 3-2



113°W
112°W
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110°W
50°N
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N
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Raymond
Milk River
Milk River
Milk River
Pakowki
Lake
11AA
11AB
Saskatchewan
U.S.A.
Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
0.01 - 10.00
10.01 - 100.00
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Petroleum
0.01 - 10.00
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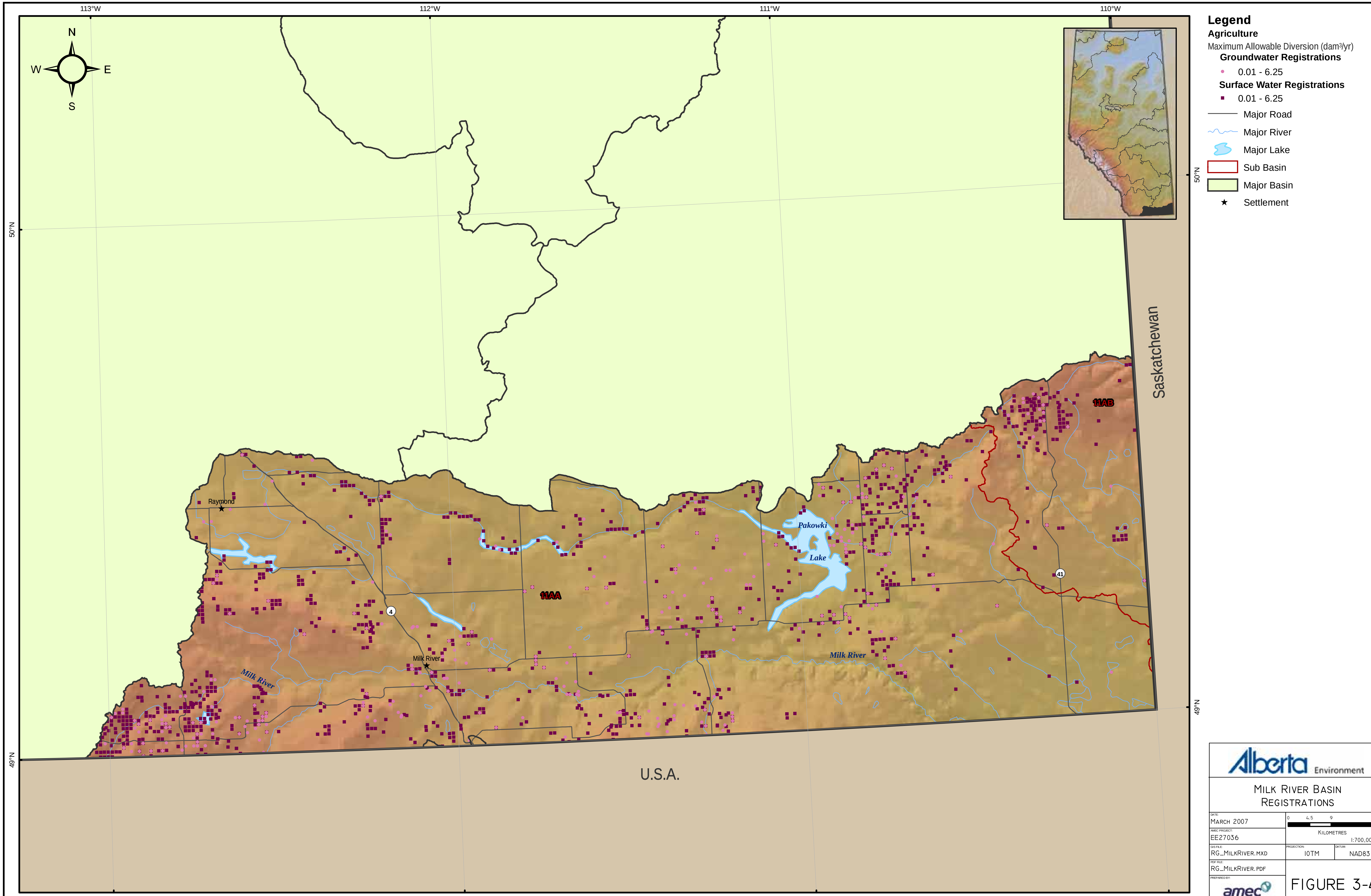
> 10000.01
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
Alberta Environment
Milk River Basin
Groundwater Licenses
March 2007
EE27036
GW_MilkRiver.mxd
GW_MilkRiver.pdf
Kilometres
1:700,000
10TM
NAD83
amec
FIGURE 3-3



Alberta Environment

Milk River Basin Registrations

Date: March 2007	0 4.5 9 18 Kilometres 1:700,000		
AMEC Project: EE27036			
GIS File: RG_MilkRiver.mxd	Projection: 10TM	Datum: NAD83	
PDF File: RG_MilkRiver.pdf			
Prepared by: amec	FIGURE 3-4		

The maximum amount of surface water that can be withdrawn in Milk Basin by the municipal sector is 1,949 dam^3. Surface water licences represent 76.8 percent of total municipal water allocations. The largest allocation is for cooperatives, farmsteads, single-multi homes and Hutterite colonies with 1,231 dam^3 over seven licences. The only other allocation type is for urban municipalities with 718 dam^3 over two licences.

The maximum amount of groundwater that can be withdrawn in Milk Basin by the municipal sector is 590 dam^3. Groundwater licences represent 23.2 percent of total municipal water allocations. The largest allocation is for cooperatives, farmsteads, single-multi homes and Hutterite colonies with 589 dam^3 for five licences. The only other groundwater allocation is for camps with 1 dam^3 for one licence.

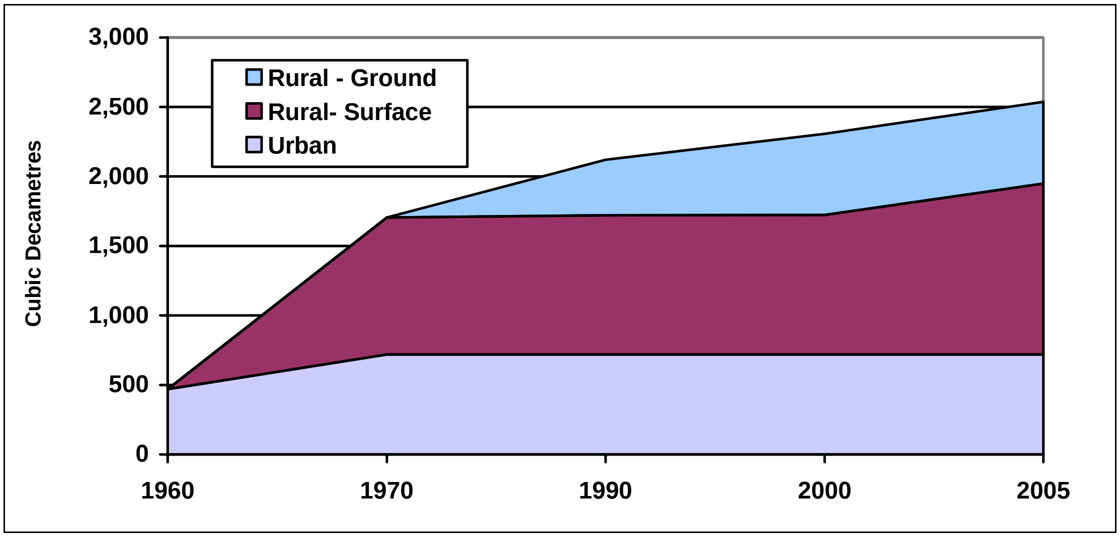
Table 3-2 shows Milk Basin municipal water licensees with allocations of greater than or equal to 100 dam^3 and the source of their water. Most municipal allocations are for surface water; groundwater allocations only account for 24 percent of the major municipal water allocations. It should also be noted that the Town of Raymond and the Village of Sterling draw their water from sources outside the basin; both communities obtain their water from the St. Mary River through the works of the St. Mary River Irrigation District (SMRID). These communities have five licences that allow withdrawals of up to 3,238 dam^3 from the Oldman River Basin as well as one small licence that allows diversion of up to 1.2 dam^3 from Etzikom Coulee in the South Saskatchewan River basin.

Table 3-2 Major Municipal Water Licensees by Source, Milk River Basin

Approval Holder	Water Source	Allocation (dam^3)
WATER OPERATIONS BRANCH, LETHBRIDGE	Surface	987
COUNTY OF WARNER NO. 5	Groundwater	568
TOWN OF MILK RIVER	Surface	471
VILLAGE OF COUTTS	Surface	247
501 WATER CO-OPERATIVE LTD.	Surface	129

Figure 3-5 shows how allocations of water for municipal water in the Milk River Basin have changed since 1960. Municipal uses accounting for less than 0.1 percent of total allocations are not shown. Figure 3-5 shows that the initial allocations were for surface water but, starting in the 1970s, groundwater has become increasingly important. Figure 3-2 also shows that allocations for the urban communities that draw on surface water have remained constant since 1970. Nearly all of the increased allocations of water for municipal purposes since the 1960s have been for rural use, which includes water cooperatives, farmsteads, single- and multi-homes and Hutterite colonies. And most of the allocations since the 1970s have been for groundwater use in the rural parts of the basin.

Figure 3-5 Historical Water Allocations for Municipal Purposes



3.1.3 Licensed Water Use

Table 3-3 summarizes licensed water use for the municipal sector in the Milk River Basin. Under the terms of these licences a maximum of 2,195 dam^3 is expected to be used (i.e. 86 percent is consumed and/or lost) with the remainder (344 dam^3) to be returned. All of the return flow allowance is associated with surface water licences issued to towns and villages. Return flow is not included in any of the licences issued for groundwater, indicating that all groundwater withdrawn is expected to be used.

3.1.4 Actual Water Use

In 2005, only four licensees reported their water diversions to the provincial government through the Water Use Reporting System (WURS) and there is no information in Environment Canada's MUD for any of the communities that draw their water from the Milk River basin. All four licensees were rural water users who have a combined allocation of 1,696 dam^3 (which represents 67 percent of all water allocated for municipal purposes in the basin) and no return flow requirements. These licensees reported actual diversions in 2005 of 1,687 dam^3, or 99.5 percent of their allocation. It should be noted that actual withdrawals of groundwater in 2005 exceeded all rural groundwater allocations by 8.1 percent. There is no return flow from these uses.

There is no information on actual water use by the other licensed municipal water users, who have allocations for 852 dam^3 of which up to 499 dam^3 can actually be used. For purposes of estimating actual use it is assumed that other rural water users also used all of their allocation (133 dam^3) and there were no return flows.

Table 3-3 Licensed Municipal Allocations and Use and Reported Actual Water Use, Milk River Basin

Use Type	Source	Number of Licenses	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Diversion	Water Use	Return
Urban*	Surface	2	718	374	344	N/A	N/A	N/A
	Groundwater	0	0	0	0	0	0	0
	Subtotal	**2**	**718**	**374**	**344**	**0**	**0**	**N/A**
Rural**	Surface	7	1,231	1,231	0	1,050	1,050	N/A
	Groundwater	5	589	589	0	637	637	N/A
	Subtotal	**12**	**1,820**	**1,820**	**0**	**1,687**	**1,687**	**N/A**
Camps	Surface	0	0	0	0	0	0	0
	Groundwater	1	1	1	0	N/A	N/A	N/A
	Subtotal	**1**	**1**	**1**	**0**	**N/A**	**N/A**	**N/A**
Total	Surface	9	1,949	1,605	344	1,050	1,050	N/A
	Groundwater	6	590	590	0	637	637	N/A
	Total	**15**	**2,539**	**2,195**	**344**	**1,687**	**1,687**	**N/A**

* Urban consists of water allocated to villages, summer villages, towns, cities and hamlets
** Rural consists of water allocated to cooperatives, farmsteads, single- and multi-homes and Hutterite colonies

For licensed urban use, actual diversions could range anywhere from 28 percent to 100 percent in 2005, suggesting actual withdrawals of between 200 and 718 dam^3, with an midpoint of about 460 dam^3. Based on licensees' information, it is assumed that 52 percent of withdrawals were actually consumed; this represents estimated consumption of about 240 dam^3.

Based on these assumptions, estimated municipal water use in the Milk River Basin in 2005 was estimated to 2,195 dam^3 or 94 percent of the use allowed in the licences (see Table 3-4). While there is some uncertainty in this estimate, about 75 percent of the estimate is based on reports from the largest municipal water users.

Table 3-4 Estimated Municipal Water Use in the Milk River Basin

Municipal Use		Withdrawals (dam^3)	Use (dam^3)	Return Flow (dam^3)
Rural	Reported	1,687	1,687	0
	Estimated	133	133	0
Urban	Estimated	460	240	220
Total		2,280	2,060	220
LICENSEES		2,539	2,195	344
Estimated Utilization		90%	94%	64%

3.1.5 Future Water Use Forecasts

Figure 3-6 shows low, medium and high population projection scenarios for Milk Basin based on Alberta Finance projections for Census Divisions. The projections suggest that the population of the Basin could increase to 13,500 people in 2025 for the low projection or to 17,500 people under the high projection.

The population forecasts in Figure 3-6 have been used to predict future municipal water use. The resulting forecasts of water use are provided in Table 3-5. These forecasts are based on the estimated water use in 2005, which saw actual withdrawals of groundwater exceeding licensed allocations. Under the low population growth scenario, municipal water use in 2025 is expected to be 12 percent greater than at present and diversions are expected to reach current maximum allocation in 2022. Under the high population growth scenario, water use will increase by 44 percent over current levels and total diversions of surface and groundwater are expected to reach current municipal maximum allocation in 2011

Figure 3-6 Milk Basin Population Growth Forecasts

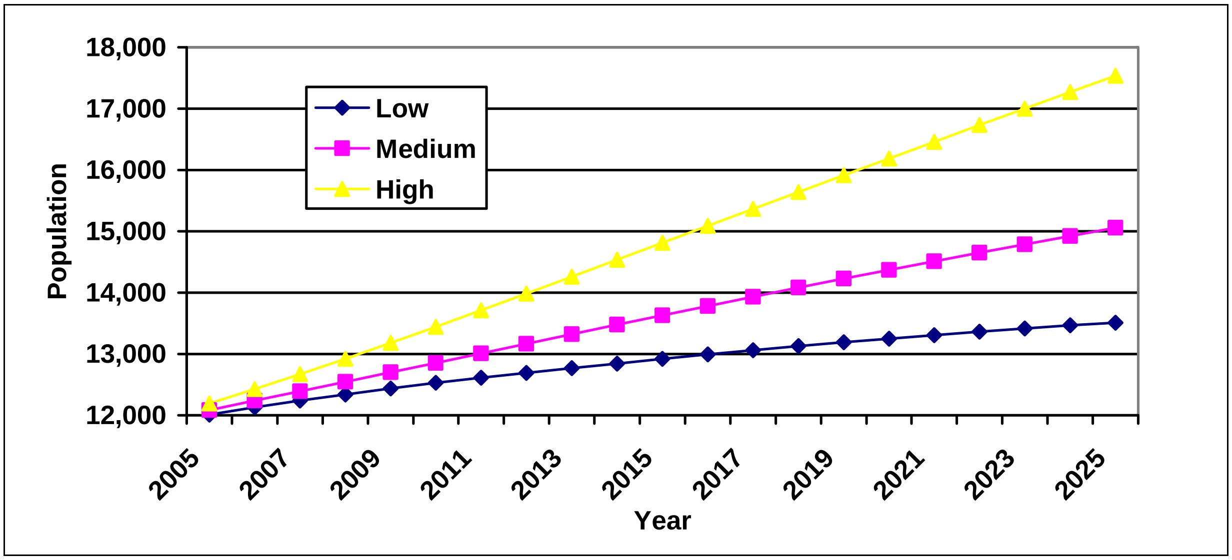


Table 3-5 Projected Water Use for the Municipal Sector in the Milk River Basin
(dam^3)

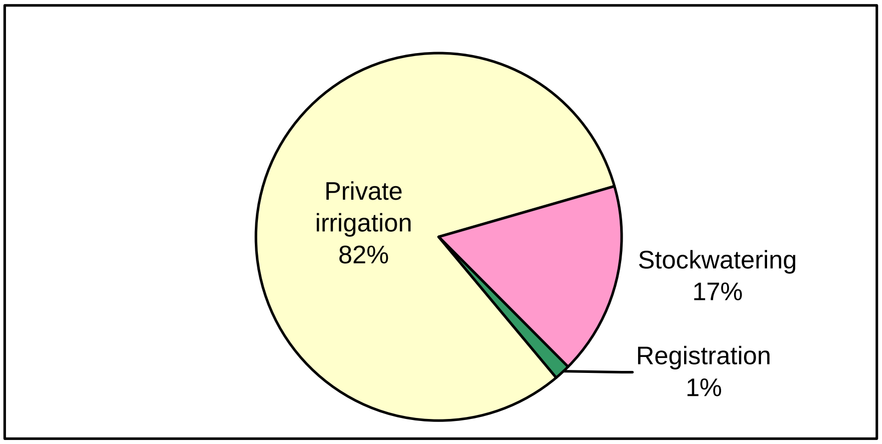
Scenario	Source	2005	2010	2015	2020	2025
Low Population Growth	Surface	1,423	1,484	1,531	1,570	1,601
	Groundwater	637	664	685	703	716
	Total	2,060	2,148	2,216	2,272	2,317
Medium Population Growth	Surface	1,423	1,514	1,605	1,692	1,773
	Groundwater	637	678	719	758	794
	Total	2,060	2,192	2,324	2,450	2,567
High Population Growth	Surface	1,423	1,569	1,729	1,889	2,047
	Groundwater	637	702	774	846	916
	Total	2,060	2,272	2,503	2,735	2,963

3.2 AGRICULTURE SECTOR

As of October 2006 a total of 54,703 dam^3 had been allocated to agricultural water use in the Milk River Basin. This includes 1,546 registrations representing 737 dam^3 of water allocation and 1,306 licences that allow diversion of 53,966 dam^3 of water. Water allocated to agriculture accounts for 88 percent of all allocations in the Milk River Basin.

Figure 3-7 shows how this water is distributed among the different agricultural uses in the Milk River Basin. It shows that the large majority of water allocations are for private irrigation (82 percent). Stockwatering accounts for 17 percent while registrations accounts for about one percent of the total allocation.

Figure 3-7 Water Allocation by Volume for Agricultural Activities in the Milk Basin



A total of 1,178 registrations and 738 licences allow withdrawals of up to 53,900 dam^3 of surface water; this accounts for 98 percent of all water that can be used by the agricultural sector. Thirty licences and 368 registrations have been issued to withdraw up to 804 dam^3 of groundwater (two percent of total allocation).

3.2.1 Overview of Agriculture in the Milk River Basin

Based on information from the 2001 Census of Agriculture, there were about 1,372 farms (three percent of Alberta total) with an average size of 1,981 acres in the Milk River basin. In Alberta, there are about 53,000 farms with an average size of 970 acres. Farms in the Milk River Basin cover an area of 2.7 million acres; this is equivalent to about 11,000 km^2 or about 93 per cent of the Milk Basin. Table 3-6 shows about 40 percent of the land in the Basin is used to raise crops. About 13 per cent of agricultural land is summerfallow. Most of the remaining land, about 45 percent, is pasture.

Table 3-6 Use of Agricultural Land in the Milk River Basin, 2001

Land Use	Acres	Percent
Crop Land	1,069,717	39.4%
Summerfallow	355,985	13.1%
Tame/Seeded Pasture	129,951	4.8%
Natural Pasture	1,127,101	41.5%
Other	34,575	1.3%
Total	**2,717,329**	**100.0%**

Table 3-7 Classifications of Farms in the Milk Basin and Alberta, 2001

Farm Type (Gross Receipts Greater that $2500)	Milk River Basin	Alberta	Percent of Alberta
Dairy Farms	1.5%	1.5%	2.5%
Cattle (Beef) Farms	33.3%	45.4%	1.9%
Hog Farms	2.0%	1.7%	3.1%
Poultry & Egg Farms	1.0%	0.9%	3.1%
Wheat Farms	28.2%	7.4%	10.1%
Grain & Oilseed Farms	14.0%	18.4%	2.0%
Field Crop Farms	7.6%	9.3%	2.1%
Fruit Farms	0.1%	0.1%	2.3%
Miscellaneous Specialty Farms	6.9%	10.9%	1.7%
Sum of Livestock Combination Farms	2.6%	2.3%	3.0%
Sum of Vegetable Farms	0.4%	0.1%	7.3%
Sum of Other Combination Farms	2.5%	2.0%	3.3%
Total	**100.0%**	**100.0%**	**2.6%**

The types of farming activity vary within the Milk River basin. Table 3-7 shows the classification of farms based on the commodity groups that accounted for 51 per cent or more of total gross farm receipts in 2000. The table shows that nearly a third of the farms in the Basin raise beef cattle (33 per cent) and about 28 percent of the farms are wheat farms. Grain and oilseed farms account for 14 percent of farms in the Milk River basin. Specialty and field crops (vegetables, potatoes, silage corn and alfalfa) accounted for about 16 percent of total farms. As noted above, farms in the Milk River Basin were was twice as large as the provincial average. Although wheat farms were more common in the Milk River Basin than in the province as a whole, there were a lower percentage of cattle (beef) farms in the basin.

3.2.2 Stockwatering

As noted in Table 3-7, about 40 percent of the farms in the Milk River Basin in 2001 were classified as livestock operations, primarily cattle. Estimated livestock populations for major species in 2001 are provided in Table 3-8. The table shows that there about 345,300 cattle and calves, which together, accounted for about 71 percent of livestock population in the basin. This is about 30 times the human population of the Milk River basin. Other livestock in the Milk Basin included pigs, sheep and lamb, horses and ponies, bison and elk.

Table 3-8 Estimated Livestock Populations in the Milk Basin and Alberta, 2001

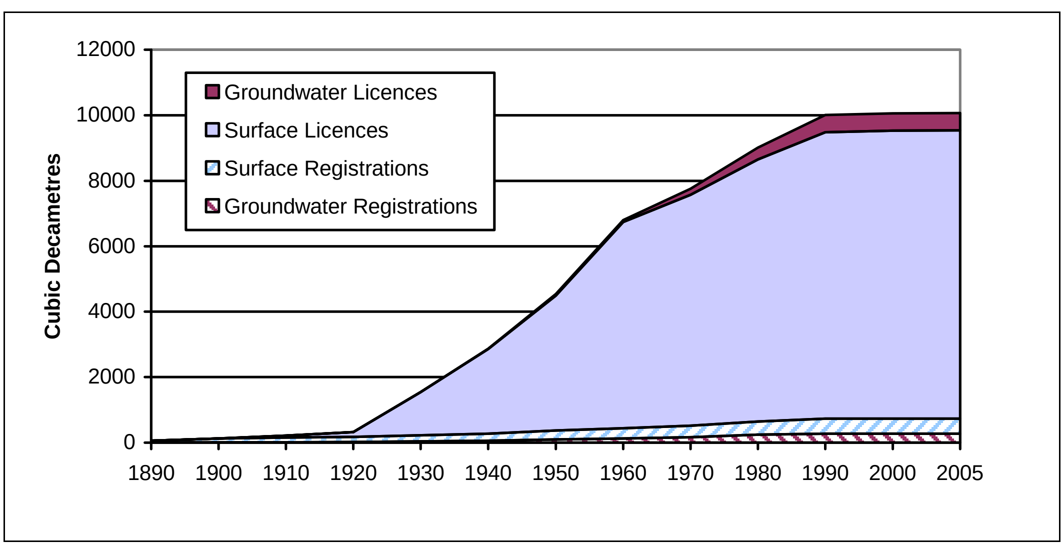
Livestock Species	Milk River Basin	Alberta	Percent of Alberta
Hens and Chickens	565,475	12,175,246	4.6%
Turkey	519	864,438	0.1%
Cattle	278,384	6,615,201	4.2%
Calves	66,883	2,169,607	3.1%
Pigs	125,289	2,027,533	6.2%
Sheep and Lambs	12,002	307,302	3.9%
Horse and Ponies	2,310	159,962	1.4%
Bison	415	79,731	0.5%
Deer	0	8,331	0.0%
Elk	148	31,304	0.5%

3.2.2.1 Water Allocation

Overall, 2,133 licences and registrations have been issued for livestock watering, with total allocation amounting to 10,622 dam^3. Registrations account for seven percent of this amount. In addition to these allocations, farmers are able to obtain up to 1,250 m^3 of water for household purposes, which include water for some livestock. The numbers of such households in the Basin is not known. Furthermore, the numbers of "exempted agricultural" users are also not known in the Milk Basin.

A historical perspective on water used for livestock is provided in Figure 3-8. The figure shows that some registrations were issued with priority dates in the 1890s while licences for stockwatering began to be issued in the 1910s. Since 1920 allocations for stockwatering have risen steadily, with the vast majority of the increase occurring through surface water licences.

Figure 3-8 Historical Trends in Water Allocation for Livestock in the Milk Basin



Since 2000 allocations have remained constant and no new licences or registrations have been issued.

As of December 2005 there were 1,178 registrations representing a total allocation of 460 dam^3 issued for surface water and 368 registrations that allocate 277 dam^3 for groundwater Surface water account for about 85 percent of total allocations for livestock in the Milk River basin. Only one licence for feedlots has been issued in the basin. Table 3-9 summarizes current water licences and registrations issued for livestock according to the water source. It shows that surface water accounts for about 95 per cent of allowable diversions for livestock and that registrations account for 11 percent of the allocations.

3.2.2.2 Licensed Water Use

Table 3-9 shows that, of the total allocations made through registrations and licences, 99 percent of water withdrawn is expected to be used. All water allocated through registrations is expected to be consumed. Only a small amount of surface water allocated through licences (42 dam^3) is expected to be returned to a water body.

3.2.2.3 Actual Water Use

There is no information in Alberta Environment's WURS that indicates the extent to which water allocations are actually used in the Milk Basin. However, a reasonable estimate of water use can be derived based on the actual animal populations in the Basin as shown in Table 3.8. Based on livestock populations for the Milk Basin in 2001, the total water required for livestock was estimated to be 3,378 dam^3, or about 50 percent of the licensed allocation. The calculations for this estimate are provided also in Table 3.10 which shows livestock populations in the Milk River Basin and daily water requirements for various livestock species as provided by Alberta Environment in its "Guide to Calculate Quantities for Water for Raising Animals". In terms of water requirements by species, cattle account for about 86 per cent of the total, about 10 percent is required by pigs, poultry requires about one per cent, and all other species accounted for the remaining three per cent.

While the estimated actual consumption based on livestock populations (3,378 dam^3) appears to be significantly less than the amount of water allocated (10,062 dam^3), the data in Table 3-10 do not include an allowance for the evaporative and seepage losses associated with storing water for livestock use. Typically, consumption accounts for only 35 percent of surface water allocated for livestock use while losses account for 65 percent (Watrecon 2005). Since eight percent of livestock water consumption comes from groundwater (no losses) and the balance comes from surface water with 50 per cent losses, a total allocation of 5,051 dam^3 would be required to support the animal populations in Table 3.8.

Table 3-9 Stockwatering Allocations and Use and Reported Actual Water Use, Milk River Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
Feedlot	Surface	1	45.7	45.7	0.0	0	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Subtotal	**1**	**45.7**	**45.7**	**0.0**	**0**	**N/A**
Stockwatering	Surface	951	8,752.8	8,710.8	42.0	0	N/A
	Groundwater	73	526.8	526.8	0.0	0	N/A
	Subtotal	**1,024**	**9,279.6**	**9,237.6**	**42.0**	**0**	**N/A**
Registration	Surface	1,178	460.3	460.3	0.0	0	N/A
	Groundwater	368	276.7	276.7	0.0	0	N/A
	Subtotal	**1,546**	**736.9**	**736.9**	**0.0**	**0**	**N/A**
Total	Surface	2,130	9,258.7	9,216.7	42.0	0	N/A
	Groundwater	441	803.5	803.5	0	0	N/A
	Total	**2,571**	**10,062.2**	**10,020.2**	**42.0**	**0**	**N/A**

Table 3-10 Estimated Livestock Water Use Based on 2001 Animal Populations

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chickens	565,475	0.045	42.2
Turkey	519	0.15	0.1
Bulls	3,069	9.0	45.8
Milk Cows	4,356	30.0	216.7
Beef Cows	57,076	9.0	851.9
Heifers	78,900	6.0	785.1
Steers	68,099	6.0	677.6
Calves	66,883	3.0	332.7
Boars	586	6.5	6.3
Sows and Gilts - Breeding	11,543	6.5	124.4
Nursing and Weaner Pigs	125,289	0.5	33.5
Grower and Finishing Pigs	72,979	1.5	181.1
Sheep and Lambs	12,002	2.0	39.8
Horse and Ponies	2,310	10.0	38.3
Bison	415	2.0	1.4
Deer	0	10.0	0.0
Elk	148	3.5	0.9
Total			**3,377.8**

This water requirement represents about 70 percent of the amount of water allocated through licences and registrations and represents the best estimated of actual livestock water use in the Milk River basin. Thus, it is appears that actual water use is less than the amount of water actually allocated for livestock. In terms of seasonal use, it is expected that most surface water withdrawals occurred during April when dugouts and storage dams are filled and flows are at their peak.

3.2.2.4 <u>Forecasts of Future Water Use</u>

The key factor affecting future livestock water demand is the extent to which cattle populations in the Basin will change over time. As noted above, cattle account for about 86 percent of livestock water demand in the Milk River basin, so changes in the populations of other livestock species will have a minimal overall impact on future water demand. Although the historical trend analysis in Figure 3-8 shows that the amount of water allocated for livestock has remained relatively unchanged since the 1990s, suggesting a stable livestock population over time, data from the Census of Agriculture shows that the cattle population increased by about 30 percent between 1996 and 2001. Thus, continued expansion of cattle populations and associated water use is expected.

Some indication of the potential for expansion of cattle populations in the Milk River Basin can be determined by examining applications for new and expanded confined feeding operations, which must be approved by the NRCB in accordance with *AOPA*. Information from the NRCB

indicates that, as of December 31, 2005, there had been no applications from farmers throughout the Basin for cattle and dairy operations.

A study undertaken by Alberta Agriculture in the late 1990s also provides some insights regarding the potential for expansion of the beef industry in the province. That study identified several criteria - manure odour and population densities, local silage supplies, water supply, landscape characteristics and land for manure spreading – to be considered in evaluating the capability of supporting a 5,000-head back grounding operation and a 20,000-head operation.. Townships suitable for livestock expansion are shown in Figures 2-3 and 2-4 in Section 2.3. The townships that meet some or all of the criteria are mostly located in the western portions of the Milk River basin. For both types of operations the limiting factors include silage and availability of groundwater but there are some townships that meet all of the criteria. The analysis shows that more townships are capable of meeting all the criteria for a 5,000-head back grounding operation than a 20,000-head operation. Based on Alberta Agriculture's assessment, it would appear that livestock expansion in the Milk River Basin could occur and would most likely consist of 5,000-head operations. While this assessment shows that there is potential for future expansion of livestock operations, the information from the NRCB suggests that this expansion has not yet occurred, probably due to the fact that the cattle industry is still adjusting to changes in markets associated with the effects of BSE.

For this analysis it is assumed that livestock populations and stockwatering requirements will increase over time. Projections are based on the expectations that cattle populations will increase at annual rates somewhere between 1.2 percent (Low Case) and 3.2 percent (High Case). Base Growth assumes 2.2 percent growth which reflects average annual growth rate in cattle population in Alberta during 1958-2005. This forecast also assumes that the current mix of livestock (86 percent cattle) and balance of surface and groundwater use will remain unchanged over the forecast period. The resulting projections are shown in Table 3-11.

Table 3-11 Projected Water Use for Livestock in the Milk River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	4,781	5,075	5,387	5,718	6,069
	Groundwater	270	287	304	323	343
	Total	**5,051**	**5,362**	**5,691**	**6,041**	**6,412**
Medium Growth	Surface	4,781	5,331	5,944	6,627	7,388
	Groundwater	270	301	336	375	418
	Total	**5,051**	**5,632**	**6,279**	**7,001**	**7,806**
High Growth	Surface	4,781	5,597	6,551	7,669	8,977
	Groundwater	270	316	370	433	507
	Total	**5,051**	**5,913**	**6,922**	**8,102**	**9,484**

Under the Low Scenario, water demand is projected to increase to 6,412 dam^3 by 2025; this represents a 27 percent increase over current use, but is still less than current allocations contained in licences and registrations. Under the High Scenario, livestock water use would

increase to 9,484 dam^3 by 2025. This is 1.9 times higher than current livestock use and is still within the current allocations.

3.2.3 Irrigation

The other major use of water for agricultural purposes is irrigation or crop watering. Unlike other river basins in southern Alberta, there are no licences for district irrigation in the Milk River basin. Farmers in the Milk River Basin are private irrigators who have their own water licences and divert water using their own pumps and water distribution equipment. And, even though part of the Raymond Irrigation District is located in the Mil River Basin, it draws its water from the Oldman River Basin.

When aggregate information from the 2001 Census of Agriculture for individual counties and municipal districts is modified to reflect river Basin boundaries, the resulting estimates suggest that 157,464 acres of land in the Milk River Basin were irrigated in 2001. This number is incorrect however, because irrigation acres are not evenly distributed throughout each county; the Milk River Basin is located in counties that all have irrigation districts that draw water from the Oldman River basin. The exact number of irrigated acres in the Milk River Basin is not known. However, based on water allocations to private irrigators and irrigation requirements of about 450 mm (18 inches), it is estimated that water allocations are sufficient to support irrigation on 36,708 acres. Although there is no information on the mix of crops grown by private irrigators, AAFRD has indicated that most private irrigation in Alberta is used to raise supplemental forages to feed livestock so most irrigation in the Milk River Basin is likely for alfalfa, hay and feed barley.

3.2.3.1 <u>Water Allocation</u>

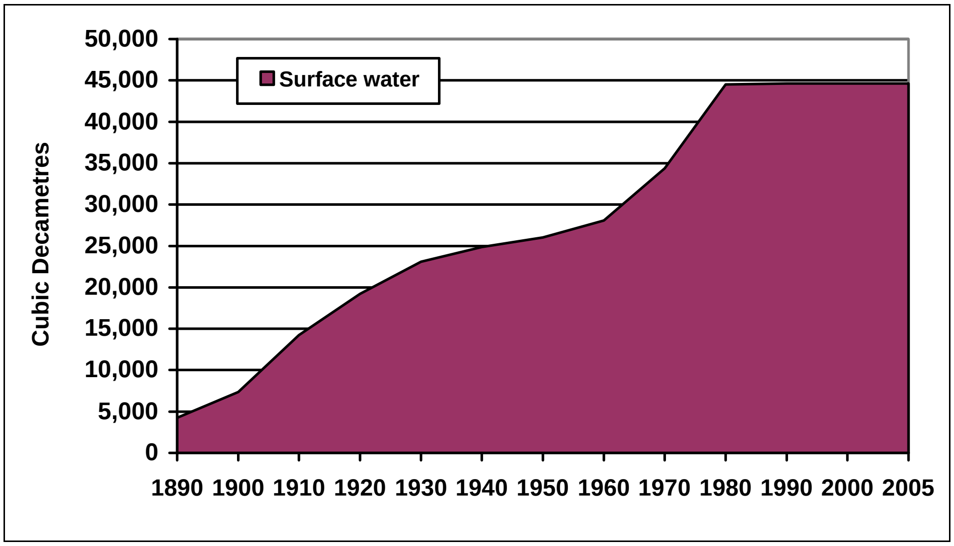
In the Milk River Basin there are 281 licences that allow withdrawals of up to approximately 44,641 dam^3 for private irrigation purposes. All of these allocations are for diversions of surface water. This Basin accounts for about seven percent of total private allocation and about 10 percent of the private licences issued in the province. A historical perspective on water allocations for private irrigation in the Milk River Basin is provided in Figure 3-9.

It shows that the oldest licences for crop watering or irrigation date back to the 1890s. The allocations for irrigation have increased over time from about 7,000 dam^3 in 1890 to 44,000 dam^3 in 1980. The amount of water allocated to irrigation has remained about the same since then.

Table 3-12 Irrigation Allocations and Use and Reported Actual Water Use, Milk River Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
District irrigation	Surface	0	0.0	0.0	0.0		
	Groundwater	0	0.0	0.0	0.0		
	Subtotal	**0**	**0.0**	**0.0**	**0.0**		
Private irrigation	Surface	281	44,640.9	43,178.0	1,462.9	0	N/A
	Groundwater	0	0.0	0.0	0.0		
	Subtotal	**281**	**44,640.9**	**43,178.0**	**1,462.9**	**0**	**N/A**
Total	Surface	181	44,640.9	43,178.0	1,462.9	0	N/A
	Groundwater	0	0.0	0.0	0.0		
	Total	**181**	**44,640.9**	**43,178.0**	**1,462.9**	**0**	**N/A**

Figure 3-9 Historical Trends in Allocations for Irrigation in the Milk Basin



3.2.3.2 Licensed Water Use

Table 3-13 summarizes the water licences issued for crop watering and irrigation according to water source. It shows that up to 97 percent of the total allocation of surface water is expected to be used and that there is an allowance for four percent (1,463 dam^3) is to be returned to surface sources.

3.2.3.3 Actual Water Use

Neither Alberta Agriculture nor Alberta Environment has any information on actual water use by private irrigators. For the purposes of this study it is assumed that actual use is equal to licensed water use. However, water use in any given year will depend on how much of the crop water demand can be satisfied by natural precipitation. It is noteworthy that licensed irrigation water use in the Milk Basin (43,178 dam^3) is nearly five times the amount of surface water that can be used for stockwatering (10,020 dam^3).

3.2.3.4 Forecasts of Future Water Use

With expansion of livestock, additional demand for livestock forage is expected. The historical trend provided as Figure 3-9 shows that water allocation for irrigation has remained relatively unchanged since 1980s, suggesting that past increases in livestock have not led to increased water demand for expansion in irrigated crop areas. Consequently, future crop water requirements are expected to be very similar to existing conditions with the assumption that some increased irrigation will be required to grow the additional forage needed to support livestock expansion. Projections are based on the expectations that water demand will increase

at annual rates somewhere between 0.5 percent (Low Case) and 1.5 percent (High Case). Base Growth assumes 1.0 percent growth.

Table 3-13 Projected Water Use for Irrigation in the Milk River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	43,178	43,286	43,394	43,503	43,612
	Groundwater	0	0	0	0	0
	Total	**43,178**	**43,286**	**43,394**	**43,503**	**43,612**
Medium Growth	Surface	43,178	43,394	43,612	43,830	44,050
	Groundwater	0	0	0	0	0
	Total	**43,178**	**43,394**	**43,612**	**43,830**	**44,050**
High Growth	Surface	43,178	46,515	50,110	53,983	58,155
	Groundwater	0	0	0	0	0
	Total	**43,178**	**46,515**	**50,110**	**53,983**	**58,155**

Water demand under the Low Growth scenario (see Table 3-12) water use will be 43,612 dam^3 by 2025 which is virtually unchanged from 2005. Under High Growth, water use will be 58,155 dam^3, an increase of 34 percent from 2005 level.

3.2.4 Summary

In summary, current agricultural water use in the Milk Basin is estimated to be about 48,229 dam^3, of which 89 percent is for irrigation and 11 percent is for livestock. In the future, agricultural water demand in the Basin is expected to increase as a result of expansion of livestock populations. Demand for irrigation is expected to grow to accommodate livestock demand for additional forage. A summary of future agricultural water demand is provided in Table 3-14. Agricultural water use in 2025 would be about 50,024 dam^3 (an increase of four percent from 2005) under the Base Case. Under High Case, water use is projected to be 67,639 dam^3 by 2025 (an increase of 40 percent from 2005).

Table 3-14 Projected Water Use for Agriculture in the Milk River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	47,959	48,361	48,781	49,221	49,681
	Groundwater	270	287	304	323	343
	Total	**48,229**	**48,648**	**49,086**	**49,544**	**50,024**
Medium Growth	Surface	47,959	48,725	49,555	50,457	51,438
	Groundwater	270	301	336	375	418
	Total	**48,229**	**49,026**	**49,891**	**50,832**	**51,856**
High Growth	Surface	47,959	52,112	56,661	61,651	67,131
	Groundwater	270	316	370	433	507
	Total	**48,229**	**52,428**	**57,032**	**62,085**	**67,639**

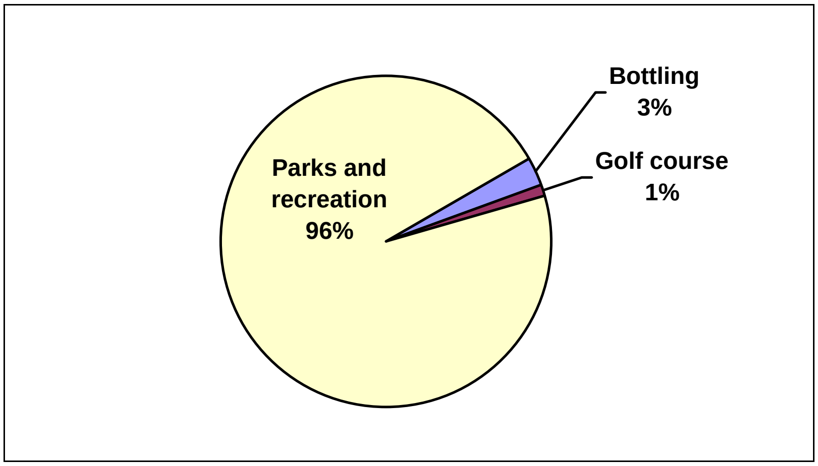
3.3 COMMERCIAL SECTOR

There are nine licences that allow diversion of 809 dam^3 of water in the Milk River basin. This allocation accounts for 1.8 percent of total allocations in the basin.

3.3.1 Water Allocations

As shown in Figure 3-10, water allocated for parks and recreation (seven licences with a combined allocation of 777 dam^3) accounts for about 95 percent of total allocation of water for commercial purposes. The remainder consists of water allocated for bottling (three percent) and for golf courses (one percent).

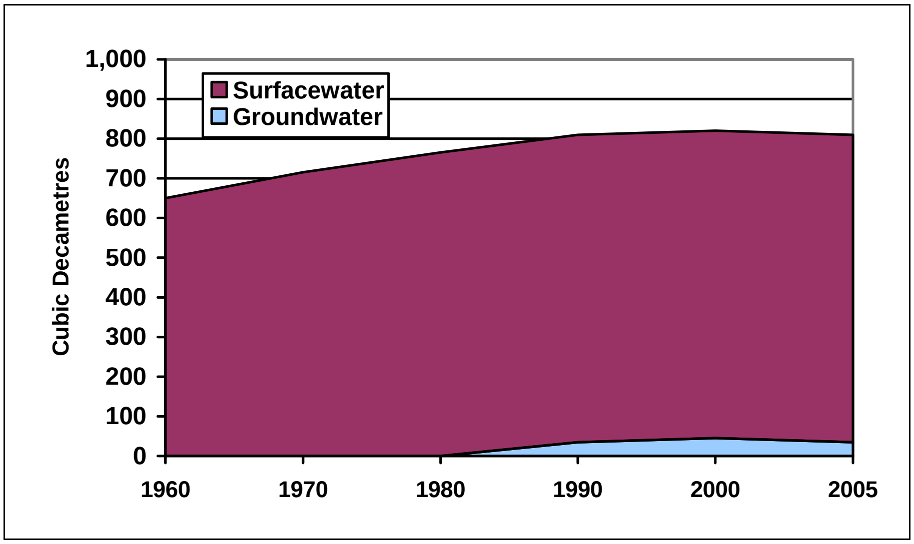
Figure 3-10 Water Allocation by Volume for Commercial Activities in the Milk Basin



Licences issued for the commercial sector allow maximum withdrawals of about 775 dam^3 of surface water and about 35 dam^3 of groundwater. Water licences issued for parks and recreation account for 99 percent of the total surface water allocation. Bottling accounts for about 70 percent of the groundwater allocation.

A historical trend of commercial sector allocation in the Milk Basin is provided in Figure 3-11. It shows that water licences for commercial purposes consisted entirely of surface water in the 1960s. Since then, allocations of surface water grew slightly in the 1970s and 1980s, but have remained constant since the 1990s. Allocations from groundwater began in the 1980s increased slightly during the 1990s but have declined slightly since 2000.

Figure 3-11 Historical Trend in Commercial Sector Water Allocation in the Milk Basin



3.3.2 Licensed Water Use

Table 3.15 provides a summary of licensed water allocations, use and return for various activities within the commercial sector in the Milk Basin. The table shows that all of the licences are expected to use the full amount being withdrawn (i.e., there is no return flow).

3.3.3 Actual Water Use

At the present time Alberta Environment's Water Use Reporting System (WURS) contains no information on actual water use in 2005 by the any of the licensees in the commercial sector in the Milk River basin. For purposes of determining water use in the basin it is assumed that all licensees are withdrawing the full amounts of water to which they are entitled. While this assumption may overstate actual water use in the basin, the commercial sector only accounts for 1.8 percent of total allocations in the Milk River basin.

3.3.4 Forecasts of Future Water Use

Since most of the commercial allocation (96 percent) is for parks and recreation, forecasts of future demand will focus on that activity. As noted in Figure 3-11, total allocations of surface water, primarily for parks and recreation purposes, have remained constant since 1990 even though the regional population has increased by 2.5 percent between 1996 and 2001. Since it is expected that future demands for commercial water will be tied to future population growth in the region, the low growth scenario assumes that the available allocation of water for commercial purposes will be sufficient for the next 20 years and no new licences will be issued.

Table 3-15 Licensed Commercial Allocations and Reported Actual Water Use, Milk River Basin

			Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
Activity	**Source**	**Number of Licences**	**Allocation**	**Water Use**	**Return**	**Licensees Reporting**	**Reported Use**	**Percent of Allocation**
Bottling	Surface	0	0	0	0			
	Groundwater	1	22	22	0	0	N/A	N/A
	Subtotal	**1**	**22**	**22**	**0**	**0**	**N/A**	**N/A**
Golf course	Surface	1	10	10	0	0	N/A	N/A
	Groundwater	0	0	0	0			
	Subtotal	**1**	**10**	**10**	**0**	**0**	**N/A**	**N/A**
Parks and recreation	Surface	4	765	765	0	0	N/A	N/A
	Groundwater	3	12	12	0	0	N/A	N/A
	Subtotal	**7**	**777**	**777**	**0**	**0**	**N/A**	**N/A**
Total	Surface	5	775	775	0	0	N/A	N/A
	Groundwater	4	35	35	0	0	N/A	N/A
	Total	**9**	**809**	**809**	**0**	**0**	**N/A**	**N/A**

As a high growth scenario, it is assumed that commercial water requirements will increase in direct relation to the size of the regional growth which, based on forecasts by the Alberta Government, will increase at a rate of 1.8 percent per year. Using these assumptions, estimated water used for commercial purposes in the Milk River Basin for the period to 2025 is provided in Table 3-16. Under the Low Growth scenario, water allocations and use will remain constant throughout the forecast period. Under the High Growth scenario, commercial water use will increase by 144 percent over 25 years, reaching 1,975 dam^3 by 2025. Nearly all of the demands for commercial water use will be for surface water.

Table 3-16 Forecast of Commercial Water Use in the Milk River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	775	775	775	775	775
	Groundwater	35	35	35	35	35
	Total	**809**	**809**	**809**	**809**	**809**
Medium Growth	Surface	775	810	886	1,013	1,212
	Groundwater	35	38	41	48	60
	Total	**809**	**846**	**926**	**1,059**	**1,268**
High Growth	Surface	775	847	1,012	1,321	1,888
	Groundwater	35	38	47	63	95
	Total	**809**	**885**	**1,058**	**1,382**	**1,975**

Commercial sector currently accounts for less than one percent of total allocation by volume in the Milk Basin. Therefore, changes to this sector's allocation will not appreciably affect the basin's overall water demand.

3.4 PETROLEUM SECTOR

There are no active petroleum water licences in the Milk Basin. Although one licence for withdrawals of 37 dam^3 of groundwater had been issued for injection purposes that licence expired in 2003. According to the EUB data provided by Geowa, the petroleum sector in the Milk Basin used 17 dam^3 of groundwater for injection purposes in 2005.

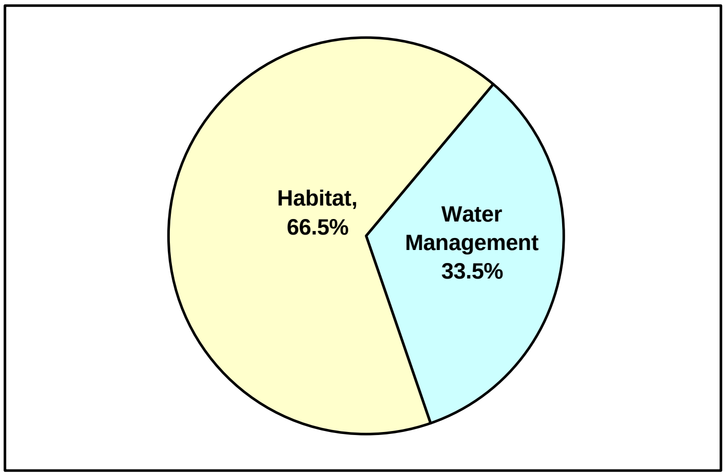
3.5 INDUSTRIAL SECTOR

There are no industrial water licences in the Milk Basin. No industrial water use outside municipalities is expected for the period to 2025.

3.6 OTHER SECTOR

In the Milk Basin, there are 13 active water licences for other sector activities which allocate 4,310 dam^3, 13 percent of which must be returned to the source. Other sector activities account for about 10 percent of licensed water use in the Milk Basin. All the water allocated to the other sector is surface water. Other sector uses include water management (flood control and lake stabilization), and fish, wildlife and habitat enhancement (Figure 3-12).

Figure 3-12 Other Sector Water Allocation by Use in the Milk River Basin



Details of the licences issued for other purposes in the Milk River Basin are provided in Table 3-17. Brief descriptions of the major uses in this sector are provided below.

3.6.1 Water Management

About 34 percent of allocations in the other sector are for water management purposes, with allocations of 1,444 dam^3 of surface water. Allocations for water management commenced in the 1960s and grew in the 1990s but have remained constant for the last 10 years. As shown in Table 3-17, the licences issued for water management purposes assume about 61 percent of surface water allocations to be used. Return flow allowances in licences amounted to 566 dam^3. There is no information on actual water diversions and consumption for water management activities and, for purposes of this analysis, it is assumed that licensees are using their full amount they are expected to use and will do so for the duration of the forecast period.

3.6.2 Habitat

About 66 percent of the allocations are for fish, wildlife and habitat enhancement. Table 3-17 shows that 2,865 dam^3 have been allocated for habitat projects, all for surface water. Surface water use for habitat commenced in the 1960s and grew until the 1990s, but there has actually been a slight decline in licensed allocations for surface water since the 1990s. There are no return flow requirements for any of the licences issued for habitat enhancement, so all water withdrawn can be used. There is no information on actual water diversions and consumption for habitat enhancement activities. For purposes of this analysis, it is assumed that licensees are using the full amount they are expected to use and will do so for the duration of the forecast period.

Table 3-17 Licensed Allocations and Reported Actual Water Use for the Other Sector, Milk River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam³)			Reported Actual Water Use (dam³)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Water Management	Surface	4	1,444.4	878.2	566.2	878.2	100.0%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0	100.0%	100.0%
	Subtotal	**4**	**1,444.4**	**878.2**	**566.2**	**878.2**	**100.0%**	**100.0%**
Habitat	Surface	9	2,865.4	2,865.4	0.0	2,865.4	100.0%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0	100.0%	100.0%
	Subtotal	**9**	**2,865.4**	**2,865.4**	**0.0**	**2,865.4**	**100.0%**	**100.0%**
Total	Surface	13	4,309.8	3,743.6	566.2	3,743.6	100.0%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0	100.0%	100.0%
	Total	**13**	**4,309.8**	**3,743.6**	**566.2**	**3,743.6**	**100.0%**	**100.0%**

3.6.3 Summary

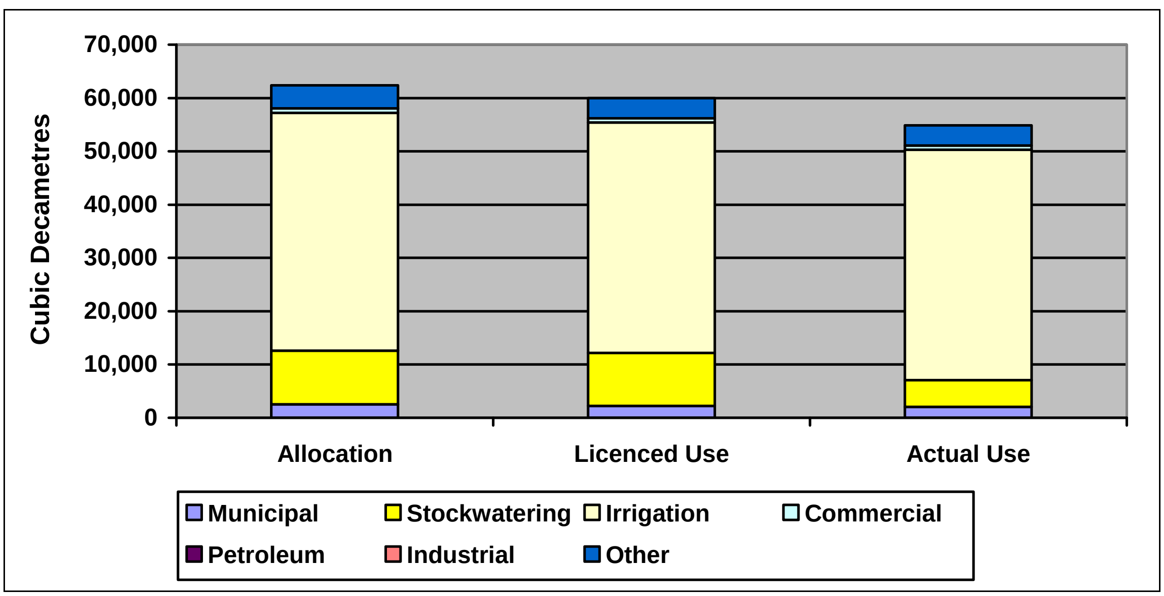
The other sector in the Milk Basin is dominated by water allocated for habitat enhancement. These projects account for 66 percent of water allocation and 77 percent of the licensed water use. For purposes of this analysis, it is assumed that licensees are using their full entitlement and will do so for the duration of the forecast period.

3.7 SUMMARY

Table 3-19 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the Milk River basin. In total, existing licence and registrations allow a maximum of 62,361 dam^3 of water to be withdrawn for use. Of this, up to 59,946 dam^3 are expected to be used and 2,415 dam^3 returned to surface water. As noted previously, the largest amounts of water have been allocated to the agriculture sector, particularly irrigation.

With respect to actual use, the exact volumes withdrawn and used in 2005 are not known because very few water use reports have been filed with Alberta Environment. However, based on the assumptions used in the previous sections, it is estimated that 54,842 dam^3 were actually used in 2005. This represents 91 percent of water use allowed in existing licences and registrations. Based on estimated use, the agricultural sector accounted for 88 percent of total water use in the Milk River Basin in 2005. Figure 3-13 shows how actual use compares to licensed allocations and use for each of the water use sectors.

Figure 3-13 Water Allocations and Actual Use, by Sector, Milk River Basin



Forecasts of future water use in the Milk River Basin are provided in Tables 3-20 to 3-22 for the low, medium and high growth scenarios. Predicted water use under the Medium growth scenario is shown in Figure 3-14. This figure shows that most of the growth in water use will

occur in the agricultural sector, with water used for stockwatering and irrigation accounting for 84 percent of total water use by 2025.

Under the medium scenario, water demand in 2025 will be about 9.8 percent higher than at present. For the other scenarios, the increase in water demand over 20 years will range from 4.7 percent for low growth and 38.7 percent for high growth. For all scenarios, actual water use will be less than the amount that can be consumed under the terms of existing licences.

Figure 3-14 Forecast Water Use in the Milk River Basin: Medium Scenario

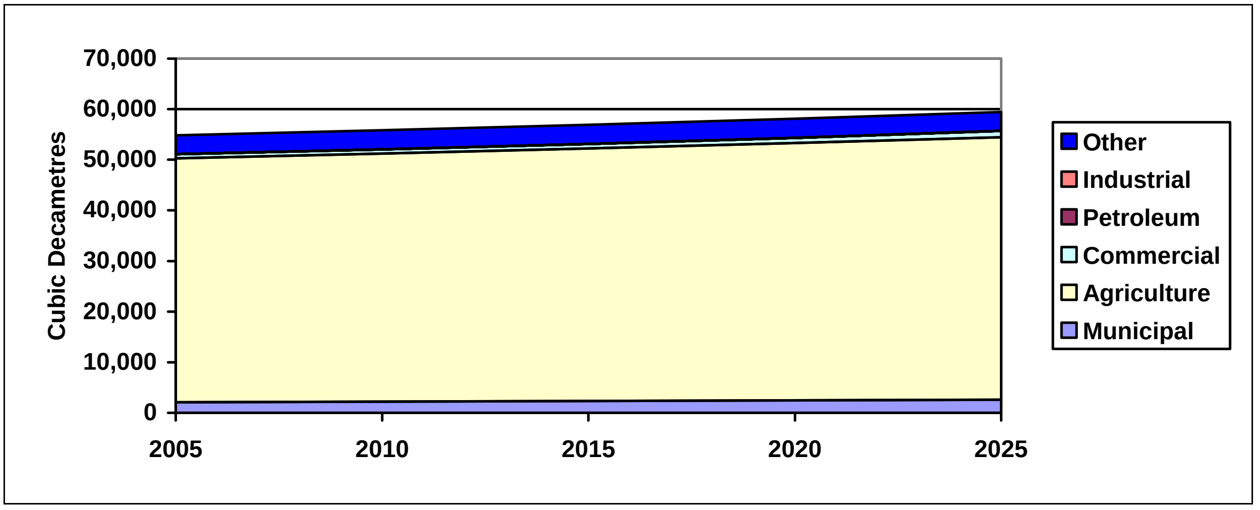


Table 3-18 Summary of Allocations and Estimated Water Use, Milk River Basin

Sector		Licensed Allocation and Use (dam^3)				Estimated Water Use (dam^3)		
		Allocation	Water Use	Return	Percent of Total Use	Use	Percent of Licensed use	Percent of Total Use
Municipal		2,539	2,195	344	4%	2,060	94%	4%
Agricultural	Stockwatering	10,062	10,020	42	17%	5,051	50%	9%
	Irrigation	44,641	43,178	1,463	72%	43,178	100%	79%
Commercial		809	809	0	1%	809	100%	1%
Petroleum		0			0%	0		0%
Industrial		0			0%	0		0%
Other		4,310	3,744	566	6%	3744	100%	7%
Total		**62,361**	**59,946**	**2,415**	**100%**	**54,842**	**91%**	**100%**

Table 3-19 Forecast Water Use, By Sector, Milk River Basin: Low Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	1,423	1,484	1,531	1,570	1,601
	Agricultural	47,959	48,361	48,781	49,221	49,681
	Commercial	775	775	775	775	775
	Petroleum	0	0	0	0	0
	Industrial	0	0	0	0	0
	Other	3,744	3,744	3,744	3,744	3,744
	Total	53,901	54,364	54,831	55,310	55,801
Groundwater	Municipal	637	664	685	703	716
	Agricultural	270	287	304	323	343
	Commercial	35	35	35	35	35
	Petroleum	0	0	0	0	0
	Industrial	0	0	0	0	0
	Other	0	0	0	0	0
	Total	942	986	1,024	1,061	1,094
Total	Municipal	2,060	2,148	2,216	2,273	2,317
	Agricultural	48,229	48,648	49,085	49,544	50,024
	Commercial	810	810	810	810	810
	Petroleum	0	0	0	0	0
	Industrial	0	0	0	0	0
	Other	3,744	3,744	3,744	3,744	3,744
	Total	54,843	55,350	55,855	56,371	56,895

Table 3-20 Forecast Water Use, By Sector, Milk River Basin: Medium Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	1,423	1,514	1,605	1,692	1,773
	Agricultural	47,959	48,725	49,555	50,457	51,438
	Commercial	775	810	886	1,013	1,212
	Petroleum	0	0	0	0	0
	Industrial	0	0	0	0	0
	Other	3,744	3,744	3,744	3,744	3,744
	Total	53,901	54,793	55,789	56,906	58,166
Groundwater	Municipal	637	678	719	758	794
	Agricultural	270	301	336	375	418
	Commercial	35	38	41	48	60
	Petroleum	0	0	0	0	0
	Industrial	0	0	0	0	0
	Other	0	0	0	0	0
	Total	942	1,017	1,096	1,181	1,272
Total	Municipal	2,060	2,192	2,324	2,450	2,567
	Agricultural	48,229	49,026	49,891	50,832	51,856
	Commercial	810	848	927	1,061	1,272
	Petroleum	0	0	0	0	0
	Industrial	0	0	0	0	0
	Other	3,744	3,744	3,744	3,744	3,744
	Total	54,843	55,810	56,885	58,087	59,438

Table 3-21 Forecast Water Use, By Sector, Milk River Basin: High Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	1,423	1,569	1,729	1,889	2,047
	Agricultural	47,959	52,112	56,661	61,651	67,131
	Commercial	775	847	1,012	1,321	1,888
	Petroleum	0	0	0	0	0
	Industrial	0	0	0	0	0
	Other	3,744	3,744	3,744	3,744	3,744
	Total	53,901	58,272	63,145	68,605	74,810
Groundwater	Municipal	637	702	774	846	916
	Agricultural	270	316	370	433	507
	Commercial	35	38	47	63	95
	Petroleum	0	0	0	0	0
	Industrial	0	0	0	0	0
	Other	0	0	0	0	0
	Total	942	1,056	1,191	1,342	1,518
Total	Municipal	2,060	2,271	2,503	2,735	2,963
	Agricultural	48,229	52,428	57,031	62,084	67,638
	Commercial	810	885	1,059	1,385	1,983
	Petroleum	0	0	0	0	0
	Industrial	0	0	0	0	0
	Other	3,744	3,744	3,744	3,744	3,744
	Total	54,843	59,327	64,337	69,947	76,327

Oldman River Basin

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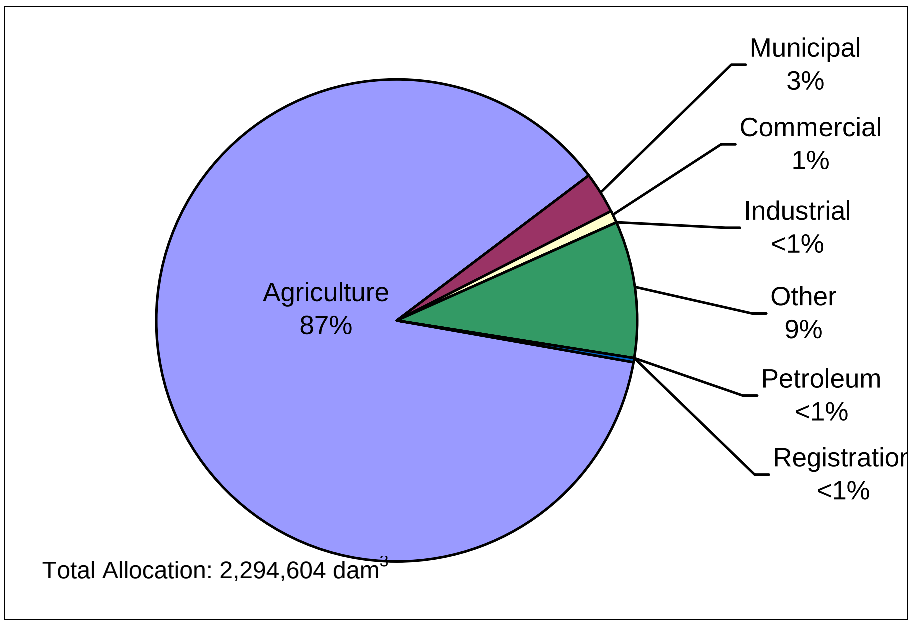
4.0 OLDMAN RIVER BASIN

The Oldman Basin is about 26,000 km^2, which represents approximately four percent of Alberta. The mean annual natural flow of the Oldman River at Lethbridge is 350,000 dam^3, and it drains into the South Saskatchewan River at the confluence of the Bow River. In 2001, the Basin had a population over 160,000 people, or 5.4 percent of the provincial population, resulting in a population density of 6.1 people per square kilometer. The Oldman Basin comprises all or parts of 26 urban municipalities, 11 rural or regional municipalities, and two First Nations.

An overview of surface and groundwater allocations existing is provided in Figure 4-1. It shows that agriculture, including registrations, accounts for 87 percent of total allocations, which totaled 2,290,851 dam^3 in 2005. The other 13 percent of water allocations consisted mainly of other and municipal uses.

Figure 4-1 Distribution of Active Water Allocation in the Oldman Basin



Figures 4-2 and 4-3 show the location of all active surface and groundwater licences in the Oldman Basin, respectively, reported in terms of the size of the allocation and sector. Figure 4-4 shows the location of all registrations issued for the Oldman River basin.

Detailed descriptions of current allocations and actual water use for each of the water use sectors are provided below.

4.1 MUNICIPAL AND RESIDENTIAL SECTOR

4.1.1 Population

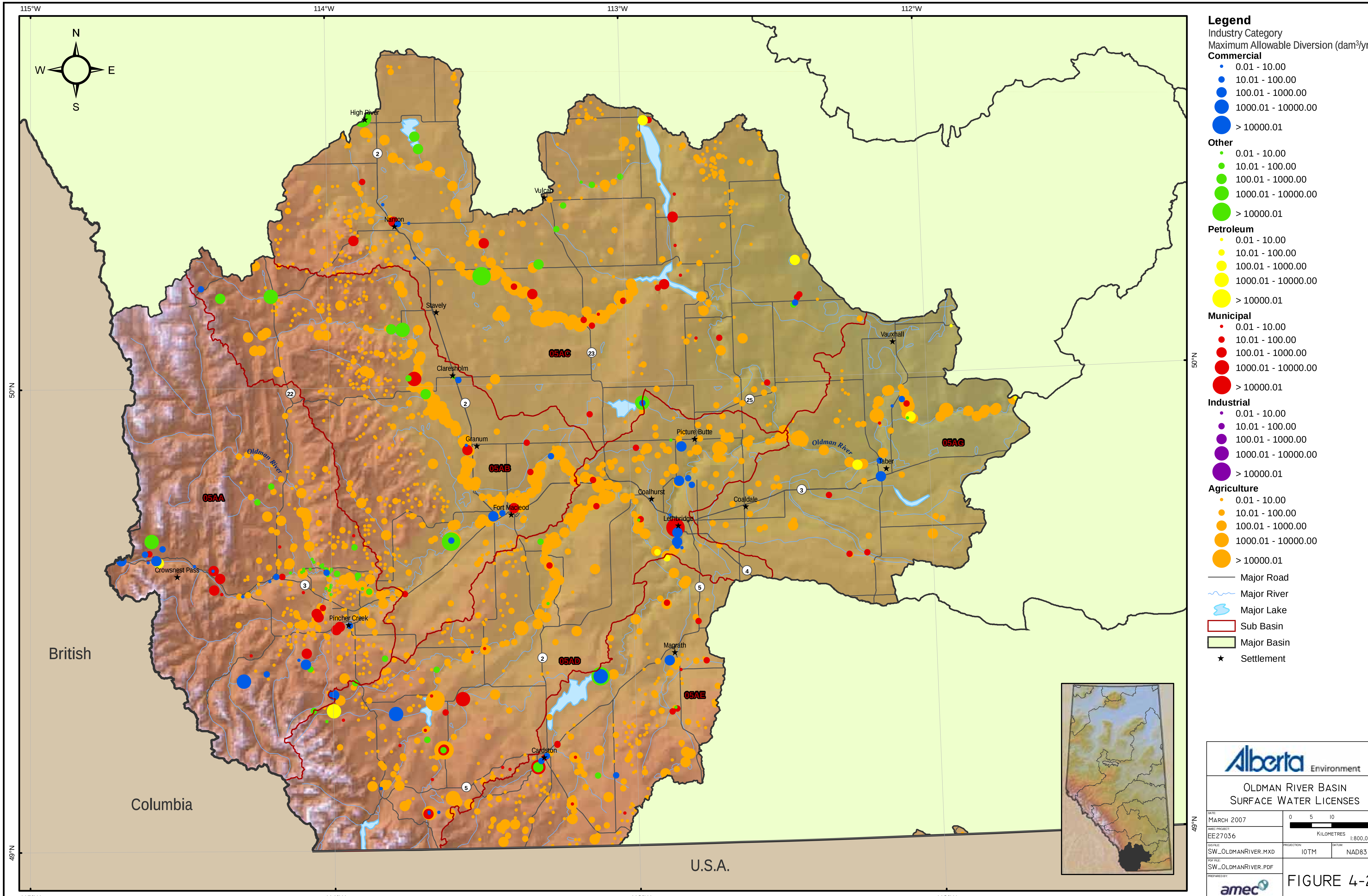
In 2001, the Oldman River Basin had an estimated population of about 162,100 people, most of whom lived in urban centres. As shown in Table 4-1, residents of villages, summer villages, towns, cities, hamlets accounted for 74 percent of the Basin population. Major population centres include the City of Lethbridge (67,374 residents) and the Towns of Taber (7,671), Coaldale (6,008), Pincher Creek (3,666), Claresholm (3,622), Fort Macleod (2,990) and Cardston (2,254). Between 1996 and 2001, the urban population increased by 6.6 percent. Table 4-2 lists all the urban and rural municipalities that intersect Oldman Basin, their population in 2001, and current water allocations in excess of 100 dam^3.

Residents of rural or regional municipalities accounted for 20 percent of the Basin population, and this number increased by only 4.9 percent between 1996 and 2001. Rural or regional municipalities with significant populations in the Basin include the County of Lethbridge (9,804), the Municipality of Crowsnest Pass (6,262), and the Municipal Districts of Willow Creek No. 26 (5,411), Foothills No. 31 (4,313) and Taber (4,267).

About 6.0 percent of the population consisted of Aboriginal people in the Blood Tribe or the Peigan Nation. First Nation populations are growing very quickly, with a total increase of 11.4 percent between 1996 and 2001. The most populous First Nation in the Basin is the Blood Tribe (7,489).

Table 4-1 Population Distribution and Growth in the Oldman River Basin, 2001

	2001		1996	1996 to 2001 Population Change
	Population	**Percent**	**Population**	**Percent**
Urban Municipality	119,589	73.8%	112,220	6.6%
Rural or Regional Municipality	32,788	20.2%	31,258	4.9%
First Nations and Métis Settlements	9,722	6.0%	8,729	11.4%
Total	**162,099**	**100%**	**152,207**	**6.5%**



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Vulcan
Nanton
Stavely
Claresholm
Granum
Fort Macleod
Coalhurst
Coaldale
Lethbridge
Picture Butte
Vauxhall
Taber
Crowsnest Pass
Pincher Creek
Magrath
Cardston
Oldman River
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05AC
05AD
05AE
05AG
British
Columbia
U.S.A.
Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
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Other
Petroleum
Municipal
Industrial
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> 10000.01
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
Alberta Environment
Oldman River Basin
Surface Water Licenses
March 2007
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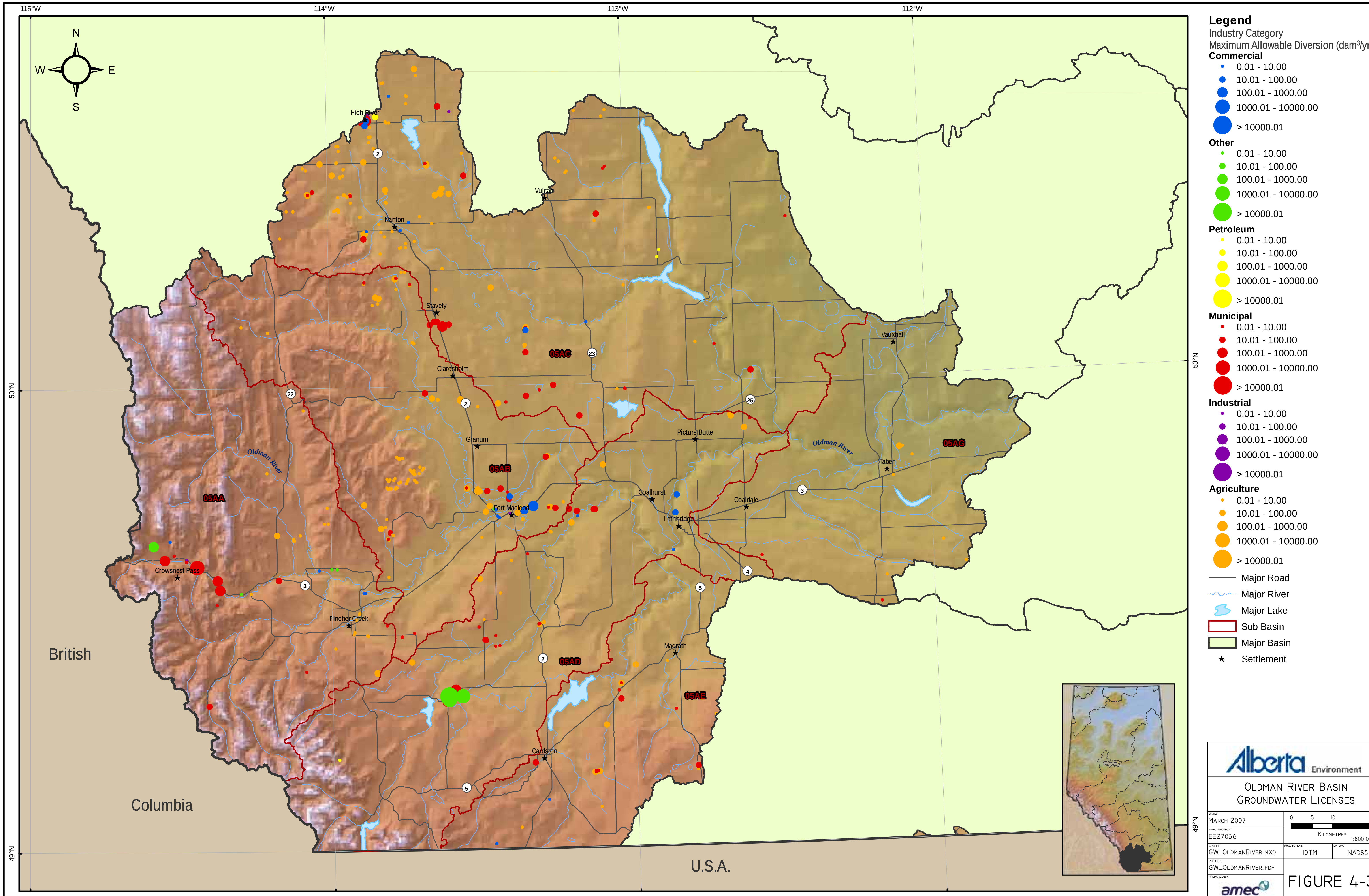
FIGURE 4-2



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05AA
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0.01 - 10.00
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Major Lake
Sub Basin
Major Basin
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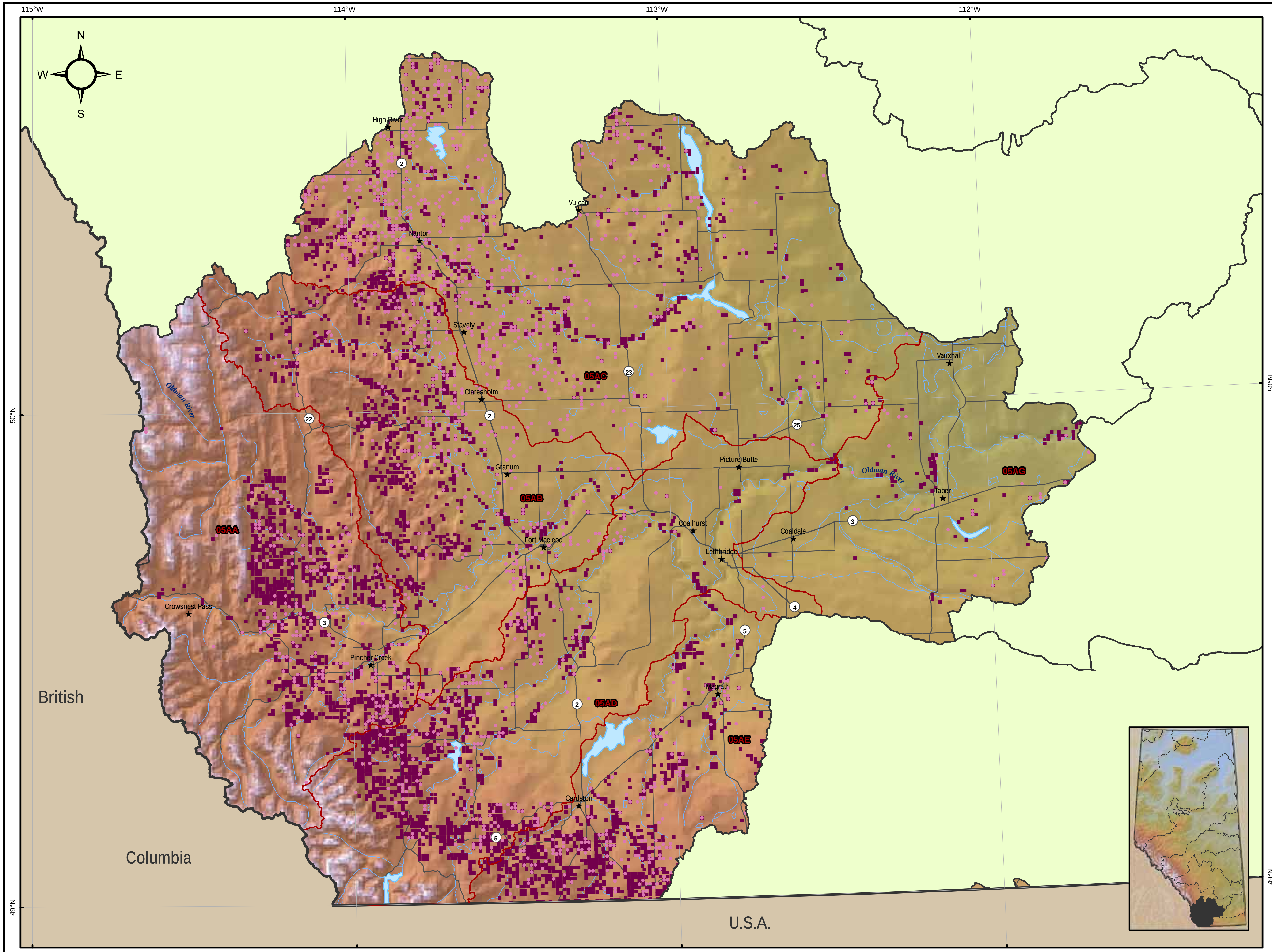
FIGURE 4-3



Alberta Environment

OLDMAN RIVER BASIN REGISTRATIONS

DATE: MARCH 2007	0 5 10 20 KILOMETRES 1:800,000
AMEC PROJECT: EE27036	
GIS FILE: RG_OLDMANRIVER.MXD	PROJECTION: 10TM / DATUM: NAD83
PDF FILE: RG_OLDMANRIVER.PDF	
PREPARED BY: amec	

FIGURE 4-4

Table 4-2 2001 Municipal Populations and Water Allocations within Oldman River Basin

Municipality Name		2001 Population	Source	2005 Allocation (dam^3)
Urban	CITY OF LETHBRIDGE	67,374	Surface	30,857
	TOWN OF TABER	7,671	Surface	3,504
	TOWN OF COALDALE	6,008	Surface	1,974
	TOWN OF PINCHER CREEK	3,666	Surface	1,816
	TOWN OF CLARESHOLM	3,622	Surface	1,444
	TOWN OF FORT MACLEOD	2,990	Surface	1,850
	TOWN OF CARDSTON	2,254	Surface	1,977
	TOWN OF MAGRATH	1,993	Surface	1,480
	TOWN OF NANTON	1,841	Surface	740
	TOWN OF PICTURE BUTTE	1,701	Surface	493
	TOWN OF VULCAN	1,496	Surface	296
	TOWN OF COALHURST	1,476		
	TOWN OF VAUXHALL	1,112		
	TOWN OF STAVELY	442	Groundwater	120
	TOWN OF GRANUM	392	Surface	185
	VILLAGE OF NOBLEFORD	615	Surface	327
	VILLAGE OF BARNWELL	548	Surface	200
	VILLAGE OF HILL SPRING	437	Surface	162
	VILLAGE OF CHAMPION	355		
	VILLAGE OF BARONS	284	Surface	106
	VILLAGE OF GLENWOOD	258	Groundwater Surface	419 205
	VILLAGE OF CARMANGAY	255		
	VILLAGE OF COWLEY	225		
	VILLAGE OF LOMOND	171		
Rural	COUNTY OF LETHBRIDGE	9,804	Surface	9,804
	MD OF CROWSNEST PASS	6,262	Groundwater Surface	4,055 1,026
	COUNTY OF WARNER NO. 5	286		
	MD OF WILLOW CREEK NO. 26	5,411	Groundwater	117
	MD OF FOOTHILLS NO. 31	4,313		
	MD OF TABER	4,267		
	MD OF PINCHER CREEK NO. 9	3,197	Surface	469
	VULCAN COUNTY	2,232		
	CARDSTON COUNTY	3,022		
	IMPROVEMENT DISTRICT NO. 4	155		
	MD OF RANCHLAND NO. 66	93		
	KANANASKIS IMPROVEMENT DISTRICT	8		
First Nations	BLOOD TRIBE	7,489		
	PEIGAN NATION	2,233		
Total		**162,099**		**63,626**

4.1.2 Water Allocations

In 2005, there were 244 active municipal water licences for 137 licensees in the Oldman Basin. These licences, which are summarized in Table 4-4, allow withdrawals of up to 64,149 dam^3, which represents 2.9 percent of licensed water allocations in Oldman Basin. Urban communities account for 92 percent of total municipal allocations; rural; communities including water cooperatives, farmsteads, single-multi homes and Hutterite colonies account for eight percent of licensed withdrawals; and other municipal uses account for less than 0.1 percent.

Licences allow withdrawals of up to 58,425 dam^3 of surface water, representing 91 percent of total municipal water allocations. Urban users can withdraw up to 54,129 dam^3 of surface water with 68 licences. The City of Lethbridge has an allocation of 30,857 dam^3 which is the largest allocation of surface water of all the basin municipalities. Rural users have been allocated 4,247 dam^3 of surface water with 58 licences.

The maximum amount of groundwater that can be withdrawn in Oldman Basin by the municipal sector is 5,724 dam^3; this represents nine percent of total municipal water allocations. The largest groundwater allocation is for urban use (4,691 dam^3 over 31 licences). Rural cooperatives, farmsteads, single-multi homes and colonies have been allocated 967 dam^3 of groundwater over 80 licences. The Municipality of Crowsnest Pass has the largest groundwater allocation of all municipal users (4,055 dam^3) but also has a surface water allocation of 1,026 dam^3.

Oldman Basin municipal water users with allocations of greater than or equal to 100 dam^3 are listed in Tables 4-2 and 4-3 which also indicate the water source. Together, these licences account for 97 percent of the allocation for municipal purposes. It should be noted that, although the Town of Raymond and the Village of Sterling are located within Milk Basin, they draw most of their water from the Oldman Basin through the works of the St. Mary River Irrigation District (SMRID). These communities have five licences that allow withdrawals of up to 3,238 dam^3 from the Oldman River basin.

While the Town of High River straddles the Bow and Oldman Basin boundaries, with two thirds of its population living within Oldman Basin, it draws all of its water from the Bow Basin. The Town of Vauxhall is located within the Oldman Basin but is licensed to draws 740 dam^3 of surface water from the Bow Basin. The Town of Bow Island is located within the South Saskatchewan Basin but is entitled to withdraw up to 678 dam^3 of surface water from the Oldman Basin.

Table 4-3 Other Large Municipal Water Licensees and Sources, Oldman River Basin

Approval Holder		Water Source	Allocation (dam^3)
Urban	TOWN OF BOW ISLAND	Surface	678
	VILLAGE OF STIRLING	Surface	463
	VILLAGE OF WARNER	Surface	150
	VILLAGE OF FOREMOST	Surface	218
Rural	COUNTY OF FORTY MILE NO. 9	Surface	123
	SOUTH EAST ALBERTA WATER CO-OP LTD.	Surface	1,605
	CONQUERVILLE WATER CO-OP LTD	Surface	323
	MINE ROAD WATER CO-OP	Surface	294
	PINCHER CREEK WATER COOP LTD	Surface	224
	BIG SKY WATER CO-OP LTD.	Groundwater	215
	SKIFF WATER CO-OPERATIVE LTD.	Surface	170
	NEW DAYTON WATER USERS LTD.	Surface	142
	CHAMPION WEST WATER CO-OP LTD.	Surface	123
	TWELVE MILE ROAD WATER CO-OPERATIVE LTD.	Surface	115
Total			**4,843**

Figure 4-5 shows how allocations for municipal water use in Oldman Basin have changed since 1960. Municipal uses accounting for less than 0.1 percent of MAD are not shown. Prior to 1960 all municipal allocations were for surface water. The first municipal licences for groundwater allocations were issued in the 1980s, but have remained very small. Most of the growth in municipal water allocations occurred in the 1980s and 1990s, and were primarily surface water.

Figure 4-5 Historical Water Allocations for Municipal Purposes

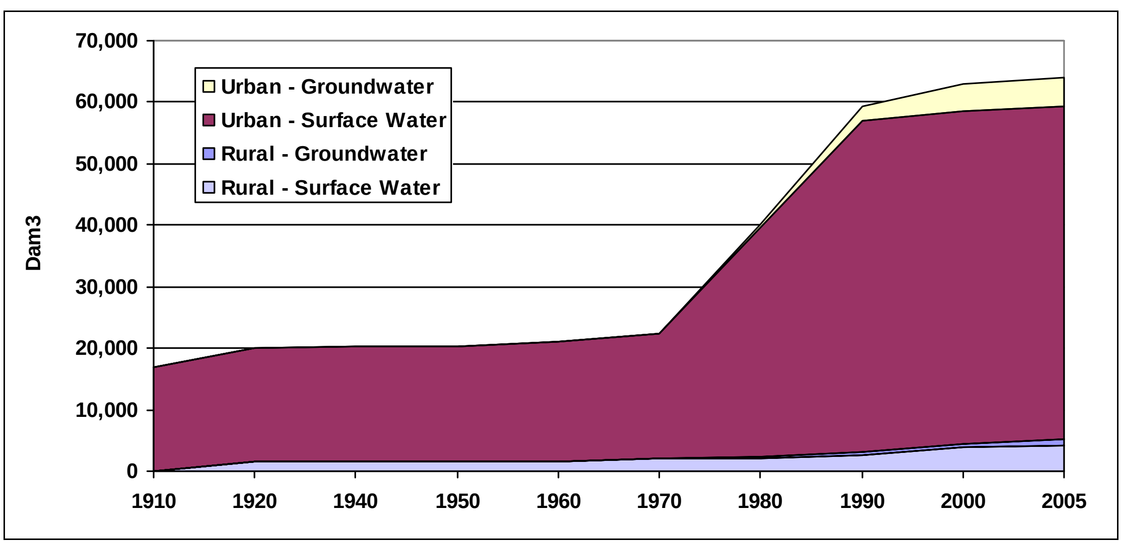


Table 4-4 Licensed Municipal Allocations and Use and Reported Actual Use, Oldman Basin

Water Use	Source	No. of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return Flow	Diversion	Estimated Use	Return Flow
Urban*	Surface	68	54,129	20,093	34,036	959	853	106
	Groundwater	31	4,691	2,346	2,345			
	Subtotal	**99**	**58,819**	**22,439**	**36,380**	**959**	**853**	**106**
Rural**	Surface	59	4,296	4,296	0			
	Groundwater	82	1,025	1,025	0	48	48	0
	Subtotal	**141**	**5,322**	**5,322**	**0**	**48**	**48**	**0**
Other***	Surface	3	0	0	0			
	Groundwater	1	9	9	0			
	Subtotal	**4**	**9**	**9**	**0**			
Total	Surface	130	58,425	24,389	34,036	959	853	106
	Groundwater	114	5,724	3,379	2,345	48	48	0
	Total	**244**	**64,149**	**27,768**	**36,380**	**1,007**	**901**	**106**

* Urban includes villages, summer villages, towns, cities, hamlets;
** Rural includes condominiums / townhouses / mobile homes / complexes, hotels / motels, cooperatives, farmsteads, single-multi homes, colonies and subdivisions
*** Other includes camps, institutions, senior/correctional centres, nursing/children's homes, hospitals

4.1.3 Licensed Water Use

Table 4-4 also summarizes the maximum amount of water than is expected to be used (i.e. consumed or lost) under the terms of municipal surface and groundwater licences issued for the Oldman River Basin. It shows that 27,768 dam^3 is expected to be used (43 percent) and there is an allowance (36,380 dam^3) to be returned. The return flow allowance differs between surface and groundwater licences and between urban and rural users. Licences for urban users include return flow allowance of 63 percent of surface water allocation (34,036 dam^3) and 50 percent of groundwater (2,345 dam^3). In contrast, there are no return flow allowances for rural users, so that all withdrawals (5,322 dam^3) are expected to be consumed.

4.1.4 Actual Water Use

In 2005, only six licensees reported their actual water diversions to the provincial government through the WURS. The allocations for those licensees who reported in 2005 were 3,183 dam^3, which is five percent of total allocations for municipal purposes. As shown in Table 4-4, reported diversions in 2005 were 1,007 dam^3, or 31.6 percent of the allocation for the small number of licensee who reported. Given that only WURS contains actual use information for only five percent of municipal allocation in the Oldman River basin, it is difficult to estimate Oldman Basin municipal water use based solely on WURS responses.

Table 4-5 Estimated Actual Municipal Water Use in the Oldman River Basin

Municipal Use	Source	Withdrawals (dam^3)	Use (dam^3)	Return Flow (dam^3)
Urban	Surface	35,477	12,037	23,440
	Groundwater	3,075	1,043	2,031
	Subtotal	38,552	13,081	25,471
Rural	Surface	2,816	2,816	0
	Groundwater	672	672	0
	Subtotal	3,487	3,487	0
Other	Surface	0	0	0
	Groundwater	6	6	0
	Subtotal	6	6	0
Total Use	Surface	38,293	14,853	23,440
	Groundwater	3,747	1,721	2,026
	Total	42,040	16,574	25,466
Licensed Use	Surface	58,425	24,389	34,036
	Groundwater	5,724	3,379	2,345
	Total	64,149	27,768	36,381
Percent of Licensed Use	Surface	65.5%	60.9%	68.9%
	Groundwater	65.5%	50.9%	86.4%
	Total	**65.5%**	**59.7%**	**70.0%**

The federal MUD includes actual diversion information for 2001 for 15 municipalities representing 76 percent of Oldman basin's 2001 population, so is a better foundation for a estimating water use. Based on information from MUD, actual municipal surface water use is

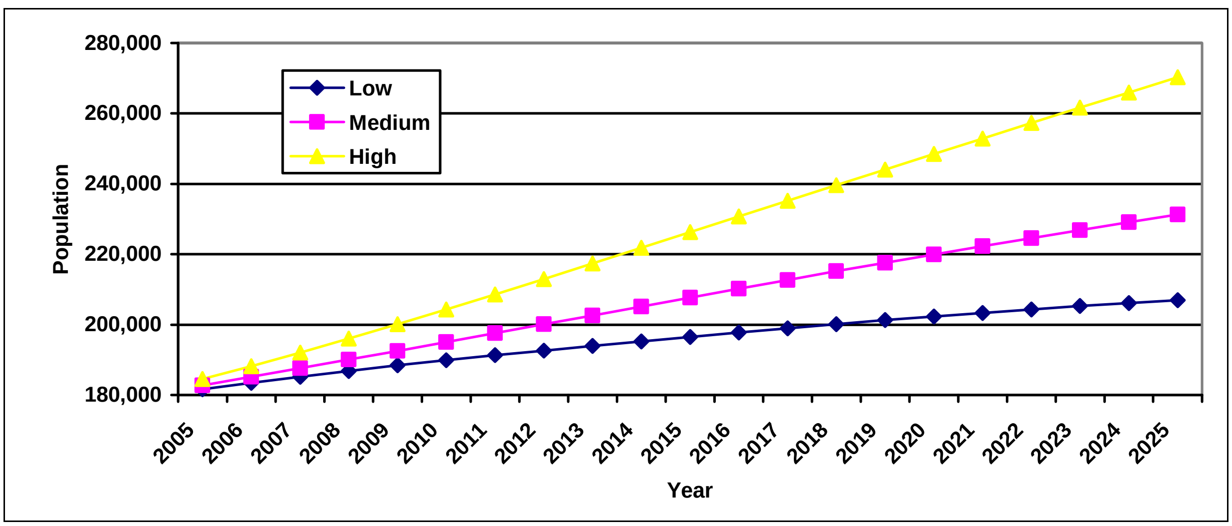
estimated to be 61 percent of the allocations, whereas actual groundwater use was determined to be 51 percent of the allocation. Estimates of actual water use are provided in Table 4-5.

Overall, actual municipal water use is estimated to be 60 percent of the municipal allocation within Oldman Basin. This underutilization leaves some room for growth in use before new municipal allocation or water demand management activities are required and to ensure sufficient water supplies in dry years.

4.1.5 Future Water Use Forecasts

Figure 4-6 shows low, medium and high population projection scenarios for Oldman Basin based on Alberta Finance Census Division projections. These forecasts have been used to predict future municipal surface and groundwater use. Under the medium growth scenario, the population is expected to grow at an annual rate of 1.2 percent. However, this could range from as low as 0.7 percent per year for the low scenario and 1.9 percent for the high scenario.

Figure 4-6 Oldman Basin Population Growth Forecast



The resulting forecasts of water use are provided in Table 4-7, and are based on the estimated per capita water use in 2005.

Table 4-6 Projected Water Use for the Municipal Sector in the Oldman Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Population Growth	Surface	14,853	15,531	16,073	16,550	16,930
	Groundwater	1,721	1,800	1,862	1,918	1,962
	Total	16,574	17,331	17,935	18,468	18,891
Medium Population Growth	Surface	14,853	15,853	16,882	17,879	18,799
	Groundwater	1,721	1,837	1,956	2,072	2,178
	Total	16,574	17,690	18,838	19,950	20,978
High Population Growth	Surface	14,853	16,448	18,214	20,005	21,758
	Groundwater	1,721	1,906	2,110	2,318	2,521
	Total	16,574	18,354	20,324	22,323	24,279

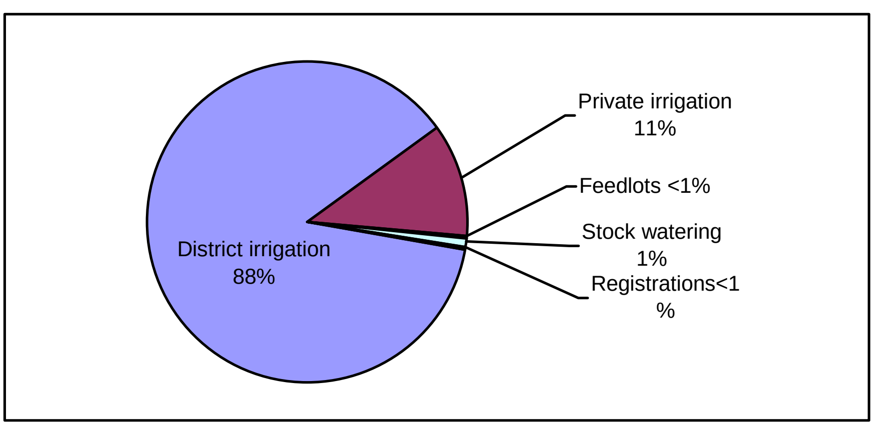
Under the low population growth scenario, municipal water use in 2025 is expected to be 14 percent greater than in 2005 and diversions are not expected to reach current MAD by 2025. Under the high population growth scenario, water use will increase by 47 percent over current levels and total diversions of surface and groundwater are expected to reach current municipal MAD in 2025.

4.2 AGRICULTURAL SECTOR

As of December 2005 nearly 2.0 million dam^3 had been allocated to the agricultural sector in the Oldman River Basin. This includes 7,980 registrations representing about 3,750 dam^3 and 2,452 licences representing 1.99 million dam^3 of water. Water allocated to agriculture accounts for 87 percent of all allocations in the Oldman River Basin.

Figure 4-7 shows how this water is distributed among the different agricultural uses in the Basin. The largest allocation is for district irrigation (88 percent). Private irrigation accounts for 11 percent; registrations and licences for stockwatering and feedlots together account for one percent of the total allocation.

Figure 4-7 Water Allocation by Volume for Agricultural Activities in the Oldman Basin



The vast majority (99 percent) of allocations for the agricultural sector are for surface water: 5,888 registrations and 2,129 licences allow withdrawals of up to about 1.99 million dam^3 of surface water. Three hundred and thirty two licensees and 2,092 registrations have been issued to withdraw up to 4,800 dam^3 of groundwater and this represents less than one percent of total allocation.

4.2.1 Overview of Agriculture in the Oldman Basin

Based on estimates derived from the 2001 Census of Agriculture, there were about 4,394 farms (eight percent of the Alberta total) with an average size of 1,194 acres in the Oldman Basin. At the provincial level there are about 53,000 farms with an average size of 970 acres. Farms in the Oldman Basin cover an area of nearly five million acres; this is equivalent to about 21,000 km^2 or about 80 percent of the basin. Table 4-7 shows about 46 percent of the land in the Basin is used to raise crops. About seven per cent of agricultural land is summer fallowed. Most of the remaining land, about 45 percent, is pasture.

Table 4-7 Agricultural Land Use in the Oldman River Basin, 2001

Land Use	Acres	Percent
Crop Land	2,392,988	45.6%
Summerfallow	343,116	6.5%
Tame/Seeded Pasture	352,489	6.7%
Natural Pasture	2,038,199	38.9%
Other	118,677	2.3%
Total	**5,245,469**	**100.0%**

The types of farming activity vary within the Oldman Basin. Table 4-8 shows the classification of farms based on the commodity groups that accounted for 51 per cent or more of total gross farm receipts. The table shows that 44 percent of the farms in the Oldman Basin raise beef cattle while about 15 percent of the farms are grain and oilseed farms. Wheat farms account for about 11 percent of farms in the Oldman Basin. Specialty and field crops include vegetables, potatoes, silage corn and alfalfa which account for about 10 percent of total farms. From a provincial perspective the Oldman Basin accounts for less than three percent of total farms in Alberta. However, as noted above, the average size of the farms in the Oldman Basin is larger (1,194 acres) than the provincial average (970 acres). Like Alberta, the single largest farm type in the Oldman Basin is cattle (beef) farm. This type of farm accounts for similar share of total farm in the as in Alberta. Wheat farms also occupy a similar share of farm type in the Oldman Basin as in Alberta. The relative distributions of other types of farms are similar for both Alberta and the Oldman Basin.

Table 4-8 Classifications of Farms in the Oldman Basin and Alberta, 2001

Farm Type (Farms with Gross Receipts >$2,500)	Percent of Farms in the Oldman Basin	Percent Share of Alberta	Alberta Farm Type (Percent)
Dairy Farms	2.1%	11.7%	1.5%
Cattle (Beef) Farms	44.1%	8.1%	45.4%
Hog Farms	2.4%	11.9%	1.7%
Poultry & Egg Farms	1.1%	10.2%	0.9%
Wheat Farms	10.8%	12.2%	7.4%
Grain & Oilseed Farms	15.0%	6.8%	18.4%
Field Crop Farms	8.7%	7.7%	9.3%
Fruit Farms	0.2%	10.6%	0.1%
Misc. Specialty Farms	9.8%	7.5%	10.9%
Sum of Livestock Comb. Farms	2.6%	9.3%	2.3%
Sum of Vegetable Farms	0.4%	21.5%	0.1%
Sum of Other Comb Farms	2.9%	12.2%	2.0%
Total	**100.0%**	**2.6%**	**100.0%**

4.2.2 Stockwatering

As noted in Table 4-8 about 44 percent of the farms in the Oldman Basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species in 2001 are provided in Table 4-9. The table shows that in 2001 there about 1.5 million cattle and calves which, together, accounted for about 90 percent of livestock population in the Oldman Basin. This is about 9.3 times the human population of the Oldman River Basin. Other livestock in the Oldman Basin included pigs, sheep and lamb, horses and ponies, bison and elk.

Table 4-9 Estimated Livestock Populations in the Oldman Basin and Alberta, 2001

	Basin Total	Alberta	% Alberta
Hens and Chicken	2,356,664	12,175,246	19.4%
Turkey	70	864,438	0.0%
Cattle	1,210,376	6,615,201	18.3%
Calves	286,386	2,169,607	13.2%
Pigs	311,235	2,027,533	15.4%
Sheep and Lamb	56,212	307,302	18.3%
Horse and Ponies	14,430	159,962	9.0%
Bison	3,835	79,731	4.8%
Deer	28	8,331	0.3%
Elk	222	31,304	0.7%

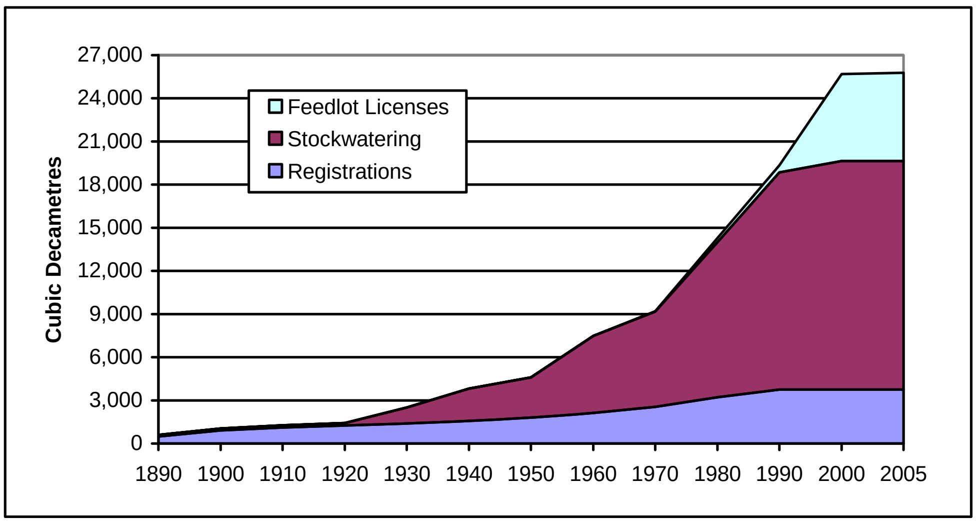
4.2.2.1 Water Allocation

Overall 9,587 licences and registrations have been issued for livestock watering with total allocation amounting to 25,870 dam^3. In addition to these allocations, farmers are able to obtain up to 1,250 m^3 of water for household purposes. The number of such households in the Basin

is not known. Furthermore, the numbers of "exempted agricultural" users are also not known in the Oldman Basin. A historical perspective on water used for livestock is provided in Figure 4-8. The figure shows that some registrations were issued with priority dates in the 1890s while licences for stockwatering began to be issued around 1920. Since that time allocations have risen steadily, mostly from licensed surface water. The allocations from registrations have remained relatively unchanged. The current total allocation of about 26,000 dam^3 is unchanged since 2000. Over the last few decades there has been a trend toward livestock intensification, resulting in an increase in the number of feedlots and water allocations for feedlots. Figure 4-8 shows that most of the water allocations for livestock issued since the 1990 have been for feedlots, although total allocations have remained constant since about 2000.

Table 4-10 summarizes current water licences and registrations issued for livestock according to the water source. It shows that surface water accounts for about 82 percent of allowable diversions for livestock and that registrations account for about 0.2 percent of the allocations.

Figure 4-8 Historical Trends in Water Allocation for Feedlots in the Oldman Basin



4.2.2.2 <u>Licensed Water Use</u>

Table 4-10 shows that no return flow allowances have been included in licences or registrations for livestocks; the entire allocations be used.

Table 4-10 Summary of Water Licences and Registrations Issued for Livestock Watering in the Oldman Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensee Reporting	Reported Use
Feedlot	Surface	39	5,859.6	5,859.6	0.0	0	N/A
	Groundwater	11	283.9	283.9	0.0	0	N/A
	Subtotal	**50**	**6,143.5**	**6,143.5**	**0.0**		
Stock watering	Surface	1,250	13,238.8	13,238.8	0.0	0	N/A
	Groundwater	307	2,675.2	2,675.2	0.0	0	N/A
	Subtotal	**1,557**	**15,914.0**	**15,914.0**	**0.0**		
Registration	Surface	5,888	2,077.6	2,077.6	0.0	0	N/A
	Groundwater	2,092	1,674.8	1,674.8	0.0	0	N/A
	Subtotal	**7,980**	**3,752.3**	**3,752.3**	**0.0**		
Total	Surface	7,177	21,175.9	21,175.9	0.0	0	N/A
	Groundwater	2,410	4,633.9	4,633.9	0.0	0	N/A
	Grand total	**9,587**	**25,809.8**	**25,809.8**	**0.0**	**0**	**N/A**

4.2.2.3 Actual Water Use

There is no information in Alberta Environment's WURS that indicates the extent to which water allocations are actually used in the Oldman Basin. However, a reasonable estimate of water use can be derived using the actual animal population in the Basin as shown in Table 4-11. Based on livestock populations for the Oldman Basin in 2001, the total water required for livestock was estimated to be 13,567 dam^3, or about 52 percent of the licensed allocation.[1] The calculations for this estimate are provided also in Table 4-11 which shows livestock populations in the Basin and the daily water requirements for various livestock species as provided by Alberta Environment in its "Guide to Calculate Quantities for Water for Raising Animals".[2] In terms of water requirements by species, cattle accounts for about 90 percent of the total, about six percent is required by pigs, one percent is required by poultry and all other species accounted for the remaining three percent.

Table 4-11 Estimated Livestock Water Requirements for 2001

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chickens	2,356,664	0.045	175.9
Turkey	70	0.15	0.0
Bulls	10,060	9.0	150.1
Milk Cows	15,660	30.0	779.1
Beef Cows	185,391	9.0	2,767.0
Heifers	387,650	6.0	3,857.1
Steers	313,264	6.0	3,117.0
Calves	286,386	3.0	1,424.8
Boars	1,467	6.5	15.8
Sows and Gilts - Breeding	29,311	6.5	315.9
Nursing and Weaner Pigs	104,852	0.5	86.9
Grower and Finishing Pigs	175,606	1.5	436.8
Sheep and Lambs	56,212	2.0	186.4
Horse and Ponies	14,430	10.0	239.3
Bison	3,835	2.0	12.7
Deer	28	10.0	0.5
Elk	222	3.5	1.3
Total			**13,566.7**

While the estimated actual consumption based on livestock populations (13,567 dam^3**)** appears to be significantly less than the amount of water allocated (25,810 dam^3), the data in Table 4-11 do not include an allowance for the evaporative and seepage losses associated with storing water for livestock use. Typically, licensed consumption accounts for only 35 per cent of surface water allocated for livestock use while losses account for 65 per cent (Watrecon 2005).

[1] This approach to estimating water use for stockwatering was employed in the 1986 Battle River Basin water use study undertaken by Stanley Associates in 1985.
[2] http://www3.gov.ab.ca/env/water/Legislation/Approvals_Licensees /CalculationChart.doc.

Since 18 percent of livestock water consumption comes from groundwater (no losses) and the balance comes from surface water with 65 percent losses, a total allocation of 19,558 dam^3 would be required to support the animal populations in Table 4-11.

This water requirement is about 75 percent of the amount of water that has been allocated through licences and registrations. However, this does not account for growth in livestock populations since 2001. Consequently, it appears that actual water use is for livestock is less than the amount of water allocated for livestock use. It is also assumed that surface water withdrawals occurred during April when dugouts and storage dams were filled and flows were at their peak.

4.2.2.4 Forecasts of Future Stockwatering Water Use

The key factor affecting future livestock water demand is changes in cattle populations in the basin. Cattle accounts for about 90 percent of livestock water demand in the Oldman Basin, so changes in the populations of other livestock species will have a minimal overall impact on future water demand. The historical trend analysis in Figure 4-8 shows that the amount of water allocated for livestock has been increasing over time, suggesting an increasing livestock population, which is corroborated by Census data that show an increase in livestock population between 1996 and 2001. Although in the last decade, the rate of growth in allocation has been much lower than historically.

Some indication of the potential for expansion of cattle populations in the Oldman River Basin can be determined by examining applications for new and expanded confined feeding operations, which must be approved by the NRCB in accordance with *AOPA*. Information from the NRCB indicates that, as of December 31, 2005, there had been 11 applications from farmers throughout the Basin for cattle and dairy operations (Table 4-12). However, most of the applications were withdrawn likely because of poor market conditions from the effects of BSE.

Table 4-12 Status of Applications Under *AOPA* in the Oldman Basin

Type of Application	Number	Withdrawn	Approved	Denied
Approval	0	0	0	0
Registrations	0	0	0	0
Authorizations	11	10	1	0
Total	**11**	**10**	**1**	**0**

A study undertaken by Alberta Agriculture in the late 1990s also provides some insights regarding the potential for expansion of the beef industry in the province. That study identified several criteria – manure, odor and population densities, local silage supplies, water supply, landscape characteristics and land for manure spreading – to be considered in evaluating the capability of supporting a 5,000-head back grounding operation and a 20,000-head operation. Townships suitable for livestock expansions are shown in Figures 2-3 and 2-4. These figures show that, in the Oldman River Basin, more townships meet all of the criteria for back grounding operations than finishing operations. For most townships that meet some of the criteria limiting factors include groundwater and silage for back grounding operations. For finishing operations

relatively few townships meet any of the criteria, however, some townships meet some criteria but are limited by groundwater and silage. Based on Alberta Agriculture's assessment, it would appear that livestock expansion in the Oldman River Basin could occur and would most likely consist of 5,000-head operations. While this assessment shows that there is potential for future expansion of livestock operations, the information from the NRCB suggests that this expansion has not yet occurred, probably due to the fact that the cattle industry is still adjusting to changes in markets associated with the effects of BSE.

Aside from the biophysical assessment of land base to support livestock operation, future expansion will be influenced by the fact that surface water allocations in the Oldman Basin are "capped", meaning no new allocations will be issued in the Basin. However, because the current allocation exceeds actual water use some growth can occur in livestock populations. Furthermore, livestock operations can also choose to buy allocations from other licensees to meet future water demand or switch to groundwater.

Projections are based on the expectations that cattle populations will increase at annual rates somewhere between 1.2 percent (Low Growth) and 3.2 percent (High Growth). As Base Growth, annual rate is assumed to be 2.2 percent which reflects average annual growth rate in cattle population in Alberta during 1958-2005. This forecast also assumes that the current mix of livestock water requirement (90 percent cattle) and balance of surface and groundwater use will remain unchanged over the forecast period. The resulting projections, based on actual use are shown in Table 4-13.

Table 4-13 Projected Water Use for Livestock in the Oldman River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	17,115	18,167	19,284	20,469	21,727
	Groundwater	2,442	2,592	2,751	2,920	3,100
	Total	**19,557**	**20,759**	**22,035**	**23,389**	**24,827**
Medium Growth	Surface	17,115	19,082	21,276	23,722	26,448
	Groundwater	2,442	2,723	3,036	3,384	3,774
	Total	**19,557**	**21,805**	**24,312**	**27,106**	**30,222**
High Growth	Surface	17,115	20,035	23,452	27,452	32,135
	Groundwater	2,442	2,858	3,346	3,917	4,585
	Total	**19,557**	**22,893**	**26,798**	**31,369**	**36,720**

Under the Low Scenario, water demand is projected to increase to 24,827 dam^3 by 2025; this increase is within the current allocations. Under the High Scenario, livestock water use would increase to 36,720 dam^3 by 2025. This increase is 1.9 times higher than current livestock use and would exceed current allocations by about 11,000 dam^3. Under Base Case, current allocations would be sufficient to handle growth in livestock water requirements up to 2015.

4.2.3 Irrigation

The other major use of water for agricultural purposes is irrigation or crop watering. The crop water allocation can be divided into licences for district irrigation and private irrigation.

There are nine irrigation districts in the Oldman River basin, with licences that allow the districts to withdraw up to 1.74 million dam^3 from the Oldman River or its tributaries. A summary of some characteristics of district irrigation is provided in Table 4-14. It shows that there are about 741,000 assessed acres for district irrigation. The table also shows that for the period from 1976 to 2005, average diversions have amounted to 928,957 dam^3 which represents about 54 percent of the total allocation. In 2005, which was a wet year, only 34 percent of allocations were diverted for use. On average, the Taber Irrigation District diverts the highest percent of its entitlement (60 percent) although the St. Mary River Irrigation District, which is the largest district in the Oldman River Basin, typically uses 57 percent of its allocation. About 44 percent of district irrigation acres are for forage production and forage production accounts for the majority of the crop mix in the seven smallest districts.

There is no information on the number of acres under private irrigation. Information from the 2001 Census of Agriculture for individual counties and municipal districts, when modified to reflect river Basin boundaries, produces estimates of irrigation that are significantly less the district irrigation so are of little value. An estimate of the private irrigated acres was based on water allocations and irrigation requirement of about 450 mm (18 inches) per acre. Based on this requirement it is estimated that water allocations are sufficient to support irrigation on about 176,000 private irrigation acres. Overall, it is estimated that there could be as many as 917,000 acres of irrigation in the Oldman River basin, of which district irrigation accounts for 80 percent.

4.2.3.1 Water Allocation

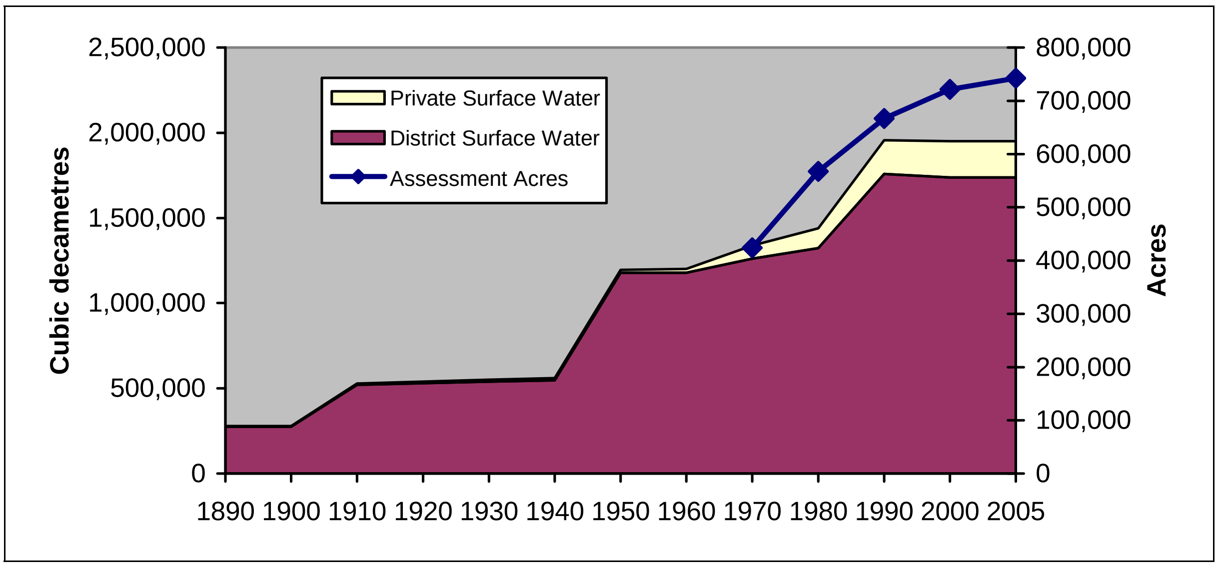
There are 42 district licences that allocate approximately 1.7 million dam^3, which represents about 90 percent of total allocation in the Oldman Basin. About 100 percent of this allocation is from surface water. This Basin accounts for about 50 percent of total district allocation and about 65 percent of the district licences issued in Alberta. There are 803 private licences that allocate approximately 0.2 million dam^3, which represents about 10 percent of the total allocation. This Basin accounts for about 30 percent of total private allocation and about 30 percent of the private licences issued in the province. Overall, about 1.9 million dam^3 of water with 845 licences are issued for the basin.

Table 4-14 District Irrigation Characteristics for the Oldman Basin

District Name	Assessed Acres (2005)	Licensed Allocation (dam³)	Average Diversion, 1976-2005		Percent of Licence Diverted (2005)	Crop Mix
			(dam³)	Percent of Allocation		
Aetna	3,608	11,102	5,045	45.4%	44.4%	100% forage
Leavitt	4,763	14,802	8,092	54.7%	52.0%	88% forage
Lethbridge Northern	175,628	391,020	204,718	52.4%	42.3%	64% forage; 24% cereals; 8% oilseeds
Magrath	18,320	41,939	15,255	36.4%	22.1%	53% forage; 34% cereals; 12% oilseeds
Mountain View	3,561	9,868	4,163	42.2%	25.8%	84% forage; 13% cereals
Raymond	46,296	99,914	38,890	38.9%	33.4%	56% forage; 34% cereals; 9% oilseeds
St. Mary River	372,619	890,587	511,030	57.4%	46.6%	33% forage; 33% cereals; 33% specialty and oilseeds
Taber	82,533	194,893	116,856	60.0%	45.9%	34% forage; 31% specialty; 30% cereals
United	34,081	81,670	24,908	30.5%	20.7%	55% forage; 35% cereals; 10% specialty and oilseeds
Total	**741,409**	**1,735,795**	**928,957**	**53.5%**	**34.2%**	

A historical perspective on water used for irrigation is provided in Figure 4-9. Some of the earliest licences for district irrigation have priority dates from 1890s. Allocations for district irrigation have undergone sharp increases periodically followed by a period of relative stability, likely as a result of completion of major water management projects that provided additional water for irrigation and other use. The most recent increase in allocation occurred during 1980 to 1990. Since 1990, the allocations have remained virtually unchanged. As of 2005, district irrigation in the Oldman Basin was allocated about 1.8 million dam^3 which is about 95 percent of total water allocation for crops in the basin. For private irrigation, some of the early licences dates back to 1890 but remained very small until about 1960. Since that time, the allocations have gradually increased to about 215,000 dam^3 as of 2005.

Figure 4-9 Historical Trends in Surface Water Allocation for Irrigation in the Oldman Basin



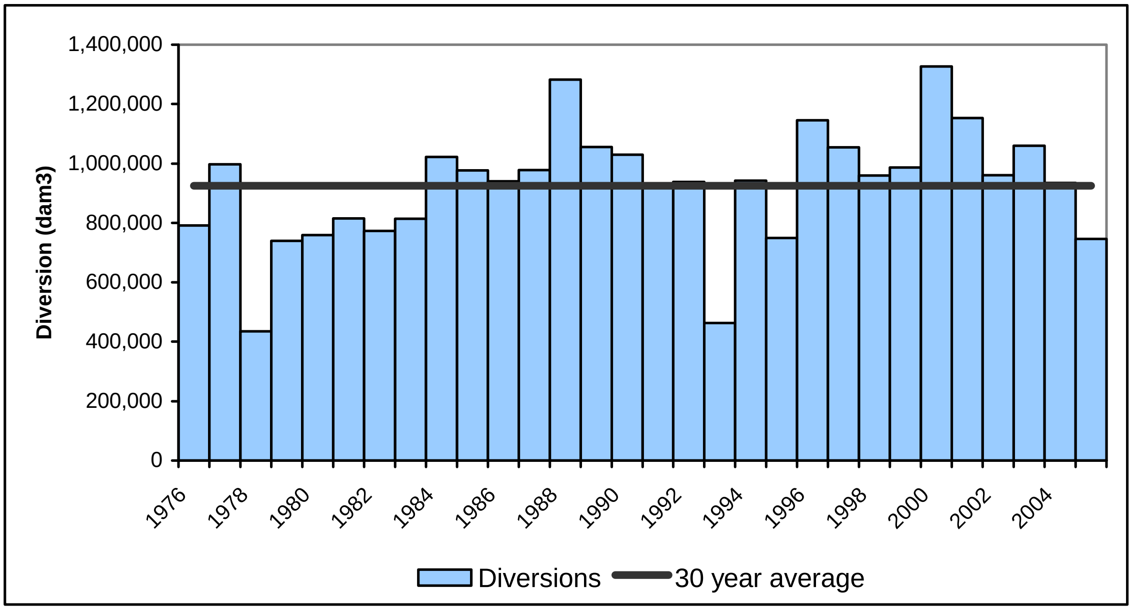
4.2.3.2 Licensed Water Use

Table 4-15 summarizes the water licences issued for irrigation according to water source. The table shows that licences issued for irrigation assume that 93 percent of the total allocation of surface water be used and that seven percent (135,592 dam^3) will be returned to surface sources. No return flow is associated with groundwater allocations for irrigation use.

4.2.3.3 Actual Water Use

The district irrigation actual water use is a function of diversion. In 2005 about 44 percent of allocation was diverted and 712,000 dam^3 was consumed as reported to WURS. However, 2005 was a wet year, 30 year (1976-2005) average diversion is about 925,000 dam^3 (43 percent of allocation). The peak diversion, 1.3 million dam^3 occurred in 2000 (Figure 4-10).

Figure 4-10 Water Diversion for District Irrigation in the Oldman Basin



For the private irrigation neither Alberta Agriculture nor Alberta Environment has any information on actual water use. However, a reasonable estimate of use can be made by assuming that private irrigators, on average divert the same proportion of the licensed volume as district irrigation over the 30 year period (43 percent). Given that both types of irrigators would face similar climatic conditions, and assuming a similar mix of crops between the two irrigators, diversion assumption is reasonable. The diversion for private irrigation is about 92,219 dam^3 (43 percent of allocation from Table 4-15). However, unlike district irrigation, there is no information on return flow. For the purposes of this study it is assumed that actual use for private irrigators is equal to the amount of water diverted but in any given year, water use will depend on how much of the crop water demand can be satisfied by natural precipitation. It is noteworthy that actual water use for irrigation in the Oldman River Basin is 13 times the amount of water used for livestock (19,557 dam^3).

4.2.3.4 Forecasts of Future Irrigation Water Use

Future water demand will be influenced by two major factors – livestock forage and specialty crops production. With the expansion of livestock, additional demand for livestock forage is expected. The forage is grown by private irrigators as well as district irrigators. . As noted in Table 4-14 about 44 percent of overall district irrigation crop mix is forages so livestock expansion is likely to require additional forage.

Table 4-15 Irrigation Allocations and Use and Reported Actual Water Use, Oldman River Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
District irrigation	Surface	42	1,758,480.0	1,626,309.7	132,170.3	8	712,435
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Subtotal	**42**	**1,758,480.0**	**1,626,309.7**	**132,170.3**	**8**	**712,435**
Private irrigation	Surface	798	214,271.9	210,850.1	3,421.9	0	N/A
	Groundwater	5	190.6	190.6	0.0	0	N/A
	Subtotal	**803**	**214,462.5**	**211,040.7**	**3,421.9**	**0**	**N/A**
Total	Surface	840	1,972,751.9	1,837,159.8	135,592.2	0	N/A
	Groundwater	5	190.6	190.6	0.0	0	N/A
	Total	**845**	**1,972,942.5**	**1,837,350.3**	**135,592.2**	**0**	**N/A**

The historical trend provided in Figure 4-9 shows that water allocation for irrigation has increased over time, particularly for district irrigation, suggesting that past increases in livestock and acres for crop production have led to increased water demand for expansion in irrigated crop areas. Acres of specialty crops, which have higher water requirements than cereal crops, are also expected to increase. This change in crop mix was examined in the Irrigation Water Management Study Committee (2002), the results of which are noted below in Table 4-16.

For private irrigators, the ability to expand irrigated acres is limited by the fact that surface water allocations in the Oldman Basin are "capped", meaning no new allocations will be issued in the Basin so increased forage production will have to be accommodated within the existing allocations. In addition to these private irrigators there are allocations specified under the *1991 South Saskatchewan Basin Water Allocation Regulation*. For the Oldman Basin six projects have been specified by the *Regulation* – Blood Indian Reserve, Western Oldman, Willow Creek, Pikani Waters and Oldman River Reservoirs, which together have been allocated 141,567 dam^3. Through discussions with Alberta Environment, it was determined that most of these allocations have already been issued so it was assumed that private irrigation allocation in Table 4-15 includes *Regulation* projects.[3] Therefore, private irrigation water use, using the assumption of 43 percent diversion of allocation and 100 percent consumption of diversion, is projected to remain unchanged at 92,219 dam^3 over the forecast period.

Table 4-16 shows the water demand for district irrigation from some of the scenarios outlined in Irrigation Water Management Study Committee (2002) (see Section 2.3.2). The water use for the three scenarios ranges from 0.8 to 1.0 million dam^3 with diversions ranging from 1.0 to 1.1 million dam^3. The values in these three scenarios fall within the estimate of all the scenarios examined in the Irrigation Water Management Study Committee (2002) which range from 1.0 to 1.2 million dam^3 for diversion and 0.8 to 1.1 million dam^3 for water use.

Table 4-16 Water Diversion, Consumption and Return Flow for District Irrigation in the Oldman Basin

Scenario	Irrigated Area (hectares)	Gross Diversion (dam^3)	Water Use (dam^3)	Return Flow	
				(dam^3)	Percent
S1 – 1999 Conditions	268,859	1,021,552	850,482	171,070	16.7%
S3 - Expansion to 1991 *Regulation* Limits	296,230	1,107,900	944,973	162,927	14.7%
S9 - Expansion to 10 percent beyond *Regulation* Limits	325,853	1,173,071	1,023,179	149,892	12.8%

As shown in Figure 4-10, yearly water demand is expected to fluctuate with dry years reporting higher rates of diversion than wet years. Most recently, the early 2000s have been dry years with water diversions exceeding the 30 year average. It is worth noting that between scenarios

[3] Licensees were issued to individuals not as projects.

S1 and S9 return flow decreases by 30 percent while gross diversion increases by about 14 percent. This trend suggests that actual water use from diversion is forecast to increase.
Note that although the *Regulation* capped the amount of acres, recent changes to the *Irrigation Districts Act* allow the districts to add more acres if approved by district members. This means that acres can expand within existing allocations through efficiency improvements and more effective water use thereby resulting in lower return flow.

Overall forecasts of water use for irrigation in the Oldman Basin are provided in Table 4-17. It should be noted that the water use estimate for district irrigation is based on the water use data from Table 4-16 and not from Table 4-15. Similarly, water use estimate for private irrigation is based on 43 percent diversion of licensed allocation, all of which is consumed. Water use for private irrigation is not expected to change in the district irrigation scenarios and that surface water will account for about 100 percent of diversions. Given the associated capital costs, scenarios S3 and S9, are assumed not to occur before 2015. Under S1, water use is projected to be about 0.94 million dam^3 by 2025. Relative to S1 in 2005, water use is projected to be 10 percent higher for S3 and 18 percent higher for S9 by 2025.

Table 4-17 Projected Average Water Use for Irrigation in the Oldman River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
S1 and private irrigation	Surface	942,619	942,619	942,619	942,619	942,619
	Groundwater	82	82	82	82	82
	Total	**942,701**	**942,701**	**942,701**	**942,701**	**942,701**
S3 and private irrigation	Surface	942,619	942,619	1,037,110	1,037,110	1,037,110
	Groundwater	82	82	82	82	82
	Total	**942,701**	**942,701**	**1,037,192**	**1,037,192**	**1,037,192**
S9 and private irrigation	Surface	942,619	942,619	1,115,316	1,115,316	1,115,316
	Groundwater	82	82	82	82	82
	Total	**942,701**	**942,701**	**1,115,398**	**1,115,398**	**1,115,398**

4.2.4 Summary

In summary, current agricultural water use in the Oldman Basin is estimated to be about 0.94 million dam^3, almost 100 percent of which is for irrigation. Since the Basin is “capped” any future demand for water will have to be accommodated through existing allocations. For stockwatering, existing allocations will meet low growth demand. For irrigation, particularly district irrigation, water allocation for all of the scenarios examined fall within the allocation limit prescribed under the *Regulation* (1.7 million dam^3).

A summary of future agricultural water demand is provided in Table 4-18. Agricultural water use in 2025 would be about 0.97 million dam^3 (virtually unchanged from 2005) under the Low Growth, S1 scenario. Under High Growth, S9 scenario, water use is projected to be 1.2 million dam^3 by 2025 (an increase of 20 percent from 2005).

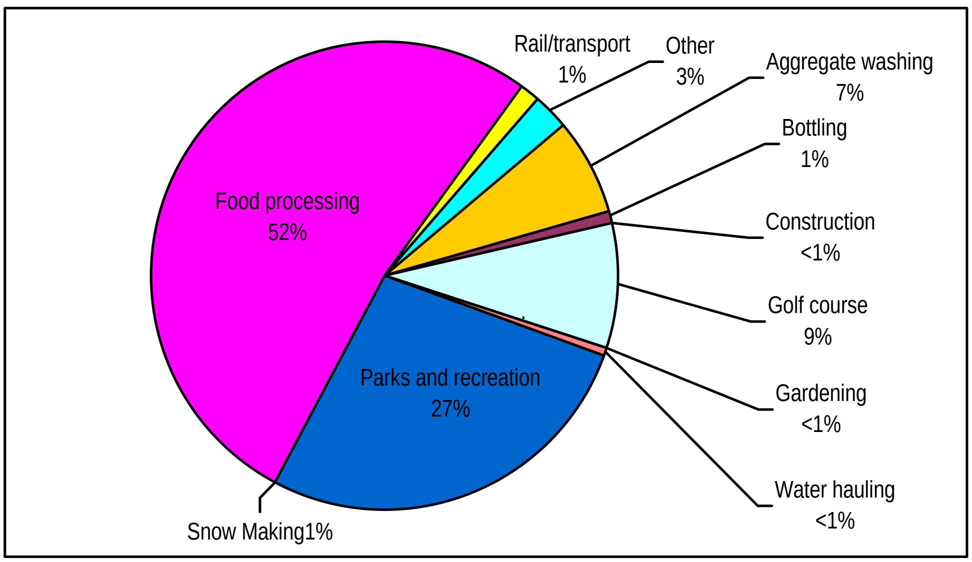
Table 4-18 Projected Average Water Use for Agriculture in the Oldman River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth (livestock) S1 irrigation	Surface	959,734	960,786	961,903	963,088	964,345
	Groundwater	2,524	2,674	2,833	3,003	3,182
	Total	**962,258**	**963,460**	**964,736**	**966,091**	**967,527**
Medium Growth (livestock) S3 irrigation	Surface	959,734	961,701	1,058,386	1,060,832	1,063,558
	Groundwater	2,524	2,805	3,118	3,467	3,856
	Total	**962,258**	**964,506**	**1,061,504**	**1,064,299**	**1,067,414**
High Growth (livestock) S9 irrigation	Surface	959,734	962,654	1,138,768	1,142,768	1,147,451
	Groundwater	2,524	2,940	3,428	3,999	4,667
	Total	**962,258**	**965,594**	**1,142,196**	**1,146,767**	**1,152,118**

4.3 COMMERCIAL SECTOR

There are 100 licences that allow diversion of about 14,000 dam^3 of water in the Oldman Basin. As shown in Figure 4-11, the largest allocations are for food processing (52 percent) and parks and recreation (27 percent) which, combined, account for about almost 80 percent of the total allocation for commercial purposes.

Figure 4-11 Water Allocation for Commercial Activities in the Oldman Basin



4.3.1 Water Allocations

Table 4-19 provides a summary of licensed allocations for each of the 10 major commercial activities. It shows that the largest allocation is for food processing; 17 licences have been issued for this activity and allow maximum withdrawals of up to 7,300 dam^3. About 3,900 dam^3

have been allocated for parks and recreation (43 licences). Commercial licences allow up to 13,500 dam^3 of surface water to be withdrawn; this represents 95 percent of total commercial water allocation. Food processing accounts for about 50 percent of surface water allocations. Thirty groundwater licences have been issued for commercial purposes, with total allocations of 600 dam^3; this represents five percent of the total commercial water allocations. The largest allocation is also for food processing which accounts for about 40 percent of the total groundwater allocation.

A historical trend of commercial sector allocation in the Oldman Basin is provided in Figure 4-12. It shows that the earliest allocation began in the 1900s and consisted of surface water allocations. Commercial allocations remained constant until the 1930s but began to increase in the 1940s. Since that time surface water allocations have steadily increased, peaking in 1990 and declining slightly to 2005. Groundwater allocations began in the 1970s and increased until 1990 but have remained constant since then. Historically, groundwater allocations have always accounted for a small proportion of water allocations for commercial purposes.

Figure 4-12 Historical Trend in Commercial Sector Water Allocation in the Oldman Basin

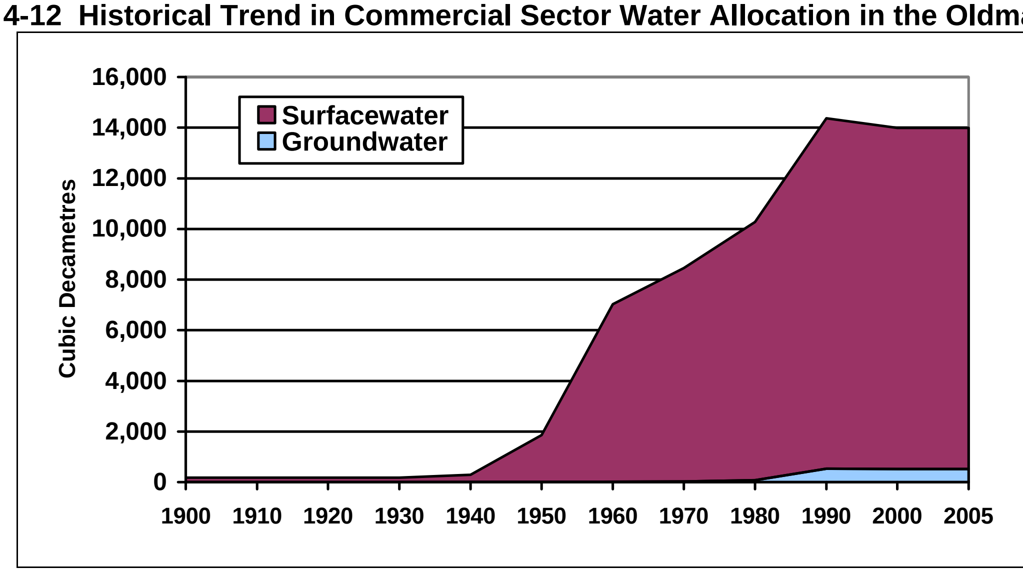


Table 4-19 Commercial Allocations and Use and Reported Actual Water Use, Oldman Basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam3)			Reported Actual Water Use (dam3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
Aggregate washing	Surface	10	892	892	0	0	N/A
	Groundwater	2	51	50	1	0	N/A
	Subtotal	**12**	**943**	**942**	**1**	**0**	**N/A**
Bottling	Surface	0	0	0	0	0	N/A
	Groundwater	6	124	124	0	0	N/A
	Subtotal	**6**	**124**	**124**	**0**	**0**	**N/A**
Golf course	Surface	10	1,214	1,214	0	0	N/A
	Groundwater	0	0	0	0	0	N/A
	Subtotal	**10**	**1,214**	**1,214**	**0**	**0**	**N/A**
Gardening	Surface	1	10	10	0	0	N/A
	Groundwater	0	0	0	0	0	N/A
	Subtotal	**1**	**10**	**10**	**0**	**0**	**N/A**
Water hauling	Surface	0	0	0	0	0	N/A
	Groundwater	1	45	45	0	0	N/A
	Subtotal	**1**	**45**	**45**	**0**	**0**	**N/A**
Parks and recreation	Surface	30	3,746	3,524	222	0	N/A
	Groundwater	13	112	108	4	0	N/A
	Subtotal	**43**	**3,858**	**3,632**	**226**	**0**	**N/A**
Dust control	Surface	2	2	2	0	0	N/A
	Groundwater	0	0	0	0	0	N/A
	Subtotal	**2**	**2**	**2**	**0**	**0**	**N/A**
Rail/transport	Surface	1	179	179	0	0	N/A
	Groundwater	0	0	0	0	0	N/A
	Subtotal	**1**	**179**	**179**	**0**	**0**	**N/A**
Food processing	Surface	10	7,106	3,829	3,277	1	0.32
	Groundwater	7	244	244	0	0	N/A
	Subtotal	**17**	**7,350**	**4,073**	**3,277**	**1**	**0.32**
Other	Surface	6	315	56	259	0	N/A
	Groundwater	1	55	55	0	0	N/A
	Subtotal	**7**	**369**	**110**	**259**	**0**	**N/A**
Total	**Surface**	70	13,463	9,705	3,758	1	0.32
	Groundwater	30	631	626	5	0	N/A
	Total	**100**	**14,094**	**10,330**	**3,764**	**1**	**0.32**

4.3.2 Licensed Water Use

Based on the water licence data in Table 4-19, about 73 percent of the allocation are expected to be used (i.e. consumed or lost) with 27 percent returned. The return flow allowance ranges from 72 percent of surface water diversions to 99 percent of groundwater diversions. For the food processing industry, 55 percent of diversions are expected to be returned. There are no return flow allowances for most of the other commercial activities, including aggregate washing, bottling, golf courses, gardening, water hauling, dust control and rail/transport. There are very small return flow allowances for parks and recreation.

4.3.3 Actual Water Use

AENV's WURS contains actual water use information for 2005 for only one licensee for the commercial sector for the Oldman Basin. As shown in Table 4-19, this licensee represents less than one percent of total licences issued for the commercial sector. No return flow was reported for this licensee.

Given the lack of information on actual water use in the commercial sector, it is assumed that actual water use in 2005 was the same as licensed water use. While this may overstate actual water use in the Oldman River basin, this is not considered to a significant issue because the commercial sector only accounted for one percent of total allocations.

4.3.4 Forecasts of Future Water Use

Although food processing and parks and recreation account for 80 percent of total allocations in the commercial sector, their total water use within the Basin is too small to warrant separate water use forecasts, so a water use forecast were prepared for the entire commercial sector. Three water use forecasts are developed, ranging from 0.5 and 2.5 percent annual growth rate, which reflects the predicted growth of the food processing industry, as described in Section 2.3.3. In assessing the future conditions, it is noted that applications for new surface water licences are no longer being accepted in the Oldman Basin so the projections are only meant to highlight future demand.

Table 4-20 presents the forecast of commercial water use in the Oldman River basin. Under the low growth scenario, water demand in 2025 is projected to rise to 18,925 dam^3, a 34 percent increase from current levels. Under the high growth scenario, water demand is projected to rise to 39,078 dam^3, a 2.7 times increase from current levels.

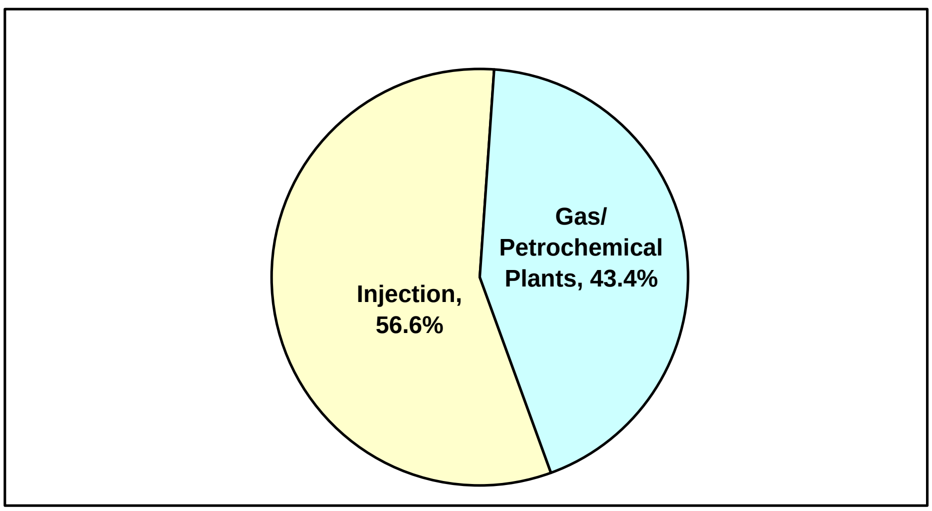
Table 4-20 Projected Water Demand for the Commercial Sector in the Oldman Basin.

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface water	9,705	9,950	10,201	10,459	10,723
	Ground water	626	642	658	675	692
	Total	**10,330**	**10,592**	**10,859**	**11,134**	**11,415**
Medium Growth	Surface water	9,705	10,455	11,263	12,134	13,071
	Ground water	626	674	726	783	843
	Total	**10,330**	**11,129**	**11,990**	**12,916**	**13,914**
High Growth	Surface water	9,705	10,980	12,423	14,056	15,903
	Ground water	626	708	801	907	1,026
	Total	**10,330**	**11,689**	**13,225**	**14,962**	**16,929**

4.4 PETROLEUM SECTOR

In the Oldman Basin, there are 18 active licences which allocate 4,270 dam^3 of water to the petroleum sector. Within the basin, allocations to the petroleum sector account for less than one percent of total allocations. Almost all of the licences are for surface water (4,267 dam^3). As shown in Figure 4-13, the petroleum sector includes water allocations for oilfield injection and gas and petrochemical plants.

Figure 4-13 Petroleum Water Allocation by Use in the Oldman Basin



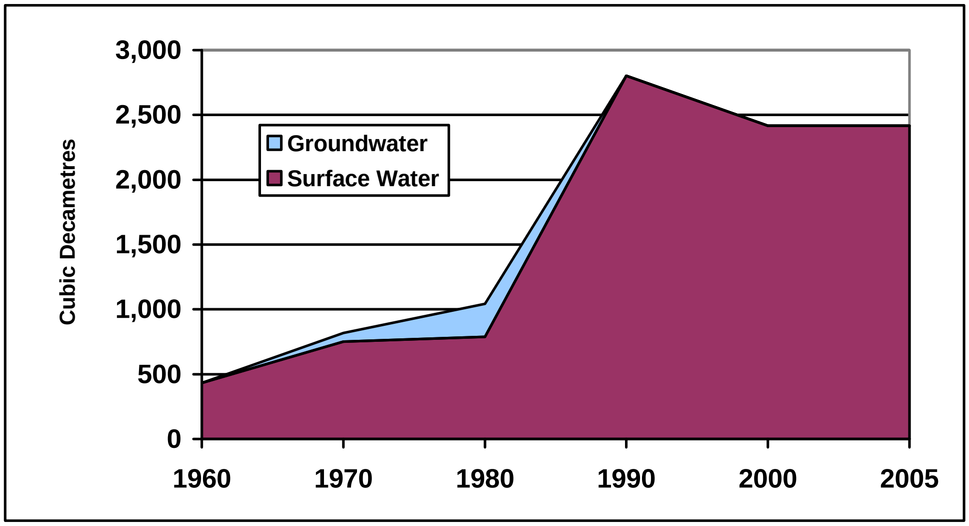
A summary of licence information for injection and gas/petrochemical plants in the Oldman River Basin is provided in Table 4-21. A detailed description of each activity is provided below.

4.4.1 Injection

About 57 percent of the allocations for the petroleum sector are for injection purposes for enhanced oil and gas recovery (2,418 dam^3). As shown in Table 4-21, 13 licences have been issued for injection purposes. All of these licences are for surface water. Figure 4-14 shows that

allocations of water for injection commenced in the 1960s and grew rapidly in 1980s. However, in the last few years the amount the allocation has declined.

Figure 4-14 Historical Trends in Water Allocations for Injection



As shown in Table 4-21, the licences issued for injection purposes assume that 100 percent of allocations will be used.

Detailed summary of reported water used for injection have been prepared by Geowa based on industry data provided to the EUB. According to this information, 398 dam^3 of fresh water was withdrawn for injection purposes in 2005. This volume includes 231 dam^3 of surface water as well as 168 dam^3 of groundwater even though there are no groundwater licences for injection. Based on the reported water use in Table 4-21, injection activities in the Basin are currently diverting and using approximately 10 percent of their licensed surface allocations and use.

The general trend in Alberta is for conventional crude oil production to decline as existing fields mature and there are fewer new finds. The most recent forecast from the EUB and CAPP have oil production decreasing by between 30 and 38 percent between 2005 and 2015, and a further decline of about 23 percent by 2020. Oil production in the Oldman Basin is expected to follow the overall Alberta production trend since most of the basin's production is from existing wells. The forecast of future water use for injection in the Oldman Basin in Table 4-21 assumes declining rates of water use required that match the rates at which oil production in Alberta is expected to decline. For the purposes of this analysis it is assumed that production forecasts for 2010 and 2020 is the same as the previous five years. Forecasts also assume that the current ratio of surface to groundwater consumption will remain the same. Given the moratorium on new water licences for the Bow, Oldman, and South Saskatchewan River basins, it is likely that with a declining demand for water for injection purposes, unused applications may be sold to new users.

Table 4-21 Forecast of Injection Water Use in the Oldman Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
High Decline	Surface	231	231	107	107	64
	Groundwater	168	168	127	127	76
	Total	**398**	**398**	**233**	**233**	**139**
Medium Decline	Surface	231	231	113	113	67
	Groundwater	168	168	133	133	79
	Total	**398**	**398**	**246**	**246**	**147**
Low Decline	Surface	231	231	128	128	76
	Groundwater	168	168	151	151	90
	Total	**398**	**398**	**279**	**279**	**167**

Under the low decline scenario, water use for injection in 2025 will decline by 65 percent from current levels. Under the high decline scenario, the decline will be 58 percent.

4.4.2 Gas/Petrochemical Plants

About 44 percent of the allocations for the petroleum sector in the Oldman Basin are for gas/petrochemical plants (1,852 dam^3). Details of the licences issued to the petroleum sector in the Oldman Basin are provided in Table 4-22. Two surface water licences account for almost all the water allocated to gas and petrochemical plants (1,852 dam^3). The remaining three groundwater licences are for only 3.1 dam^3. Water use for injection commenced in the 1960s and has remained constant since the 1970s.

Licences issued for gas/petrochemical plants assume that 60 percent of the surface water allocation and 100 percent of groundwater allocation will be consumed. Return flow allowances in licences amount to 740 dam^3. Thus, licensed water use for gas/petrochemical plants is expected to be 1,112 dam^3. Information from WURS indicates that, in 2005, gas/petrochemical plants in the Oldman River Basin diverted and used 591 dam^3 of surface water; this represents 53 of what they are expected to use. It is assumed that all of the groundwater allocations (3 dam^3) were diverted and used.

There is a moratorium on new water licences for the Bow, Oldman, and South Saskatchewan River basins. As no new water licences can be issued for these basins it is assumed that there will be no change in the amount of water allocated to the petroleum sector unless they acquire water rights from other users in the basin. While it is possible that the sector could increase its water use to the full capacity of the licence (1,112 dam^3), it is more likely that water use will remain constant or decline as the remaining oil and gas reserves in the Oldman River Basin are extracted.

Table 4-22 Allocations and Estimated Water Use for the Petroleum Sector, Oldman River Basin

Water Use	Source	Number of Licence	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Injection	Surface	13	2,418.0	2,418.0	0.0	230.9	9.5%	9.5%
	Groundwater	0	0.0	0.0	0.0	167.5		
	Subtotal	**13**	**2,418.0**	**2,418.0**	**0.0**	**398.4**	**16.5%**	**16.5%**
Gas/Petrochemical Plant	Surface	2	1,849.0	1,108.9	740.1	591.0	53.3%	32.0%
	Groundwater	3	3.1	3.1	0.0	3.1	100.0%	100.0%
	Subtotal	**5**	**1,852.1**	**1,112.0**	**740.1**	**594.1**	**53.4%**	**32.1%**
Total	Surface	15	4,267.0	3,526.9	740.1	821.9	23.3%	19.3%
	Groundwater	3	3.1	3.1	0.0	170.6	5539.9%	5539.9%
	Subtotal	**18**	**4,270.1**	**3,530.0**	**740.1**	**992.5**	**28.1%**	**23.2%**

4.4.3 Summary

Water use data shows that although water licences allow up to 3,530 dam^3 of water to be consumed for petroleum purposes, licensees are only using 28 percent of this amount. There is a moratorium on new surface water licences for the Bow, Oldman, and South Saskatchewan River basins. As no new water licences can be issued for these basins it is assumed that there will be no change in the amount of water allocated to the petroleum sector unless they acquire water rights from other users in the Basin or switch to groundwater. It is possible, although unlikely, that the sector could increase its water use to the full capacity of the licences (3,530 dam^3) (Table 4-23). Forecasts of future water demand are based on 2005 water use data.

Table 4-23 Forecast of Water Use by Petroleum Activities in the Oldman Basin

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	822	822	698	698	655
	Groundwater	171	171	130	130	79
	Total	**993**	**993**	**828**	**828**	**733**
Medium Growth	Surface	822	822	704	704	658
	Groundwater	171	171	136	136	83
	Total	**993**	**993**	**840**	**840**	**741**
High Growth	Surface	822	822	719	719	667
	Groundwater	171	171	154	154	93
	Total	**993**	**993**	**873**	**873**	**761**

Table 4-23 shows that, for all three scenarios, the overall demand for water in the Oldman Basin is expected to decrease over the forecast period largely due to the decrease in water required for injection.

4.5 INDUSTRIAL SECTOR

There are only three active licences which allocate 11 dam^3 of water to the industrial sector in the Oldman River basin. These industrial water licences account for less than one percent of the total allocations in the basin. All of the water licences are for groundwater.

Figure 4-15 Industrial Water Allocation by Use in the Oldman Basin

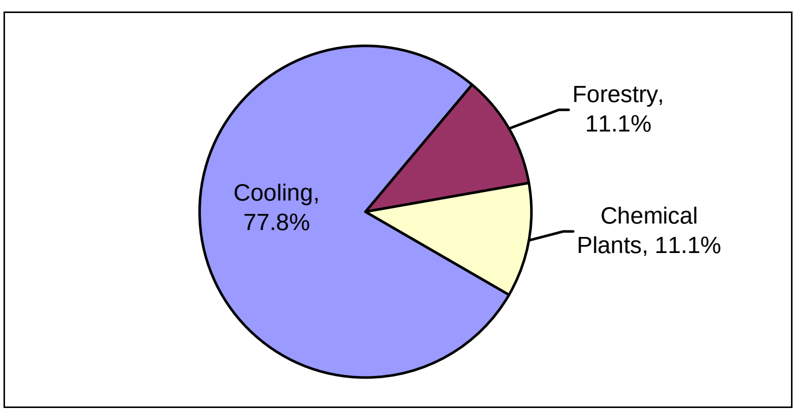


Table 4-24 Water Allocations and Estimated Water Use for the Industrial Sector, Oldman River Basin.

Activity	Source	Number of Licence	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Cooling	Surface	0	0.0	0.0	0.0	0	100%	100%
	Groundwater	1	8.6	8.6	0.0	8.6	100%	100%
	Subtotal	**1**	**8.6**	**8.6**	**0.0**	**8.6***	**100%**	**100%**
Forestry	Surface	0	0.0	0.0	0.0	0	100%	100%
	Groundwater	1	1.2	1.2	0.0	1.2	100%	100%
	Subtotal	**1**	**1.2**	**1.2**	**0.0**	**1.2 ***	**100%**	**100%**
Chemical Plants	Surface	0	0.0	0.0	0.0	0	100%	100%
	Groundwater	1	1.2	1.2	0.0	1.2	100%	100%
	Subtotal	**1**	**1.2**	**1.2**	**0.0**	**1.2 ***	**100%**	**100%**
Total	Surface	0	0.0	0.0	0.0	0	100%	100%
	Groundwater	3	11.1	11.1	0.0	11.1	100%	100%
	Total	**3**	**11.1**	**11.1**	**0.0**	**11.1**	**100%**	**100%**
* Estimated water use assumes 100% consumption.								

As shown in Figure 4-15, the industrial sector includes water allocations for cooling, chemical plants and forestry activities. A summary of the licensed water allocation, use, and return associated with industrial licences for each of these activities is provided in Table 4-24.

4.5.1 Cooling

One licence has been issued for cooling in the Oldman Basin. It allows withdrawals of up to 8.6 dam^3 of groundwater. This allocation was issued in the 1980s and has remained the same since. Licensees are expected to consume 100 percent of the groundwater they are allocated. There is no information on actual water diversions or consumption for cooling. For purposes of this analysis, it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water for cooling in the Oldman Basin will remain constant for the forecast period.

4.5.2 Forestry

One licence that allows withdrawals of up to 1.2 dam^3 of groundwater has been issued for forestry in the Oldman Basin. This allocation was issued in the 1960s and has remained the same since. The licence assumes all groundwater withdrawn will be consumed. There is no information on actual water diversions or consumption for forestry. For purposes of this analysis, it is assumed that the licensee is using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by forestry in the Oldman Basin will remain constant for the forecast period.

4.5.3 Chemical Plants

One licence has been issued for chemical plants in the Oldman Basin. It allows withdrawals of up to 1.2 dam^3 of groundwater and was issued in the 1980s. The licence assumes that all withdrawals of groundwater will be consumed. There is no information on actual water diversions or consumption for chemical plants and, for purposes of this analysis; it is assumed that the licensee is using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by chemical plants in the Oldman Basin will remain constant for the forecast period.

4.5.4 Summary

Total allocations of water for industrial sector in the Oldman Basin amount to only 11 dam^3 of groundwater. This sector is assumed to be using the full capacity of its licences and it is expected that current use will continue for the forecast period.

Table 4-25 Forecast of Industrial Water Use in the Oldman Basin
(dam^3)

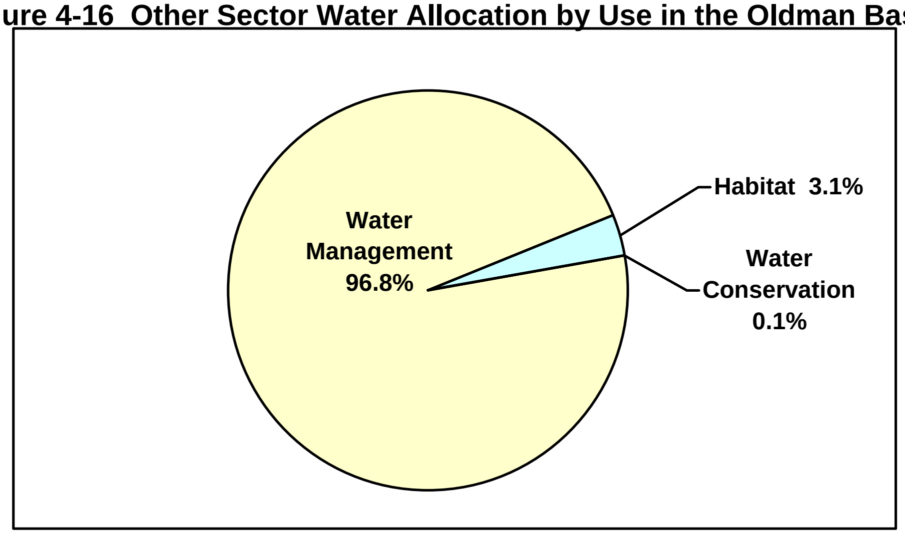
Scenario	Source	2005	2010	2015	2020	2025
Medium	Surface	0	0	0	0	0
	Groundwater	11	11	11	11	11
	Total	**11**	**11**	**11**	**11**	**11**

Even if demand for the industrial sector were to increase, there is a moratorium on new surface water licences for the Bow, Oldman, and South Saskatchewan River basins.

4.6 OTHER SECTOR

The Oldman Basin has 105 active licences which allocate 211,124 dam^3 of water to the other sector. A large percentage of the water licences are for surface water (161,243 dam^3 in total) accounting for 79.0 percent of the other licences. Figure 4-16 illustrates the mix of water use by other sector activities in the Oldman Basin. It shows that 97 percent of the water allocated to the other sector is for water management (35 licences for a total of 204,402 dam^3). Fish, wildlife and habitat enhancement accounts for three percent of the allocations (60 licences for a total of 6,485 dam^3). There is also a small amount of water allocated to water conservation (five licences for a total of 229 dam^3), and others uses specified by an AENV director (five licences for a total of eight dam^3). Table 4-26 summarizes the water allocation, use, and return associated with the licences issued for other purposes in the Oldman Basin.

Figure 4-16 Other Sector Water Allocation by Use in the Oldman Basin.



Detailed descriptions for each of these three major uses are provided below.

4.6.1 Water Management

Almost 97 percent of the allocations are for water management purposes such flood control and lake stabilization (204,402 dam^3). Table 4-26 shows that 35 licences have been issued for water management purposes, with 74 percent of these for surface water. Nine licences have

been issued for groundwater (46,415 dam^3). Allocations of surface water for water management commenced in the 1900s but grew rapidly from the 1950s to the 1990s (Figure 4-18). A relatively sizeable amount of groundwater has been allocated to water management beginning in the 1940s and this amount has increased slowly over time. Allocations from both water sources for water management purposed have remained the same since the 1990s.

Figure 4-17 Historical Trends in Water Allocations for Water Management

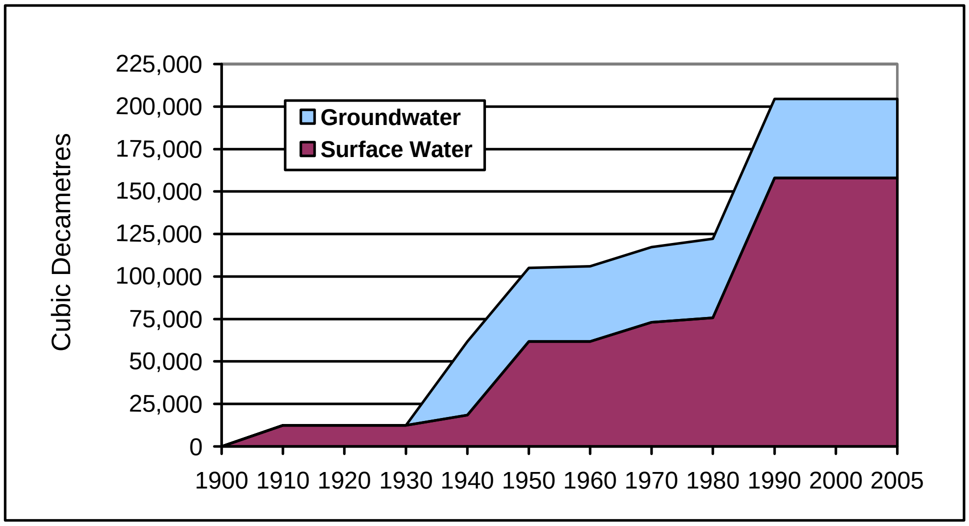


Table 4-26 shows that licences issued for water management purposes assume about 93 percent of surface water allocations and three percent of groundwater allocations will be used. Return flow allowances in licences amounted to 146,200 dam^3 for surface water and 1,309 dam^3 for groundwater. There is no information on actual water diversions or consumption for water management activities and, for purposes of this analysis, it is assumed that licensees are using the full amount they are expected to use and will continue to do so throughout the forecast period.

4.6.2 Habitat

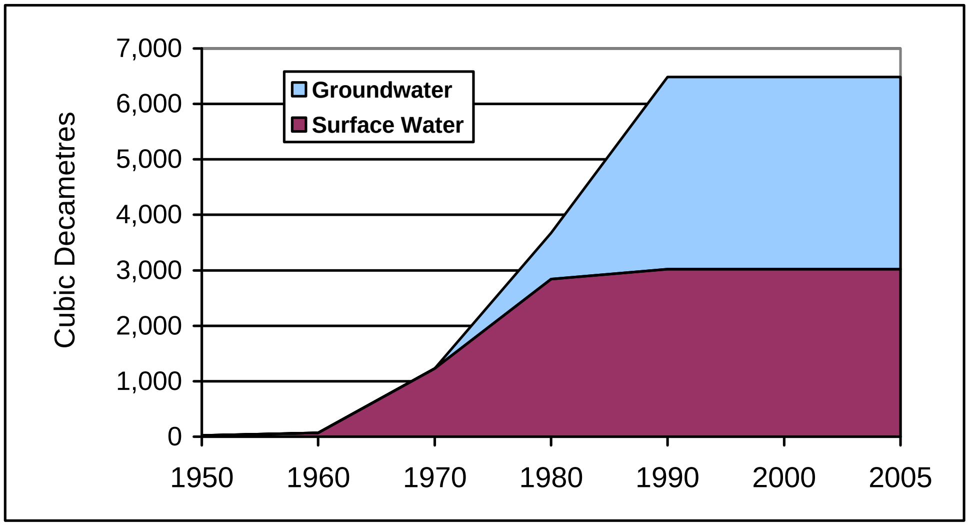
About three percent of the allocations for other purposes are for fish, wildlife and habitat enhancement (6,485 dam^3). Details of the licences issued to the other sector in the Oldman are provided in Table 4-26. The table shows that 60 licences have been issued for habitat projects, with 80 percent of these for surface water. Twelve licences have been issued for groundwater (3,465 dam^3). Figure 4-19 shows that allocations of surface water for habitat commenced in the 1950s and grew between the 1970s and 1990s. Groundwater use for habitat commenced in the 1980s and grew throughout the 1990s. There have been no new allocations issued for habitat since the 1990s.

Table 4-26 Licensed Allocations and Estimated Water Use for Other Purposes, Oldman Basin.

Water Use	Source	Number of Licence	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Water Management	Surface	26	157,987.0	146,199.8	11,787.2	146,199.8	100%	92.5%
	Groundwater	9	46,414.7	1,309.4	45,105.4	1,309.4	100%	2.8%
	Subtotal	**35**	**204,401.7**	**147,509.2**	**56,892.5**	**147,509.2***	**100%**	**72.2%**
Habitat	Surface	48	3,019.8	2,990.2	29.6	2,990.2	100%	99.0%
	Groundwater	12	3,465.3	85.3	3,380.0	85.3	100%	2.5%
	Subtotal	**60**	**6,485.1**	**3,075.5**	**3,409.6**	**3,075.5 ***	**100%**	**47.4%**
Water Conservation	Surface	5	228.6	228.6	0.0	228.6	100%	100.0%
	Groundwater	0	0.0	0.0	0.0			
	Subtotal	**5**	**228.6**	**228.6**	**0.0**	**228.6 ***	**100%**	**100.0%**
Specified	Surface	4	7.7	7.7	0.0	7.7	100%	100.0%
	Groundwater	1	0.4	0.4	0.0	0.4	100%	100.0%
	Subtotal	**5**	**8.2**	**8.2**	**0.0**	**8.2 ***	**100%**	**100.0%**
Total	Surface	83	161,243.1	149,426.3	11,816.8	149,426.3	100%	92.7%
	Groundwater	22	49,880.5	1,395.1	48,485.4	1,395.1	100%	2.8%
	Subtotal	**105**	**211,123.6**	**150,821.4**	**60,302.2**	**150,821.4**	**100%**	**71.4%**
* Estimated water use assumes 100% consumption.								

Table 4-26 shows that the licences issued for habitat enhancement purposes assume about 99 percent of surface water allocations and three percent of groundwater allocations will be used. Return flow allowances in licences amounted to 2,990 dam^3 for surface water and 3,380 dam^3 for ground water. There is no information on actual water diversions or consumption for habitat enhancement activities and, for purposes of this analysis, it is assumed that licensees are using the full amounts they are expected to use will continue to do so throughout the forecast period.

Figure 4-18 Historical Trends in Water Allocations for Habitat Enhancement



4.6.3 Water Conservation and Director-Specified Activities

About 0.1 percent of allocations for other purposes are for water conservation (229 dam^3) and for other activities specified by an AENV director (8.2 dam^3). Details of these licences are provided in Table 4-25. All of the water consideration licences and most of the licences for other specified activities are for surface water. The table shows that, for both types of licences, there are no return flow allowances. There is no information on actual water diversions or consumption for water conservation activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement and will continue to do so for the forecast period.

4.6.4 Summary

The other sector in the Oldman Basin is dominated by water allocated for water management. Water management projects account for almost 97 percent of water allocated and almost 98 percent of the licensed water use. There is a moratorium on new water licences for the Bow, Oldman, and South Saskatchewan River Basins. As no new water licences can be issued for these basins it is assumed that there will be no change in the amount of water allocated to the sector unless they obtain the water right from other activities within the basin. The forecasts in Table 4-27 assume that future water use by all other sector activities will remain constant over time. There is a possibility that allocations for water conservation may increase over time

because the Province of Alberta can retain 10 percent of allocations that are permanently transferred from one user to another, but such increases have not been included in the forecasts.

Table 4-27 Forecast of Other Water Use in the Oldman Basin
(dam^3)

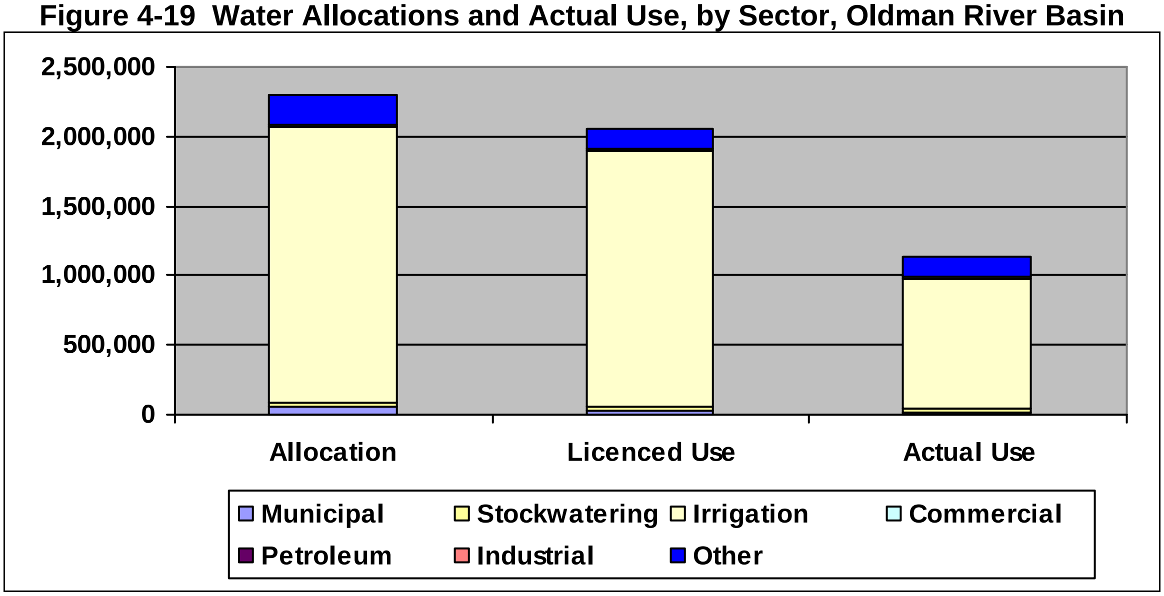
Scenario	Source	2005	2010	2015	2020	2025
Medium	Surface	149,426	149,426	149,426	149,426	149,426
	Groundwater	1,395	1,395	1,395	1,395	1,395
	Total	**150,821**	**150,821**	**150,821**	**150,821**	**150,821**

4.7 SUMMARY

Table 4-28 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the Oldman River basin. In total, existing licence and registrations allow a maximum of 2,292,401 dam^3 of water to be withdrawn for use. These licences assume up to 2,055,620 dam^3 will be used and include a return flow allowance of 236,778 dam^3. As noted previously, the largest amounts of water have been allocated to the agriculture sector, particularly irrigation.

With respect to actual use, the exact volumes withdrawn and used in 2005 are not known because very few water use reports have been filed with Alberta Environment. However, based on the assumptions used in the previous sections, it is estimated that 1,140,988 dam^3 were actually used in 2005. This represents 56 percent of water use allowed in existing licences and registrations. Based on estimated use, the agricultural sector accounted for 84 percent of total water use in the Oldman River Basin in 2005. Figure 4-19 shows how actual use compares to licensed allocations and use for each of the water use sectors.

Figure 4-19 Water Allocations and Actual Use, by Sector, Oldman River Basin



Forecasts of future water use in the Oldman River Basin are provided in Tables 4-29 to 4-31 for the low, medium and high growth scenarios. Predicted water use under the Medium growth scenario is shown in Figure 4-20. This figure shows that most of the growth in water use will occur in the agricultural sector, with water used for stockwatering and irrigation accounting for 86 percent of total water use by 2025. Under the medium scenario, water demand in 2025 will be about 10 percent higher than at present. For the other scenarios, the increase in water demand over 20 years will range from 0.7 percent for low growth and 17.9 percent for high growth. For all scenarios, actual water use will be less than the amount that can be consumed under the terms of existing licences.

Figure 4-20 Forecast Water Use in the Oldman River Basin: Medium Scenario

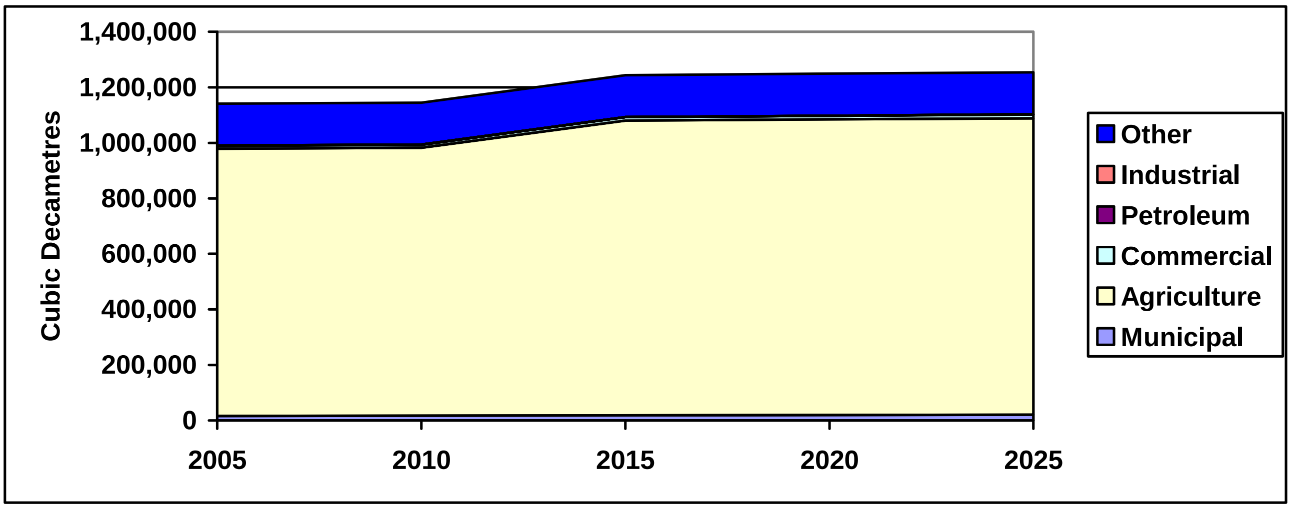


Table 4-28 Summary of Allocations and Estimated Water Use, Oldman River Basin

Sector		Licensed Allocation and Use (dam^3)				Estimated Water Use (dam^3)		
		Allocation	Water Use	Return	Percent of Total Use	Use	Percent of Licensed use	Percent of Total Use
Municipal		64,149	27,768	36,380	1%	16,574	60%	1%
Agricultural	Stockwatering	25,810	25,810	0	1%	19,558	76%	2%
	Irrigation	1,972,943	1,837,350	135,592	89%	942,701	51%	83%
Commercial		14,094	10,330	3,764	1%	10,330	100%	1%
Petroleum		4,270	3,530	740	0%	993	28%	0%
Industrial		11	11	0	0%	11	100%	0%
Other		211,124	150,821	60,302	7%	150,821	100%	13%
Total		**2,292,401**	**2,055,620**	**236,778**	**100%**	**1,140,988**	**56%**	**100%**

Table 4-29 Forecast Water Use, By Sector, Oldman River Basin: Low Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	14,853	15,531	16,073	16,550	16,930
	Agricultural	959,734	960,786	961,903	963,088	964,345
	Commercial	9,705	9,950	10,201	10,459	10,723
	Petroleum	822	822	698	698	655
	Industrial	0	0	0	0	0
	Other	149,426	149,426	149,426	149,426	149,426
	Total	1,134,540	1,136,515	1,138,301	1,140,221	1,142,079
Groundwater	Municipal	1,721	1,800	1,862	1,918	1,962
	Agricultural	2,524	2,674	2,833	3,003	3,182
	Commercial	626	642	658	675	692
	Petroleum	171	171	130	130	79
	Industrial	11	11	11	11	11
	Other	1,395	1,395	1,395	1,395	1,395
	Total	6,448	6,693	6,889	7,132	7,321
Total	Municipal	16,574	17,331	17,935	18,468	18,892
	Agricultural	962,258	963,460	964,736	966,091	967,527
	Commercial	10,331	10,592	10,859	11,134	11,415
	Petroleum	993	993	828	828	734
	Industrial	11	11	11	11	11
	Other	150,821	150,821	150,821	150,821	150,821
	Total	1,140,988	1,143,208	1,145,190	1,147,353	1,149,400

Table 4-30 Forecast Water Use, By Sector, Oldman River Basin: Medium Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	14,853	15,853	16,882	17,879	18,799
	Agricultural	959,734	961,701	1,058,386	1,060,832	1,063,558
	Commercial	9,705	10,455	11,263	12,134	13,071
	Petroleum	822	822	704	704	658
	Industrial	0	0	0	0	0
	Other	149,426	149,426	149,426	149,426	149,426
	Total	1,134,540	1,138,257	1,236,661	1,240,975	1,245,512
Groundwater	Municipal	1,721	1,837	1,956	2,072	2,178
	Agricultural	2,524	2,805	3,118	3,467	3,856
	Commercial	626	674	726	783	843
	Petroleum	171	171	136	136	83
	Industrial	11	11	11	11	11
	Other	1,395	1,395	1,395	1,395	1,395
	Total	6,448	6,893	7,342	7,864	8,366
Total	Municipal	16,574	17,690	18,838	19,951	20,977
	Agricultural	962,258	964,506	1,061,504	1,064,299	1,067,414
	Commercial	10,331	11,129	11,989	12,917	13,914
	Petroleum	993	993	840	840	741
	Industrial	11	11	11	11	11
	Other	150,821	150,821	150,821	150,821	150,821
	Total	1,140,988	1,145,150	1,244,003	1,248,839	1,253,878

Table 4-31 Forecast Water Use, By Sector, Oldman River Basin: High Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	14,853	16,448	18,214	20,005	21,758
	Agricultural	959,734	962,654	1,138,768	1,142,768	1,147,451
	Commercial	9,705	10,980	12,423	14,056	15,903
	Petroleum	822	822	719	719	667
	Industrial	0	0	0	0	0
	Other	149,426	149,426	149,426	149,426	149,426
	Total	1,134,540	1,140,330	1,319,550	1,326,974	1,335,205
Groundwater	Municipal	1,721	1,906	2,110	2,318	2,521
	Agricultural	2,524	2,940	3,428	3,999	4,667
	Commercial	626	708	801	907	1,026
	Petroleum	171	171	154	154	93
	Industrial	11	11	11	11	11
	Other	1,395	1,395	1,395	1,395	1,395
	Total	6,448	7,131	7,899	8,784	9,713
Total	Municipal	16,574	18,354	20,324	22,323	24,279
	Agricultural	962,258	965,594	1,142,196	1,146,767	1,152,118
	Commercial	10,331	11,688	13,224	14,963	16,929
	Petroleum	993	993	873	873	760
	Industrial	11	11	11	11	11
	Other	150,821	150,821	150,821	150,821	150,821
	Total	1,140,988	1,147,461	1,327,449	1,335,758	1,344,918

Bow River Basin

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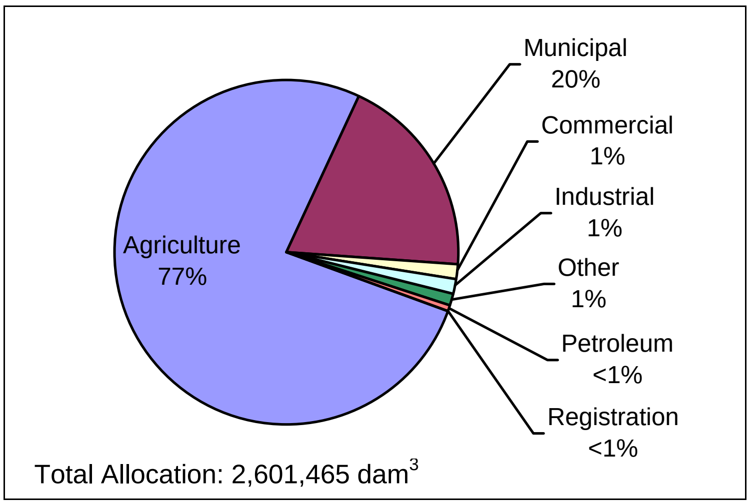
5.0 BOW RIVER BASIN

The Bow Basin, at almost 25,000 km^2, occupies 4.1 percent of Alberta by area. It flows into the South Saskatchewan River and forms part of the Nelson River system, which eventually drains into Hudson Bay. In 2001, the Basin had a population of 1,009,865 people, or 34 percent of the provincial population, and a population density of 41 people per square kilometre. The Bow River Basin consists of all or parts of 22 urban municipalities, 12 rural or regional municipalities and three First Nations.

An overview of current surface and groundwater allocations is provided in Figure 5-1. It shows that the agricultural sector accounts for 77 percent of total allocations or 1,987,458 dam^3 in 2005. The municipal sector accounts for most of the remaining allocations, totalling 500,472 dam^3 (20 percent). Total allocations in the Basin in 2005 were 2,601,465 dam^3

Figure 5-1 Distribution of Active Water Allocations in the Bow Basin



Figures 5-2 and 5-3 show the location, allocation and sector of all active surface water and groundwater licences in the Bow River Basin. Figure 5-4 shows the location of all registrations issued in the Bow River Basin.

5.1 MUNICIPAL AND RESIDENTIAL SECTOR

5.1.1 Population

The population of Bow Basin is 95 percent urban, dominated by the City of Calgary, with four percent residing in rural or regional municipalities and less than one percent in Aboriginal settlements, as shown in Table 5-1. All types of municipalities showed significant population growth between 1996 and 2001. The overall population of the Basin increased by 16 percent over this period; this is equivalent to 3 percent per year. However, the rural population actually grew at a faster rate (20 percent).

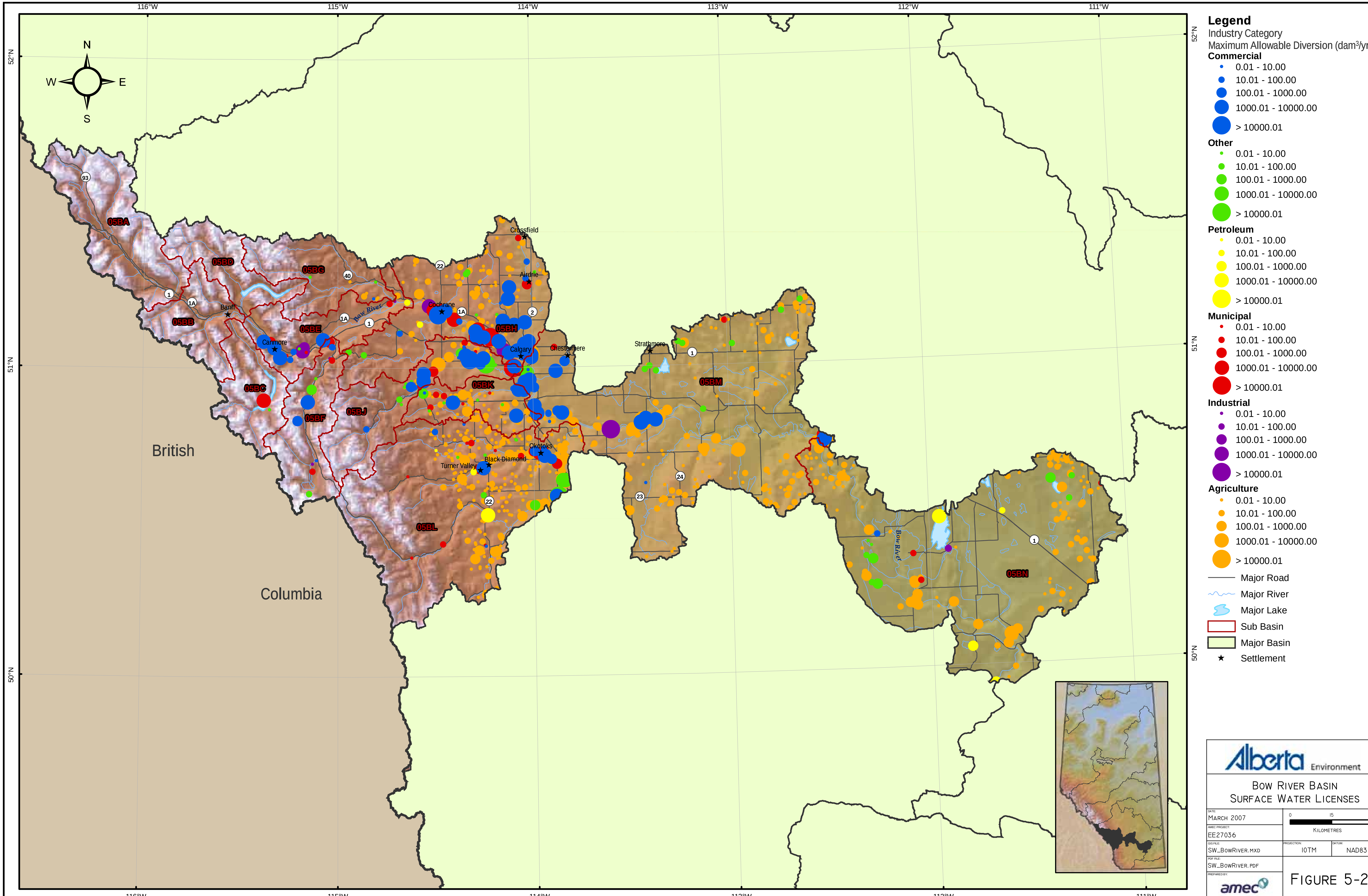
Table 5-1 Population Distribution and Growth in Bow River Basin, 2001

.	2001		1996	1996 to 2001 Population Change
	Population	Percent	Population	Percent
Urban Municipality	963,085	95.4%	831,873	15.8%
Rural or Regional Municipality	38,840	3.8%	32,470	19.6%
First Nations and Métis Settlements	7,940	0.8%	7,110	11.7%
Total	**1,009,865**	**100%**	**871,453**	**15.9%**

Table 5-2 lists all municipalities situated in the Bow River Basin, their estimated 2001 populations of each municipality, and a summary of water licence information for those communities that have licence for 100 dam^3 or more. The major population centres include the City of Calgary (877,112 residents) and the City of Airdrie (20,382). Rural or regional municipalities with significant populations in the Basin include the Municipal District of Rockyview No. 44 (17,682) and the Municipal District of Foothills No. 31 (12,451). The Stony Band has the largest population of the three Aboriginal jurisdictions in the Basin (3,486).

5.1.2 Allocations and Use

As of 2005, there were 341 active municipal water licences for 185 licensees in the Bow Basin. These licences allow maximum withdrawals of 500,473 dam^3 per year. As shown in Figure 5-1, municipal water allocations account for 20 percent of licensed water allocations in the basin. Within the basin, the City of Calgary accounts for 92 percent of all licensed allocations. Other urban users account for another 6.5 percent of licensed allocations. Water allocations for rural residents (subdivisions, cooperatives, farmsteads, single-multi homes and colonies) account for 1.4 percent of the total while allocations to other municipal uses account for less than 0.1 percent.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Maximum Allowable Diversion (dam³/yr)
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10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
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Petroleum
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10.01 - 100.00
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Municipal
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Agriculture
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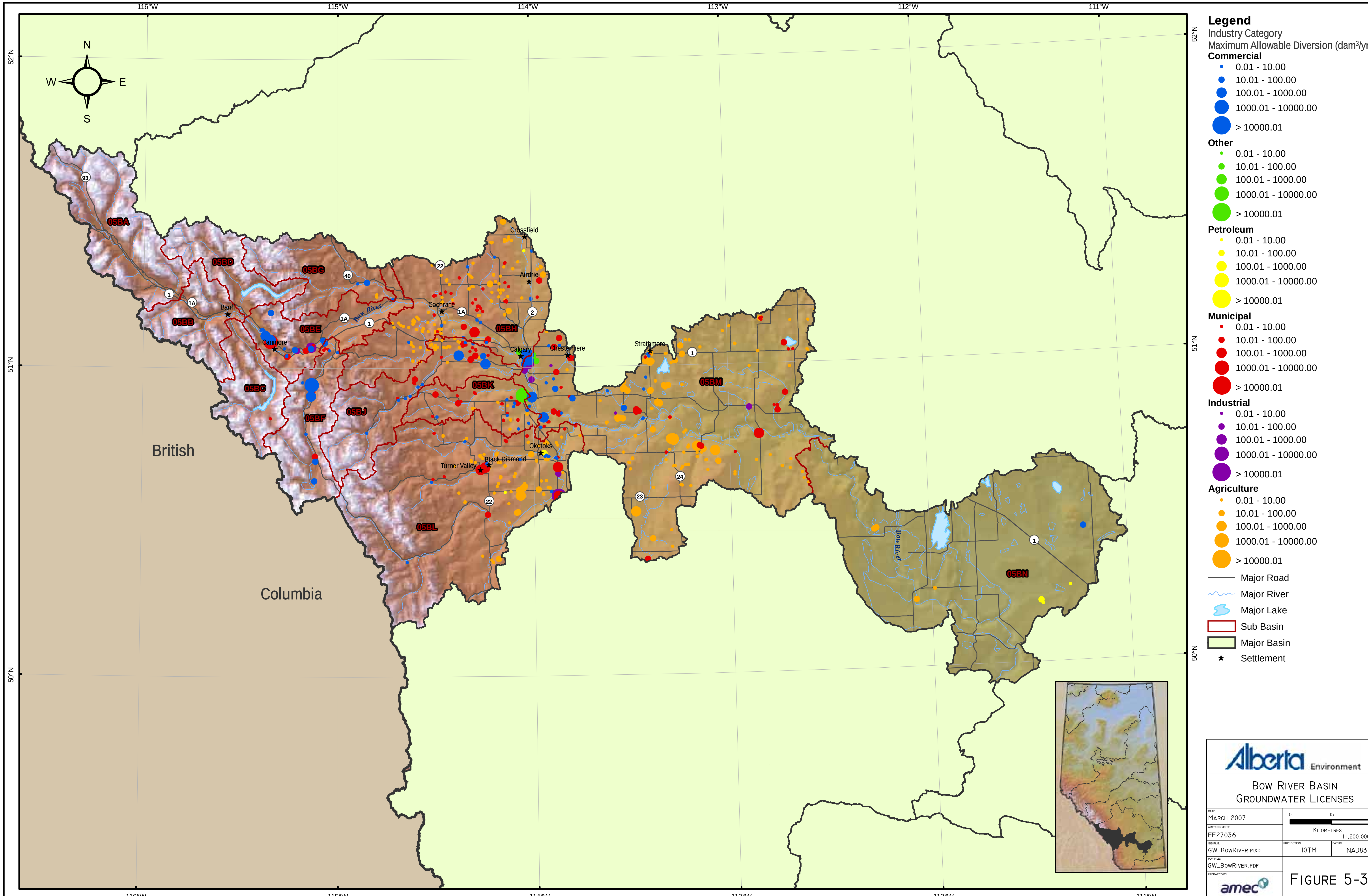
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
British
Columbia
Bow River
Crossfield
Airdrie
Cochrane
Calgary
Chestermere
Strathmore
Banff
Canmore
Okotoks
Black Diamond
Turner Valley
05BA
05BB
05BC
05BD
05BE
05BF
05BG
05BH
05BJ
05BK
05BL
05BM
05BN
116°W
115°W
114°W
113°W
112°W
111°W
52°N
51°N
50°N
Alberta Environment
Bow River Basin
Surface Water Licenses
March 2007
EE27036
SW_BowRiver.mxd
SW_BowRiver.pdf
10TM
NAD83
Kilometres
amec
Figure 5-2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Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
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10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
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Petroleum
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Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
British
Columbia
Bow River
Crossfield
Airdrie
Cochrane
Banff
Canmore
Calgary
Chestermere
Strathmore
Okotoks
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Alberta Environment
Bow River Basin
Groundwater Licenses
March 2007
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Kilometres
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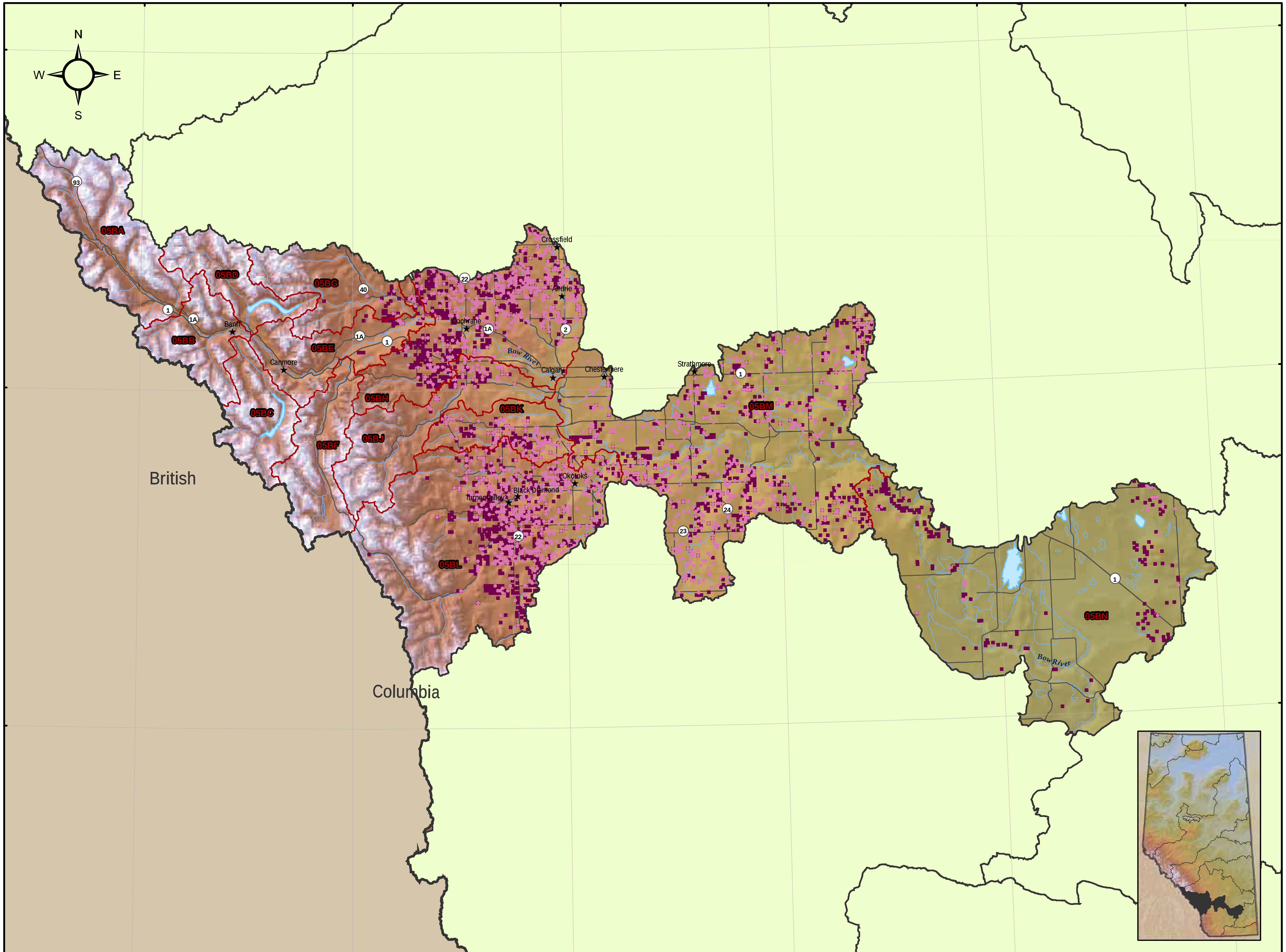
amec
Figure 5-3



Alberta Environment

Bow River Basin Registrations

Date: March 2007	0 15 30 Kilometres 1:1,200,000
AMEC Project: EE27036	
GIS File: RG_BowRiver.mxd	Projection: 10TM / Datum: NAD83
PDF File: RG_BowRiver.pdf	
Prepared by: amec	Figure 5-4

Table 5-2 2001 Municipal Populations and Water Allocations within the Bow River Basin

Urban Municipality Name		2001 Population	Source	2005 Allocation (dam^3)
Cities	AIRDRIE	20,382	Surface	588
	CALGARY	877,112	Surface	460,184
Towns	BANFF	7,135		
	BLACK DIAMOND	1,866	Groundwater	955
	CANMORE	10,792	Surface Groundwater	3,876 1,195
	CHESTERMERE	3,414		
	COCHRANE	11,798	Surface	4,940
	CROSSFIELD	2,028		
	HIGH RIVER	3,204	Groundwater	4,622
	OKOTOKS	11,664	Surface	2,766
	STRATHMORE	6,258	Surface	2,659
	TURNER VALLEY	1,608	Groundwater Surface	370 146
	VULCAN	266		
Villages	ARROWWOOD	196		
	HUSSAR	181		
	LONGVIEW	300		
	MILO	115		
	STANDARD	389	Surface	123
	TILLEY	422	Surface	137
Summer Villages	GHOST LAKE	69		
	WAIPAROUS	55		
Total		**959254**		**482,561**

Rural Municipality Name		2001 Population	Source	2005 Allocation (dam^3)
Rural or Regional	NEWELL NO. 4	3,010	Surface	612
	CYPRESS	712		
	ID NO. 9	1,221		
	KANANASKIS ID	454		
	MOUNTAIN VIEW	38		
	BIGHORN NO. 8	646		
	FOOTHILLS NO. 31	12,451	Surface Groundwater	159 127
	RANCHLAND NO. 66	3		
	ROCKY VIEW NO. 44	17,682	Groundwater Surface	352 1,812
	TABER	1,077		
	WILLOW CREEK NO. 26	1		
	VULCAN	1,546		
	WHEATLAND	3,830	Surface Groundwater	604 110
	TOTAL	**42,671**		**3,776**
First Nations	SIKSIKA NATION	3,247	Groundwater	142
	STONEY BAND	3,486	Surface	141
	TSUU T'INA NATION	1,206	Surface	148
	TOTAL	**7,939**		**431**

Surface water licences represent 98 percent of total municipal water allocations. The maximum amount of surface water that can be withdrawn in Bow Basin by the municipal sector is 491,192 dam^3. Urban municipalities account for the vast majority of surface water allocations (485,238 dam^3 over 77 licences). Surface water allocations to rural users only amounts to 5,754 dam^3 over 53 licences.

Groundwater licences represent two percent of total municipal water allocations. The maximum amount of groundwater that can be withdrawn in Bow Basin by the municipal sector is 9,280 dam^3. Urban uses are licensed to withdraw a maximum of 7,657 dam^3 over 52 licences. Rural users have 127 licences that allow withdrawals of up to 1,427 dam^3.

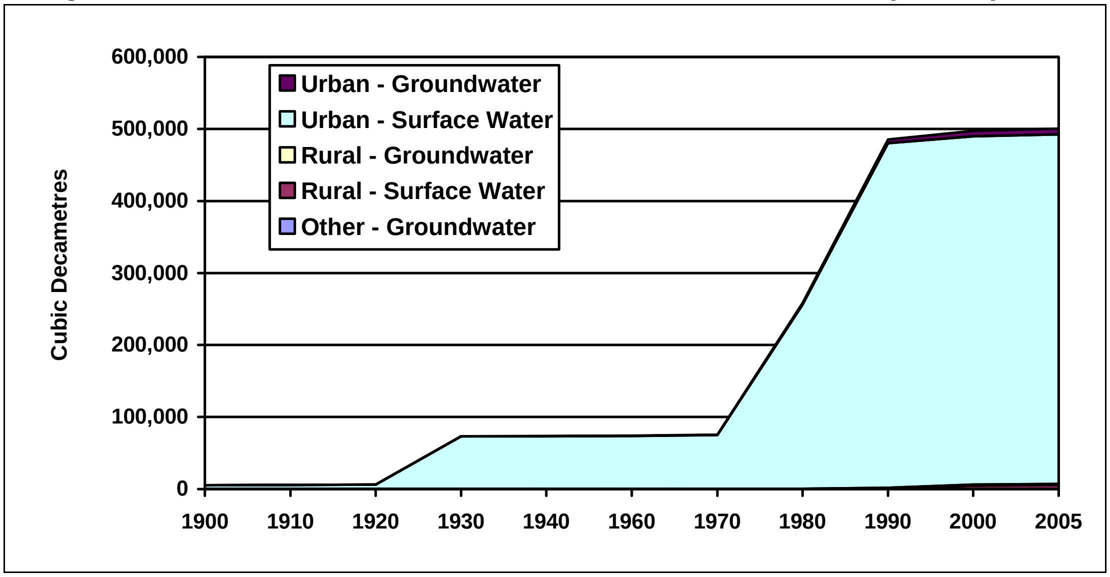
Table 5-3 lists the other municipal water licensees that are allowed to withdraw large amounts of water (100 dam^3 or more) from the Bow River Basin. In combination, the allocations listed in Tables 5-2 and 5-3 account for almost 100 percent of the total allocations for municipal purposes. It should be noted that although the City of Brooks and the Town of Bassano draw water from the Bow Basin, they are geographically located in the Red Deer Basin. The Town of High River draws water from Bow Basin but straddles the Bow and Oldman Basins, with the majority of the municipal population living in the Oldman Basin. The Town of Vauxhall also draws water from the Bow Basin but is located within the Oldman Basin.

Table 5-3 Other Large Municipal Water Licensees in the Bow River Basin

Approval Holder	Water Source	Allocation (dam^3)
CITY OF BROOKS	Surface	4,934
TOWN OF BASSANO	Surface	840
TOWN OF VAUXHALL	Surface	740
VILLAGE OF CHAMPION	Surface	130
VILLAGE OF DUCHESS	Surface	321
VILLAGE OF ROCKYFORD	Surface	130
AL AZHAR TEMPLE	Surface	366
BEARSPAW AQUA LTD.	Surface	121
COCHRANE LAKE PROPERTIES LTD.	Surface	755
CORIX UTILITIES (FOOTHILLS WATER) INC.	Surface	612
COUNTY OF NEWELL NO. 4	Surface	612
EASTERN IRRIGATION DISTRICT	Surface	313
LOMOND NORTH WATER USERS CO-OP	Surface	205
MCGREGOR WATER USERS CO-OP LTD	Surface	426
MUIRFIELD VILLAGE HOMEOWNERS ASSOCIATION	Surface	221
POPLAR VIEW WATER CO-OPERATIVE LTD.	Surface	222
SPRING CREEK MOUNTAIN VILLAGE INC.	Groundwater	216
WESTRIDGE UTILITIES INC.	Surface	1,314
Total		**12,478**

Figure 5-5 shows how allocations for municipal water use in Bow Basin have changed since 1900. Municipal uses accounting for less than 0.1 percent of total allocations are not shown. Virtually all municipal allocations since 1900 have been for urban surface water, and a five-fold increase in allocations occurred in the 1970's and 1980's. Rural surface and groundwater allocations and urban groundwater allocations have grown steadily since 1980. There has been little change in allocations for municipal purposes since 1990.

Figure 5-5 Bow Basin Historical Water Allocations for Municipal Purposes



5.1.3 Licensed Water Use

Table 5-4 summarizes licensed water use for the municipal sector in the Bow River Basin. Municipal allocations consist of 109,303 dam^3 that can be used (i.e. 22 percent of allocations consumed and/or lost) 391,170 dam^3 for return flow. Return flow allowances are similar for surface water allocations (77 percent) and for groundwater allocations (79 percent). For rural users, groundwater allocations include a return flow allowance of 25 percent compared to less than five percent of surface water allocations.

5.1.4 Actual Water Use

In 2005, only 15 or 8.1 percent of approval holders reported their water diversions to the Alberta Environment through the WURS. The total allocation for those 15 licences was 471,684 dam^3, which represents 94.1 percent of total municipal water allocations in the Bow River Basin. These licensees reported diverting 132,362 dam^3 in 2005, and this represents only 28 percent of their total allocations. Thus, actual water diversions in 2005 are well below the maximums allowed in the licences.

Table 5-4 Licensed and Reported Diversions, Water Use and Returns by Type of Municipal Use for Bow Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Diversion	Estimated Use	Return
Urban*	Surface	77	485,238	100,603	384,635	131,373	N/A	1
	Groundwater	52	7,657	1,753	5,904	9	N/A	N/A
	Subtotal	**129**	**492,895**	**102,356**	**390,539**	**131,382**	**N/A**	**1**
Rural**	Surface	53	5,754	5,495	259	276	N/A	N/A
	Groundwater	127	1,427	1,068	361	35	N/A	N/A
	Subtotal	**180**	**7,182**	**6,563**	**620**	**311**	**N/A**	**N/A**
Other***	Surface	9	200	200	0	5	N/A	N/A
	Groundwater	23	196	185	11	N/A	N/A	N/A
	Subtotal	**32**	**395**	**384**	**11**	**5**	**N/A**	**N/A**
Total	Surface	139	491,192	106,298	384,894	131,653	N/A	N/A
	Groundwater	202	9,280	3,005	6,275	45	N/A	N/A
	Total	**341**	**500,472**	**109,303**	**391,170**	**131,698**	**N/A**	**N/A**

* Urban includes villages, summer villages, towns, cities, hamlets;

** Rural includes condominiums / townhouses / mobile homes / complexes, hotels / motels, cooperatives, farmsteads, single-multi homes, colonies and subdivisions

*** Other includes camps, institutions, senior/correctional centres, nursing/children's homes, hospitals

With respect to return flows, which are needed to measure net consumption, WURS only contains information for the Town of Crossfield, which reported returning one of the 21 dam^3 of water it diverted in 2005. Additional information on return flows was available from Environment Canada's MUD database. The data base includes withdrawal information for 11 municipalities that represented 96.3 percent of the basin's population in 2001, and return flow estimates were provided by five of these municipalities. Based on this information, it is estimated that return flow accounted for 74 percent of total withdrawals for the urban communities, indicating that 26 percent of withdrawals were actually consumed.

Based on the available information for the Bow River Basin and using the general approach outlined in Section 2, estimates of actual municipal water use were developed for the basin. These estimates are provided in Table 5-5. The table shows that all municipal water users were withdrawing 44 percent of their maximum entitlements and were actually using 55 percent of the amounts allowed in surface water licences and 48 percent of the amounts allowed in groundwater licences. Overall, municipal water users are estimated to have actually used 55 percent of the maximum allowed in their licences, indicating that, in general, the populations of municipalities in the Bow River Basin can increase substantially before new water allocations will be required.

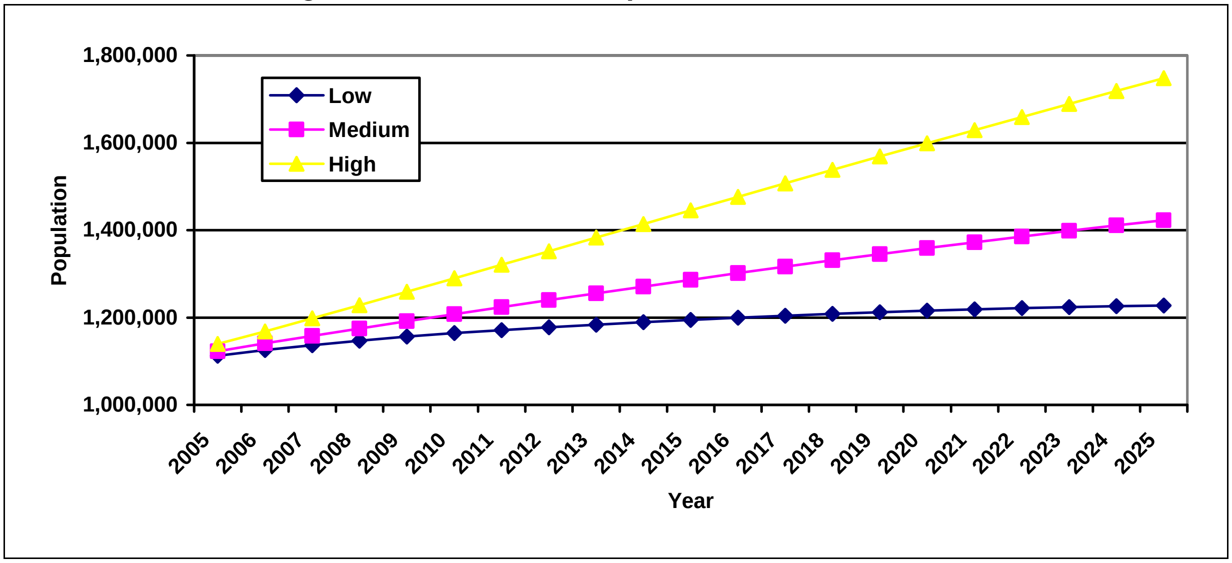
Table 5-5 Estimated Municipal Water Use in the Bow River Basin

Municipal Use	Source	Withdrawals (dam^3)	Use (dam^3)	Return Flow (dam^3)
Urban	Surface	213,231	56,378	156,852
	Groundwater	3,365	890	2,475
	Subtotal	**216,595**	**57,268**	**159,327**
Rural	Surface	2,529	2,415	114
	Groundwater	627	469	158
	Subtotal	**3,156**	**2,884**	**272**
Other	Surface	88	88	0
	Groundwater	86	81	5
	Subtotal	**174**	**169**	**5**
Total Use	Surface	215,847	58,881	156,966
	Groundwater	4,078	1,440	2,638
	Subtotal	**219,925**	**60,321**	**159,604**
Licensed Use	Surface	491,192	106,298	384,894
	Groundwater	9,280	3,005	6,275
	Subtotal	**500,472**	**109,303**	**391,170**
Percent of Licensed Use	Surface	43.9%	55.4%	40.8%
	Groundwater	43.9%	47.9%	42.0%
	Subtotal	**43.9%**	**55.2%**	**40.8%**

5.1.5 Future Water Use Forecasts

Figure 5-5 shows the low, medium and high population projection scenarios for Bow Basin based on Alberta Finance Census Division projections. The population forecasts in Figure 5-6 have been used to predict future municipal surface and groundwater use. The resulting forecasts of water use are provided in Table 5-6 and are based on the assumption that 2005 per capita water use will continue over the forecast period.

Figure 5-6 Bow Basin Population Growth Forecast



Under the low population growth scenario, municipal water use in 2025 is expected to be 10 percent greater than at present and diversions will be approximately half of the maximum allocations allowed in current licences. For the medium growth scenario, water use is expected to increase to two-thirds of current licensed use by 2025. Under the high population growth scenario, total use of surface and groundwater is expected to be 85 percent of current licensed use under the high population growth scenario in 2025.

Table 5-6 Projected Water Use for the Municipal Sector in the Bow Basin
(dam^3)

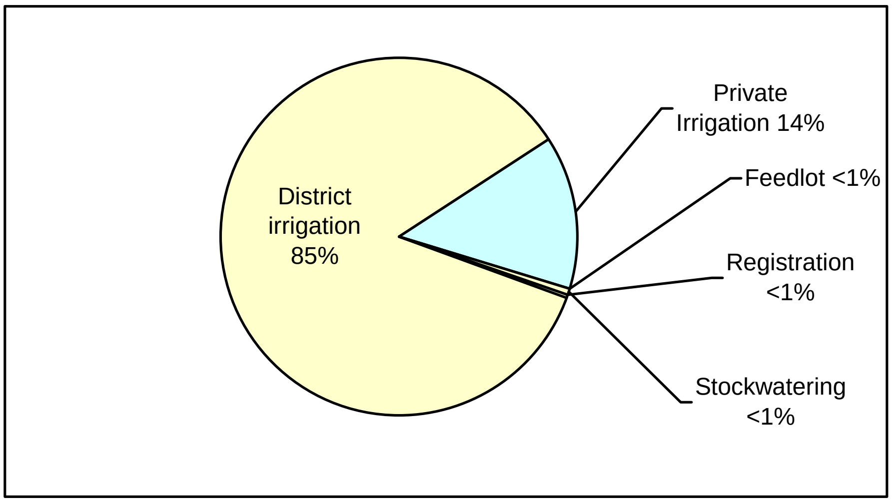
Scenario	Source	2005	2010	2015	2020	2025
Low Population Growth	Surface	58,881	61,612	63,224	64,342	64,958
	Groundwater	1,440	1,507	1,546	1,574	1,589
	Total	**60,321**	**63,119**	**64,770**	**65,915**	**66,547**
Medium Population Growth	Surface	58,881	63,342	67,470	71,255	74,624
	Groundwater	1,440	1,549	1,650	1,743	1,825
	Total	**60,321**	**64,891**	**69,120**	**72,997**	**76,449**
High Population Growth	Surface	58,881	66,668	74,712	82,658	90,346
	Groundwater	1,440	1,630	1,827	2,022	2,210
	Total	**60,321**	**68,298**	**76,539**	**84,680**	**92,555**

5.2 AGRICULTURAL SECTOR

As of December 2005 about 1.99 million dam^3 had been allocated to the agricultural sector in the Bow River Basin. This includes 5,125 registrations representing about 2,850 dam^3 and 189 licences representing 1.97 million dam^3 of water. Water allocated to agriculture accounts for 77 percent of all allocations in the Bow River Basin.

Figure 5-7 shows how this water is distributed among the different agricultural uses in the Basin. The largest allocation is for district irrigation (85 percent). Private irrigation accounts for 14 percent, while stockwatering, registrations and feedlot together account for one percent of the total allocation.

Figure 5-7 Water Allocation by Volume for Agricultural Activities in the Bow Basin



A total of 2,795 registrations and 787 licences have been issued for water withdrawals from surface sources and they allow withdrawals of up to about 1.9 million dam^3; this represents more than 99 percent of all water allocations to the agricultural sector. Groundwater accounts for less than one percent of total allocations, with 471 licences and 2,330 allowing maximum withdrawals of 6,200 dam^3 of groundwater.

5.2.1 Overview of Agriculture in the Bow River Basin

Based on estimates derived from the 2001 Census of Agriculture, there were about 3,200 farms in the Bow River Basin (six percent of the Alberta total) with an average size of 1,079 acres. In Alberta there were about 53,000 farms with an average size of 970 acres. Farms in the Bow River Basin covered an area of nearly 3.5 million acres; this is equivalent to about 14, 000 km^2 or about 55 per cent of the basin. Table 5-7 shows about 44 percent of farm land in the Basin is used to raise crops. About seven per cent of agricultural land is summer fallowed. Most of the remaining land, about 46 percent is pasture.

Table 5-7 Agricultural Land Use in the Bow River Basin, 2001

Land Use	Acres	Percent
Crop Land	1,508,317	43.7%
Summerfallow	254,106	7.4%
Tame/Seeded Pasture	277,879	8.1%
Natural Pasture	1,322,749	38.3%
Other	88,072	2.6%
Total	**3,451,123**	**100.0%**

The types of farming activity vary within the Bow Basin. Table 5-8 shows the classification of farms based on the commodity groups that accounted for 51 per cent or more of total gross farm receipts. The table shows that about 40 percent of the farms in the Bow Basin raise beef cattle and about 15 percent of the farms are grain and oilseed farms. Wheat farms account for about 10 percent of farms in the Bow Basin. Farms growing specialty and field crops, including vegetables, potatoes, silage corn and alfalfa, account for about 15 percent of total farms. From a provincial perspective the Bow Basin accounts for less than three percent of total farms in Alberta. However, as noted above, the average size of the farms in the Bow Basin is larger (1,079 acres) than the provincial average (970 acres). Like Alberta, cattle (beef) farms account for the majority of farms in the Bow Basin. There was slightly higher proportion of wheat and specialty farms in the Bow River Basin but here were fewer dairy farms.

Table 5-8 Classifications of Farms in the Bow Basin and Alberta, 200

Farm Type (Farms with Gross Receipts >$2,500)	Percent of Farms in the Bow Basin	Percent Share of Alberta	Alberta Farm Type (Percent)
Dairy Farms	0.6%	2.2%	1.5%
Cattle (beef) Farms	42.4%	5.5%	45.4%
Hog Farms	1.1%	3.9%	1.7%
Poultry & Egg Farms	0.8%	5.3%	0.9%
Wheat Farms	10.2%	8.1%	7.4%
Grain & Oilseed Farms	17.1%	5.4%	18.4%
Field Crop Farms	8.1%	5.1%	9.3%
Fruit Farms	0.2%	8.8%	0.1%
Misc.Speciality Farms	14.8%	8.0%	10.9%
Sum of Livestock Comb. Farms	2.6%	6.6%	2.3%
Sum of Vegetable Farms	0.2%	8.6%	0.1%
Sum of Other Comb Farms	2.1%	6.1%	2.0%
Total	**100.0%**	**2.6%**	**100.0%**

5.2.2 Stockwatering

As noted in Table 5-8 more than 40 percent of the farms in the Bow Basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species in 2001 are provided in Table 5-9. The table shows that there about 0.7 million cattle and calves, which together, accounted for about 90 percent of livestock population in the Bow Basin. The population of cattle and calves was equivalent to about 70 percent of the human population of the Basin. Other livestock in the Bow Basin included pigs, sheep and lamb, horses and ponies, bison deer and elk.

Table 5-9 Estimated Livestock Populations in the Bow Basin and Alberta, 2001

Livestock Species	Basin Total	Alberta	% Alberta
Hens and Chicken	652,531	12,175,246	5.4%
Turkey	1,123	864,438	0.1%
Cattle	532,515	6,615,201	8.0%
Calves	160,052	2,169,607	7.4%
Pigs	148,015	2,027,533	7.3%
Sheep and Lamb	19,014	307,302	6.2%
Horse and Ponies	11,640	159,962	7.3%
Bison	1,327	79,731	1.7%
Deer	204	8,331	2.5%
Elk	683	31,304	2.2%

5.2.2.1 <u>Water Allocation</u>

Overall 6,194 licences and registrations have been issued for livestock watering with the total allocation amounting to 17,243 dam^3. In addition to these allocations, farmers are able to obtain up to 1,250 m^3 of water for household purposes. The numbers of such households in the Basin is not known. Furthermore, the numbers of “exempted agricultural” users are also not known in the Oldman Basin.

A historical perspective on water allocations for livestock watering is provided in Figure 5-8. The figure shows that some registrations were issued with priority dates in the 1890s while licences for stockwatering began to be issued in the 1890s. Allocations for stockwatering, including feedlots, have risen steadily since the 1920s, with most of the licensed allocations being for surface water. In contrast, most of the registrations have been issued for groundwater. Since 2000 allocations for stockwatering and feedlots have remained relatively steady at about 17,000 dam^3.

Over the last few decades livestock operations have gone through intensification, characterized by an increasing number of feedlots. The first allocations for feedlots were issued in the 1960s and there was a substantial increase starting in the 1980s but allocations have remained constant since about 2000. At the present time total allocations for feedlots total 2,688 dam^3, and this represents 16 percent of allocations for livestock.

Figure 5-8 Historical Trends in Water Allocation for Livestock in Bow Basin

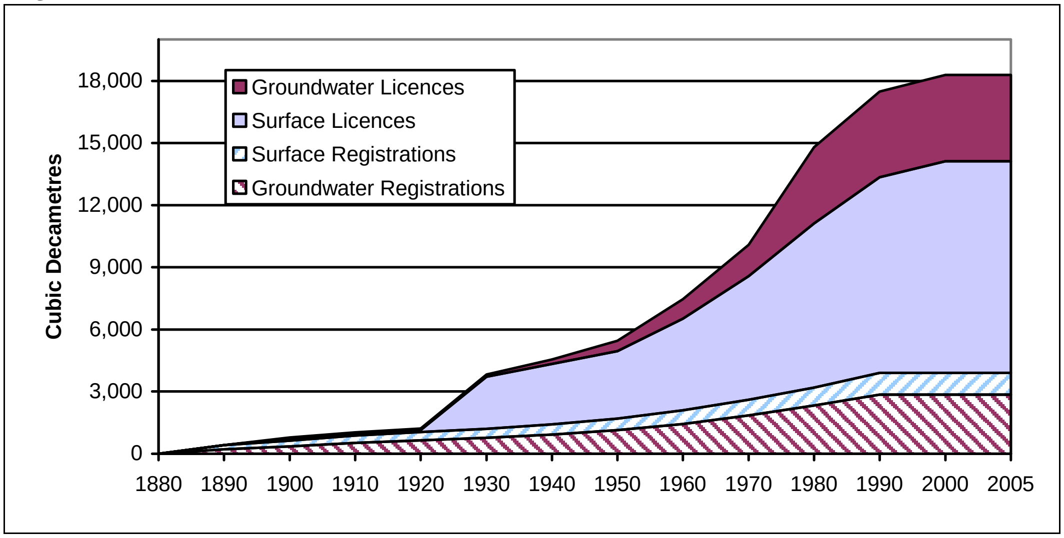


Table 5-10 summarizes current water licences and registrations issued for livestock according to the water source. It shows that surface water accounts for about 65 percent of allowable diversions for livestock and that registrations account for about 0.1 percent of the allocations.

For the Bow River Basin, 2,795 registrations representing a total allocation of 1,043 dam^3 have been issued for surface water. Another 2,330 registrations have been issued for groundwater and allow withdrawals and consumption of 1,800 dam^3. As of 2005, about 600 surface water licences had been issued for stockwatering and feedlots. These licences allow diversion of up to 10,229 dam^3. Another 469 licences have been issued for groundwater and allow diversion of up to 4,164 dam^3. Table 5-10 only accounts for water allocations through licences and registrations. Farmers are able to obtain up to 1,250 m^3 of water for household purposes, which allow some livestock watering, and they can also withdraw water as "exempted agricultural" users. The extent of this unlicensed water use in the Bow River Basin is not known.

5.2.2.2 <u>Licensed Water Use</u>

Table 5-10 shows that no return flow allowances are included in registrations or licences issued for feedlots. Thus, all of the water withdrawn for these uses is expected to be consumed or lost. Some surface water licences issued for stockwatering have return flow allowances. These allowances (1,110 dam^3) amount to about nine percent of surface water allocations, which means that 91 percent is expected to be used. There are no return flow allowances in stockwatering licences issued for groundwater.

Table 5-10 Summary of Water Licences and Registrations Issued for Livestock Watering in the Bow Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use(dam^3)
Feedlot	Surface	17	1,945.5	1,945.5	0.0	0	N/A
	Groundwater	19	742.1	742.1	0.0	0	N/A
	Subtotal	**36**	**2,687.5**	**2,687.5**	**0.0**	**0**	**N/A**
Stock watering	Surface	583	8,283.1	7,173.0	1,110.1	0	N/A
	Groundwater	450	3,421.9	3,421.9	0.0	0	N/A
	Subtotal	**1,033**	**11,705.0**	**10,594.9**	**1,110.1**	**0**	**N/A**
Registration	Surface	2,795	1,043.3	1,043.3	0.0	0	N/A
	Groundwater	2,330	1,806.9	1,806.9	0.0	0	N/A
	Subtotal	**5,125**	**2,850.2**	**2,850.2**	**0.0**	**0**	**N/A**
Total	Surface	3,395	11,271.8	10,161.7	1,110.1	0	N/A
	Groundwater	2,799	5,970.9	5,970.9	0.0	0	N/A
	Total	**6,194**	**17,242.8**	**16,132.6**	**1,110.1**	**0**	**N/A**

5.2.2.3 Actual Water Use

There is no information in Alberta Environment's WURS that indicates the extent to which water allocations for livestock are actually used in the Bow River Basin. However, a reasonable estimate of water use can be derived using the actual animal population in the Basin as shown in Table 5-9. Based on livestock populations for the Bow Basin in 2001, it is estimated that their water requirements amount to 5,931 dam^3, or about 37 percent of the licensed allocation.[1] The calculations for this estimate are provided also in Table 5-11 which shows livestock populations in the basin, and their daily water requirements for various livestock species as provided by Alberta Environment in its "Guide to Calculate Quantities for Water for Raising Animals".[2] In terms of water requirements by species, cattle account for about 88 percent of the total, about six percent is required by pigs, one percent is required by poultry and all other species accounted for the remaining five percent.

Table 5-11 Estimated Livestock Water Requirements for 2001

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chickens	652,531	0.045	48.7
Turkey	1,123	0.15	0.3
Bulls	7,186	9.0	107.3
Milk Cows	3,224	30.0	160.4
Beef Cows	123,632	9.0	1,845.2
Heifers	82,097	6.0	816.9
Steers	151,944	6.0	1,511.8
Calves	160,052	3.0	796.3
Boars	545	6.5	5.9
Sows and Gilts - Breeding	15,003	6.5	161.7
Nursing and Weaner Pigs	59,201	0.5	49.1
Grower and Finishing Pigs	64,127	1.5	159.5
Sheep and Lambs	19,014	2.0	63.1
Horse and Ponies	11,640	10.0	193.0
Bison	1,327	2.0	4.4
Deer	204	10.0	3.4
Elk	683	3.5	4.0
Total			**5,930.8**

While the estimated actual consumption based on livestock populations (5,931 dam^3**)** appears to be significantly less than the amount of licensed water use (16,133 dam^3), the data in Table 5-11 do not include an allowance for the evaporative and seepage losses associated with storing water for livestock use. Typically, licensed consumption accounts for only 35 per cent of surface water allocated for livestock use while losses account for 65 per cent (Watrecon 2005). Since 35 percent of livestock water consumption comes from groundwater (no losses) and the

[1] This approach to estimating water use for stockwatering was employed in the 1986 Battle River Basin water use study undertaken by Stanley Associates in 1985.
[2] http://www3.gov.ab.ca/env/water/Legislation/Approvals_Licences/CalculationChart.doc.

balance comes from surface water with 65 percent losses, a total allocation of 8,007 dam^3 would be required to support the animal populations in Table 5-11. This water requirement is about 50 percent of water use allowed by licences and registrations. Consequently, it is assumed that actual water use is less than the amount of water allocated for livestock. It is also assumed that surface water withdrawals occurred during April when dugouts and storage dams were filled and flows were at their peak.

5.2.2.4 Forecasts of Future Stockwatering Water Use

The key factor affecting future livestock water demand is changes in cattle populations in the basin. Cattle accounts for about 88 percent of livestock water demand in the Bow Basin, so changes in the populations of other livestock species will have a minimal overall impact on future water demand. The historical trend analysis in Figure 5-8 shows that the amount of water allocated for livestock has been increasing over time, suggesting an increasing livestock population, which is corroborated by Census data that show an increase in livestock population between 1996 and 2001. However, the rate of growth in water allocation in the last decade has been much lower than the long term rate of increase.

Some indication of the potential for expansion of cattle populations in the Bow River Basin can be determined by examining applications for new and expanded confined feeding operations, which must be approved by the NRCB in accordance with AOPA. Information from the NRCB indicates that, as of December 31, 2005, there had been 11 applications from farmers throughout the Basin for cattle and dairy operations (Table 5-12).

Table 5-12 Status of Applications under AOPA in the Bow Basin

Type of Application	Number	Withdrawn	Approved	Denied
Approval	1	0	1	0
Registrations	6	0	5	1
Authorizations	6	0	6	0
Total	**13**	**0**	**12**	**1**

A study undertaken by Alberta Agriculture in the late 1990s also provides some insights regarding the potential for expansion of the beef industry in the province. That study identified several criteria – manure, odour and population densities, local silage supplies, water supply, landscape characteristics and land for manure spreading – to be considered in evaluating the capability of supporting a 5,000-head back grounding operation and a 20,000-head operation. Townships suitable for livestock expansions are shown in Figures 2-2 and 2-3 in Section 2.3. The figure shows that more townships meet all of the criteria for backgrounding operations than finishing operations. For most townships that meet some of the criteria limiting factors include groundwater and landscape for backgrounding operations. Relatively few townships meet any of the criteria for finishing operations; however, some townships meet some criteria but are limited by groundwater and silage. Based on Alberta Agriculture's assessment, it would appear that livestock expansion in the Bow River Basin could occur and would most likely consist of 5,000-head operations. This assessment shows that there is potential for future expansion of

livestock operations, and the information from the NRCB suggests that this expansion is likely to occur.

Aside from the biophysical assessment of land base to support livestock operation, future expansion will be influenced by the fact that the Bow Basin is "capped", meaning no new applications for water licences in the Bow River Basin are being accepted. However, because the current allocation exceeds actual water use, some growth can occur in livestock populations. Furthermore, livestock operations can also choose to buy allocations from other licensees to meet future water demand.

Projections are based on the expectations that cattle populations will increase at annual rates somewhere between 1.2 percent (Low Growth) and 3.2 percent (High Growth). As Base Growth, annual rate is assumed to be 2.2 percent which reflects average annual growth rate in cattle population in Alberta during 1958-2005. This forecast also assumes that the current mix of livestock water requirement (88 percent cattle) and balance of surface and groundwater use will remain unchanged over the forecast period. The resulting projections, based on actual use are shown in Table 5-13.

Table 5-13 Water Use for Livestock in the Bow River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	5,931	6,296	6,682	7,093	7,529
	Groundwater	2,076	2,203	2,339	2,483	2,635
	Total	**8,007**	**8,499**	**9,021**	**9,576**	**10,164**
Medium Growth	Surface	5,931	6,613	7,373	8,220	9,165
	Groundwater	2,076	2,314	2,580	2,877	3,208
	Total	**8,007**	**8,927**	**9,953**	**11,097**	**12,373**
High Growth	Surface	5,931	6,943	8,127	9,513	11,136
	Groundwater	2,076	2,430	2,844	3,330	3,897
	Total	**8,007**	**9,373**	**10,971**	**12,843**	**15,033**

Under the Low Scenario, water demand is projected to increase to 10,164 dam^3 by 2025 – a 27 percent increase; this increase is within the current allocations. Under the High Scenario, livestock water use would increase to 15,033 dam^3 by 2025. This increase is 88 percent higher than current livestock use but is also within current allocations. These findings suggest that current allocations are sufficient to support livestock expansion.

5.2.3 Irrigation

The other major use of water for agricultural purposes is irrigation or crop watering. The crop water allocation can be divided into licences for district irrigation and private irrigation. Three irrigation districts draw their water from the Bow River: the Western Irrigation District (WID), the Bow River Irrigation District (BRID), and the Eastern Irrigation District (EID). As shown in Table 5-14, the three districts are entitled to divert up to 1,692,855 dam^3 although, between 1976 and

2005, average diversions amounted to only about 74 percent of this amount. With 2005 being a relatively wet year, the districts only diverted 761,240 dam^3 which represents 45 percent of the maximum allowed in their licences. Together, the three districts have 599,584 acres on their assessment rolls and, in 2005, about 91 percent of these (544,905 acres) were actually irrigated.

For private irrigators there is no information on the actual number of acres of land irrigated in 2005. However, based on their water allocations and irrigation requirement of about 450 mm (18 inches), it is estimated that water allocations are sufficient to support irrigation on about 227,442. Although there is no information on the mix of crops grown by private irrigators; AAFRD[3] has indicated that most private irrigation in Alberta is used to raise supplemental forages to feed livestock. Overall, it is estimated that allocations for irrigation in the Bow River Basin are sufficient to support about 827,000 acres of irrigation, of which 72 percent are in the three irrigation districts.

5.2.3.1 Water Allocation

Table 5-15 summarizes water licence information for district and private irrigation in the Bow River Basin. There are 16 district licences that allocate approximately 1.7 million dam^3, which represents about 86 percent of total allocation for irrigation in the Bow River Basin. All allocations for district irrigation are for surface water. The Bow Basin accounts for about 50 percent of total district allocation and about 25 percent of the district licences issued in the province. Table 5-15 also shows there are 173 private licences that allocate approximately 0.2 million dam^3, which represents about 14 percent of the total allocation for irrigation. The Bow River Basin accounts for about 40 percent of total private allocation in Alberta and about six percent of the private licences issued in the province. Overall, about 1.9 million dam^3 of water with 189 licences are issued for the basin.

A historical perspective on water used for irrigation is provided in Figure 5-9. The first licences for district irrigation were issued in the 1890s. Allocations for district irrigation have undergone sharp increases periodically followed by a period of relative stability, likely associated with the completion of major water storage projects. The most recent increase in allocation occurred between 1980 and 1990. Since 1990, the allocations for irrigation have remained virtually unchanged. The first allocations for private irrigation commenced in the 1930s, grew slightly until 1990, and have doubled since then, to about 277,000 dam^3 as of 2005.

[3] Cited in Watrecon (2005) as Personal communication, Wally Chinn, Head - Irrigation Development Section, Irrigation Branch, AAFRD, January 7, 2005.

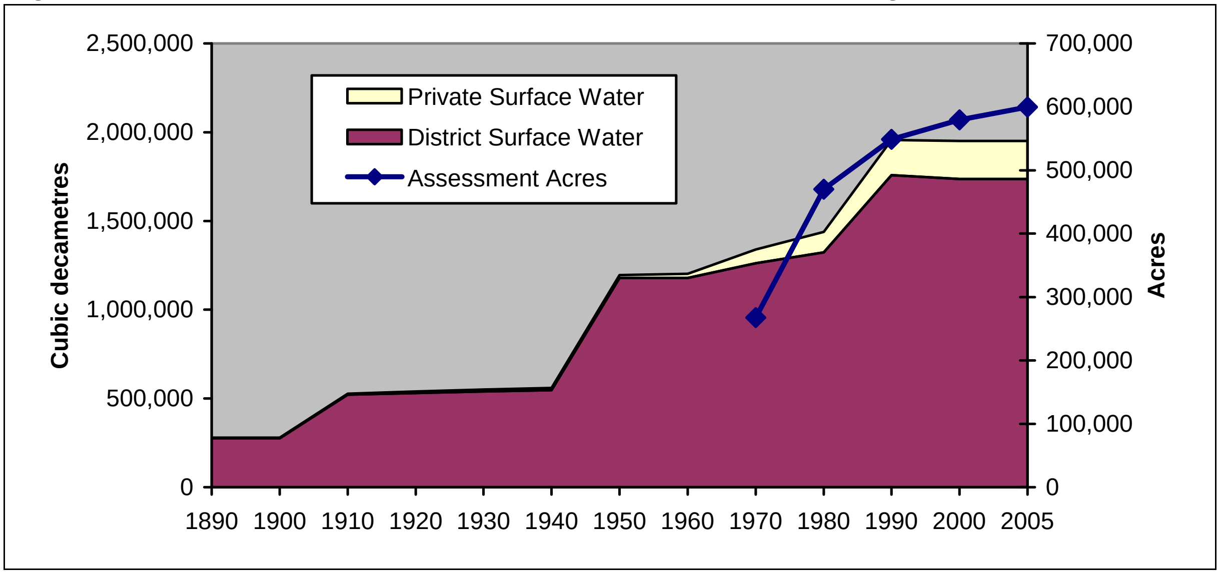
Table 5-14 District Irrigation Characteristics for the Bow River Basin

Irrigation District Name	Assessed Acres (2005)	Licensed Allocation (dam^3)	Average Diversion, 1976-2005		Percent of Licence Diverted (2005)	Crop Mix
			(dam^3)	Percent of Allocation		
Bow River	219,733	555,075	381,150	68.7%	41.0%	28% forage 36 % cereal 10% oil seeds 19% specialty crops
Eastern	283,706	939,927	704,303	74.9%	42.4%	58% forage 26% cereal 8% oil seeds 7% specialty crops
Western	96,415	197,853	163,895	82.8%	68.3%	60% forage; 29% cereals; 8% oilseeds
Total	**599,854**	**1,692,855**	**1,249,348**	**73.8%**	**45.0%**	

Table 5-15 Irrigation Allocations and Use and Reported Actual Water Use, Bow River Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
District irrigation	Surface	16	1,693,618.2	1,570,270.0	123,348.2	2	318,366.6
	Groundwater	0	0.0	0.0	0.0		
	Subtotal	**16**	**1,693,618.2**	**1,570,270.0**	**123,348.2**	**2**	**318,366.6**
Private irrigation	Surface	171	276,342.3	276,291.7	50.6	0	N/A
	Groundwater	2	249.2	249.2	0.0		
	Subtotal	**173**	**276,591.5**	**276,540.9**	**50.6**	**0**	**N/A**
Total	Surface	187	1,969,960.5	1,846,561.7	123,398.8	0	N/A
	Groundwater	2	249.2	249.2	0.0		
	Total	**189**	**1,970,209.6**	**1,846,810.9**	**123,398.8**	**2**	**318,366.6**

Figure 5-9 Historical Trends in Surface Water Allocation for Irrigation in the Bow Basin



5.2.3.2 Licensed Water Use

Table 5-15 shows that no return flow allowances have been included in any of the irrigation licences issued for groundwater, meaning that all withdrawals are assumed to be consumed or lost. Surface water licences include a return flow allowance of 123,399 dam^3; this represents six percent of allocations and means that the remainder (94 percent) of withdrawals are assumed to be consumed or lost.

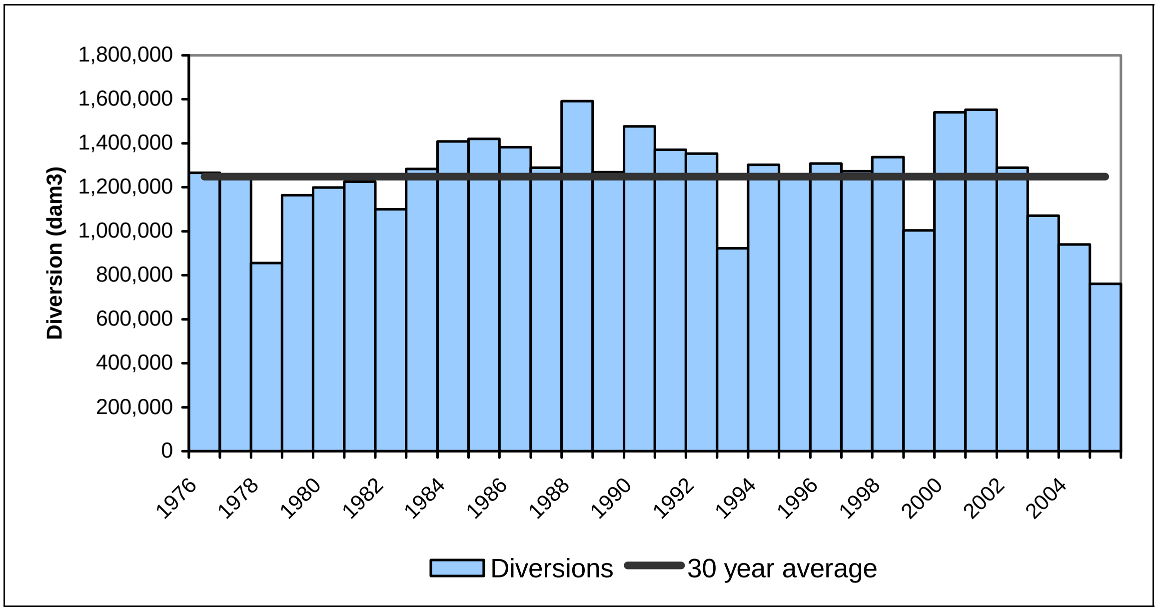
5.2.3.3 Actual Water Use

Actual water use by the irrigation districts varies considerably from year to year, depending on natural precipitation and crop water requirements. As noted in Table 5-14, about 45 percent of allocation was diverted in 2005, which was a wet year. Water diversions between 1976 and 2005 averaged about 1.25 million dam^3 which is 74 percent of the total allocation. Figure 5-10 shows that the peak diversion by the three irrigation districts in the Bow River Basin amounted to 1.5 million dam^3 and occurred in 2001. WURD only contains information on actual water use by two licences, and the reported withdrawals (318,367 dam^3) account for only 42 percent of the diversions for the three districts as reported by AAFRD.

For the private irrigation neither AAFRD nor AENV has any information on actual water use. However, a reasonable estimate of use can be made by assuming that private irrigators, on average divert the same proportion of the licensed volume as district irrigation over the 30 year period (74 percent). This assumption is based on the observation that both types of irrigators faced similar climatic conditions, and use water to grow a similar mix of crops. Thus, estimated diversion for private irrigation is assumed to be about 204,678 dam^3, which represents 74 percent of licensed water use as reported in Table 5-15 and includes the small requirements for return flows. It is noteworthy that actual water use for irrigation in the Basin is over 60 times

the amount of water used for livestock (8,000 dam^3).

Figure 5-10 Water Diversion for District Irrigation in the Bow Basin



5.2.3.4 <u>Forecasts of Future Irrigation Water Use</u>

Future water demand will be influenced by two major factors – livestock forage and specialty crops. With the expansion of livestock, additional demand for livestock forage is expected. The forage is grown by private irrigators as well as district irrigators. Information from AAFRD indicates that in 2005 about 46 percent of overall district irrigation crop mix is forages[4]; it is assumed that the district irrigation in the Bow Basin accounts for similar proportion. The historical trend provided in Figure 5-9 shows that water allocation for irrigation has increased over time, particularly for district irrigation, suggesting that past increases in livestock and acres for crop production have led to increased water demand for expansion in irrigated crop areas. The acres of specialty crops, which have higher water requirements than cereal crops, are also expected to increase. This change in crop mix was examined in the Irrigation Water Management Study Committee (2002), the results of which are noted below in Table 5-16.

For private irrigators, the ability to expand irrigated acres will be limited by the fact that the Bow Basin is “capped”, meaning no new applications for new surface water licences in the Bow River Basin are being accepted so the water required for increased forage production will have to be accommodated through existing allocations. However, based on information in the *1991 South Saskatchewan Basin Water Allocation Regulation*, there is some potential for increased water use by private irrigators. The *Regulation* identifies two projects - Blackfoot and Little Bow- that together have been allocated 46,256 dam^3. A third project identified in the Regulation (Keho)

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[4] Alberta Agriculture. 2006. Irrigation in Alberta: Facts and Figures for the Year 2005. Irrigation Branch, Irrigation Development Section, Alberta Agriculture, Food and Rural Development, Lethbridge.

has not yet been developed. Through discussions with Alberta Environment, it was determined that water allocations for the Blackfoot and Little Bow projects have already been issued so it was assumed that private irrigation allocation in Table 5-15 includes water available from these two projects. The allocation for the Keho project was undetermined. Therefore, private irrigation water use, using the assumption of 74 percent diversion of allocation and 100 percent consumption of diversion, is projected to remain unchanged at 204,640 dam^3 over the forecast period.

Table 5-16 shows the water demand for district irrigation based on three of the scenarios outlined by the Irrigation Water Management Study Committee (2002). Under these three scenarios, actual water use ranges from 0.8 to 1.0 million dam^3 with diversions ranging from 1.1 to 1.3 million dam^3. As shown in Figure 5-10, actual water demand will fluctuate from year to year, with higher rates of diversion occurring during dry years. For scenarios S1 and S9, return flow is estimated to decrease by 30 percent while gross diversion increases by about 14 percent. This trend suggests that, over time, actual water use will account for a higher percentage of diversions.

Although the Regulation capped the amount of acres, recent changes to the Irrigation Districts Act allow the districts to add more acres if approved by district members. This means that the number of acres being irrigated can be expanded within existing allocations through efficiency improvements and more effective water use, thereby resulting in lower return flows.

Table 5-16 Water Diversion, Consumption and Return Flow for District Irrigation in the Bow Basin.

Scenario	Irrigated Area (hectares)	Gross Diversion (dam^3)	Water Use (dam^3)	Return Flow (dam^3)	% Return flow
S1 – 1999 Conditions	221,526	1,165,466	801,116	364,350	31.3%
S3 - Expansion to 1991 Regulation Limits	239,170	1,267,601	968,638	298,963	23.6%
S9 - Expansion to 10 percent beyond Regulation Limits	263,086	1,304,907	1,028,667	276,240	21.2%

Overall water use for irrigation in the Bow Basin is provided in Table 5-17. It should be noted that the water use estimate for district irrigation is based on the water use data from Table 5-16 and not from Table 5-15. Similarly, the water use estimate for private irrigation is based on 74 percent diversion of licensed allocation, all of which is consumed. Water use for private irrigation is not expected to change in the district irrigation scenarios and surface water will account for about 100 percent of diversions. Given the associated capital costs, scenarios S3 and S9, are assumed not to occur before 2015. Under S1, water use is projected to be about 0.94 million dam^3 by 2025. Relative to S1 in 2005, water use is projected to be 10 percent higher for S3 and 18 percent higher for S9 by 2025.

Table 5-17 Projected Average Water Use for Irrigation in the Bow River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
S1 and private irrigation	Surface	1,005,609	1,005,609	1,005,609	1,005,609	1,005,609
	Groundwater	185	185	185	185	185
	Total	**1,005,794**	**1,005,794**	**1,005,794**	**1,005,794**	**1,005,794**
S3 and private irrigation	Surface	1,005,609	1,005,609	1,173,131	1,173,131	1,173,131
	Groundwater	185	185	185	185	185
	Total	**1,005,794**	**1,005,794**	**1,173,316**	**1,173,316**	**1,173,316**
S9 and private irrigation	Surface	1,005,609	1,005,609	1,233,160	1,233,160	1,233,160
	Groundwater	185	185	185	185	185
	Total	**1,005,794**	**1,005,794**	**1,233,345**	**1,233,345**	**1,233,345**

5.2.4 Summary

In summary, current agricultural water use in the Bow Basin is estimated to be about 1.0 million dam^3, almost 100 percent of which is for irrigation. Since the Basin is "capped" any future demand for water will have to be accommodated through more efficienct use of existing allocations. For stockwatering, existing allocations will meet High Growth water demand. For irrigation, particularly district irrigation, water allocation for all of the scenarios examined fall within the allocation limit prescribed under the Regulation (1.7 million dam^3).

A summary of future agricultural water demand is provided in Table 5-18. Agricultural water use in 2025 would be about 1.0 million dam^3 (virtually unchanged from 2005) under the Low Growth, S1 scenario. Under High Growth, S9 scenario, water use is projected to be 1.2 million dam^3 by 2025 (an increase of 20 percent from 2005).

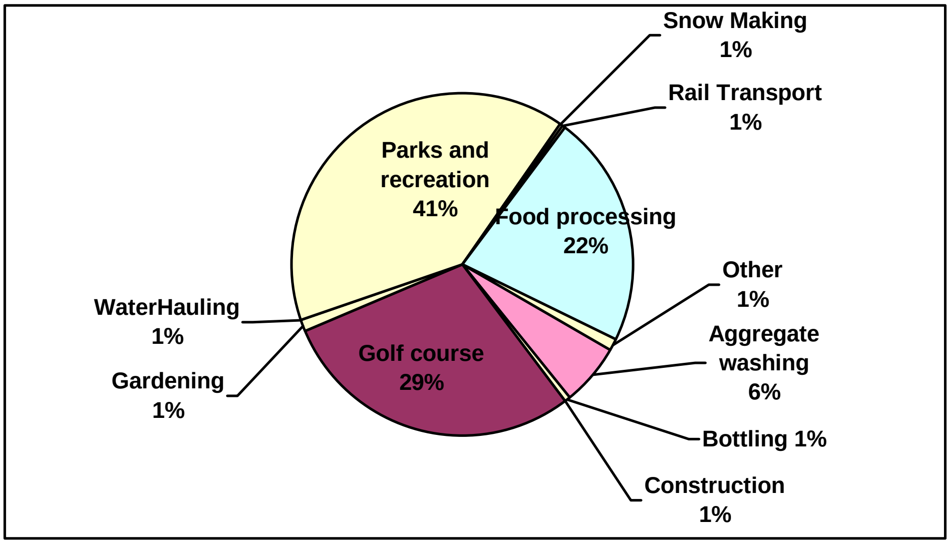
Table 5-18 Projected Water Use for Agriculture in the Bow River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth (livestock) S1 irrigation	Surface	1,011,540	1,011,905	1,012,292	1,012,702	1,013,138
	Groundwater	2,260	2,388	2,523	2,667	2,820
	Total	**1,013,800**	**1,014,293**	**1,014,815**	**1,015,369**	**1,015,958**
Medium Growth (livestock) S3 irrigation	Surface	1,011,540	1,012,222	1,180,504	1,181,352	1,182,297
	Groundwater	2,260	2,499	2,765	3,061	3,392
	Total	**1,013,800**	**1,014,721**	**1,183,269**	**1,184,413**	**1,185,689**
High Growth (livestock) S9 irrigation	Surface	1,011,540	1,012,552	1,241,287	1,242,673	1,244,296
	Groundwater	2,260	2,614	3,029	3,514	4,082
	Total	**1,013,800**	**1,015,166**	**1,244,316**	**1,246,187.4**	**1,248,378**

5.3 COMMERCIAL SECTOR

There are 272 licences that allow diversion of about 36,000 dam^3 of water in the Bow River Basin. As shown in Figure 5-11, the largest allocations are for parks and recreation, golf courses and food processing which, combined, account for about 90 percent of total allocation.

Figure 5-11 Water Allocation by Volume for Commercial Activities in the Bow Basin



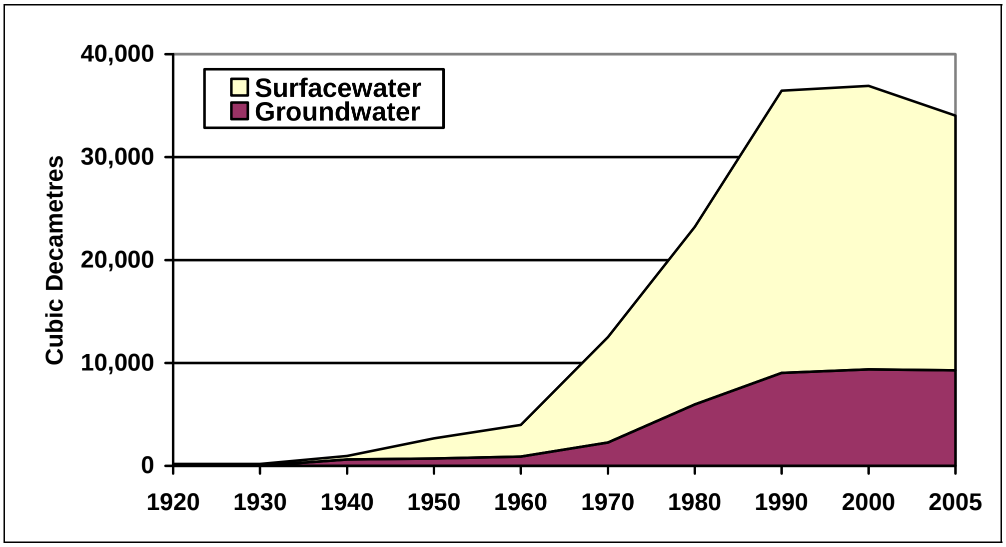
5.3.1 Water Allocation

As shown in Figure 5-11, the largest water use activities within the commercial sector include parks and recreation (123 licences with allocation of 14,290 dam^3), golf courses (64 licences with allocation of 10,378 dam^3), and food processing (11 licences with allocation of 7,764 dam^3).

Licences issued for the commercial sector allow maximum withdrawals of about 26,249 dam^3 of surface water (74 percent of allocations for the commercial sector). The largest allocation is for parks and recreation which accounts for about 35 percent of the total surface water allocation. Licences issued for the commercial sector allow maximum withdrawals of 9,399 dam^3 of groundwater (26 percent of allocation). The largest allocation is also for parks and recreation which accounts for about 50 percent of the total groundwater allocation.

A historical trend of commercial sector allocation in the Bow Basin is provided in Figure 5-12. The earliest allocation began in the 1920s and steadily increased, mostly from surface water allocations. The increases in surface water allocations through the 1960s to 1980s were due to golf course, parks and recreation and food processing activities. Since 2000 there has been a slight decrease in surface water allocations. Groundwater allocations increased from the 1960s but have remained relatively unchanged since 1990s. Since 2000, there has been a slight decrease in overall allocation.

Figure 5-12 Historical Trend in Commercial Sector Water Allocation in the Bow Basin



5.3.2 Licensed Water Use

Table 5-19 provides a summary of licensed water allocations, use and return for various activities within the commercial sector in the Bow Basin. Licences issued for commercial purposes assume that 31 percent of allocation be returned (10,905 dam^3) and 69 percent will be consumed or lost. Return flow allowances are higher for users of groundwater (40 percent) that for surface water (27 percent). Return flow allowances also vary from use to use. There are no return flows allowances for bottling, gardening and very small return flows for food processing. For surface water users, return flow allowances range from 10 percent for aggregate washing to 14 percent for golf courses to 64 percent for parks and recreation.

5.3.3 Actual Water Use

WURS contains actual water use reports for 2005 for only seven licences that accounted for 54 percent of total allocations for the commercial sector. Water use reports were provided by five of the 52 licences for golf courses, and the reported diversions for these five (15,065 dam^3 actually exceeded the total allocations for all golf courses by 66 percent. WURS contains reports for two of 11 food processing activities and reported withdrawals in 2005 accounted for 79 percent of licensed allocations for all food processing licences.

Given the lack of data to indicate otherwise, it is assumed that all licensees are withdrawing and using the full amounts of water to which they are entitled. While this assumption may overstate actual water use in the basin, the commercial sector accounts for 1.4 percent of total allocations so it will not appreciably affect overall water use estimate for the Bow Basin.

Table 5-19 Licensed Commercial Allocations and Reported Actual Water Use, Bow River Basin

Activity	Source	Number of Licences	Licensed Allocations and Use (dam^3)			Reported Actual water Use (dam^3)		
			Allocation	Water Use	Return	Licensees Reporting	Reported Use	Percent of Allocation
Aggregate washing	Surface	12	1,996	1,802	194	0	N/A	N/A
	Groundwater	4	85	85	0	0	N/A	N/A
	Subtotal	**16**	**2,081**	**1,887**	**194**	**0**	**N/A**	**N/A**
Bottling	Surface	0	0	0	0	0	N/A	N/A
	Groundwater	4	163	163	0	0	N/A	N/A
	Subtotal	**4**	**163**	**163**	**0**	**0**	**N/A**	**N/A**
Construction	Surface	0	0	0	0	0	N/A	N/A
	Groundwater	1	1	1	0	0	N/A	N/A
	Subtotal	**1**	**1**	**1**	**0**	**0**	**N/A**	**N/A**
Golf course	Surface	52	9,006	7,750	1,256	5	15,065	166 %
	Groundwater	12	1,372	1,372	0	0	N/A	N/A
	Subtotal	**64**	**10,378**	**10,378**	**0**	**5**	**15,065**	**166 %**
Gardening	Surface	13	250	250	0	0	N/A	N/A
	Groundwater	18	69	69	0	0	N/A	N/A
	Subtotal	**31**	**319**	**319**	**0**	**0**	**N/A**	**N/A**
Water hauling	Surface	0	0	0	0	0	N/A	N/A
	Groundwater	1	4	4	0	0	N/A	N/A
	Subtotal	**1**	**4**	**4**	**0**	**0**	**N/A**	**N/A**
Parks and recreation	Surface	51	9,491	3,797	5,694	0	N/A	N/A
	Groundwater	72	4,799	1,341	3,459	0	N/A	N/A
	Subtotal	**123**	**14,290**	**5,138**	**9,152**	**0**	**N/A**	**N/A**
Snow making	Surface	2	93	93	1	0	N/A	N/A
	Groundwater	0	0	0	0	0	N/A	N/A
	Subtotal	**2**	**93**	**93**	**1**	**0**	**N/A**	**N/A**
Rail/ transport	Surface	0	0	0	0	0	N/A	N/A
	Groundwater	2	139	28	112	0	N/A	N/A
	Subtotal	**2**	**139**	**28**	**112**	**0**	**N/A**	**N/A**

Table 5- 19 Licensed Commercial Allocations and Reported Actual Water Use, Bow River Basin (continued)

Activity	Source	Number of Licences	Licensed Allocations and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Licensees Reporting	Reported Use	Percent of Allocation
Food processing	Surface	4	5,253	5,253	0	2	4,132	78.8 %
	Groundwater	7	2,511	2,510	1	0	N/A	N/A
	Subtotal	**11**	**7,764**	**7,763**	**1**	**2**	**4,132**	**78.8 %**
Other	Surface	8	161	147	14	0	N/A	N/A
	Groundwater	9	255	78	177	0	N/A	N/A
	Subtotal	**17**	**416**	**225**	**191**	**0**	**N/A**	**N/A**
Total	Surface	142	26,249	19,092	7,157	7	19,197	73.3%
	Groundwater	130	9,399	5,650	3,748	0	N/A	N/A
	Total	**272**	**35,648**	**24,742**	**10,905**	**7**	**19,197**	**53.8%**

5.3.4 Forecasts of Future Water Use

Since most of the allocation (90 percent) is for three activities, parks and recreation, golf course and food processing, forecasts of future demand will focus on those activities. In assessing the future conditions, it is noted that the Bow is a "closed" Basin so new allocations are not being issued. Therefore, projections are meant to show future water demand conditions and not necessarily imply that these conditions will be met.

5.3.4.1 Parks and Recreation

There is no actual use information for parks and recreation activity therefore, actual use is assumed to equal licensed use. Projections are based on 0.4 percent annual growth (Low), 1.2 percent annual growth (Base) and 2.5 percent (High) annual growth rate and the resulting estimates of water use are shown in Table 5-20. The water use is projected to increase to 5,564 dam^3 by 2025, a 10 percent increase from current level under Low Growth. Under High Growth, water use is expected to increase to 5,613 dam^3 which is a 55 percent increase from current use.

Table 5-20 Forecast of Parks and Recreation Water Use in the Bow River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	3,797	3,873	3,951	4,031	4,112
	Groundwater	1,341	1,368	1,395	1,424	1,452
	Total	**5,138**	**5,241**	**5,347**	**5,455**	**5,565**
Medium Growth	Surface	3,797	4,030	4,278	4,541	4,820
	Groundwater	1,341	1,423	1,511	1,604	1,702
	Total	**5,138**	**5,453**	**5,789**	**6,144**	**6,522**
High Growth	Surface	3,797	4,296	4,860	5,499	6,222
	Groundwater	1,341	1,517	1,716	1,942	2,197
	Total	**5,138**	**5,813**	**6,577**	**7,441**	**8,419**

5.3.4.2 Golf Courses

The water demand forecast for golf courses employs the approach outlined in Watrecon (2005) which links water use to expansion of the golf courses which is tied to population growth rates. The forecasts assume that the proportion of surface and groundwater use will not change over the forecast period. The resulting projections are shown in Table 5-21. Under the High Growth water use is 42,290 dam^3 by 2025, which is 4.6 times the current use. Under Low Growth water use is 11,208 dam^3 by 2025, which is 23 percent higher than current use.

Table 5-21 Projected Water Use for Golf Course, Bow Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	7,750	8,546	9,016	9,342	9,522
	Groundwater	1,372	1,513	1,596	1,654	1,686
	Total	**9,122**	**10,059**	**10,613**	**10,996**	**11,208**
Medium Growth	Surface	7,750	10,375	12,804	15,032	17,015
	Groundwater	1,372	1,837	2,267	2,661	3,012
	Total	**9,122**	**12,212**	**15,071**	**17,693**	**20,027**
High Growth	Surface	7,750	14,724	21,928	29,045	35,930
	Groundwater	1,372	2,607	3,882	5,142	6,361
	Total	**9,122**	**17,330**	**25,810**	**34,187**	**42,290**

5.3.4.3 Food Processing

Despite information on actual water use for food processing in the WURS database, licensed use is assumed to equal actual use. The growth in water demand is projected based on 0.5, 1.5 and 2.5 percent annual growth in actual water use for the Low, Base and High Growth Cases. The resulting estimates are provided in Table 5-22. Water demand is expected to increase to 8,578 dam^3 by 2025 under Low Growth, which is a 11 percent increase from current use. Using High Growth, water demand is projected to increase to 12,720 dam^3 by 2025 which is an increase of 64 percent from the current water use.

Table 5-22 Forecast of Food Processing Water Use in Bow Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	5,253	5,386	5,522	5,662	5,804
	Groundwater	2,510	2,573	2,638	2,705	2,773
	Total	**7,763**	**7,959**	**8,160**	**8,366**	**8,577**
Medium Growth	Surface	5,253	5,659	6,097	6,568	7,076
	Groundwater	2,510	2,704	2,912	3,138	3,380
	Total	**7,763**	**8,363**	**9,009**	**9,705**	**10,456**
High Growth	Surface	5,253	5,944	6,725	7,609	8,608
	Groundwater	2,510	2,839	3,212	3,635	4,112
	Total	**7,763**	**8,783**	**9,937**	**11,243**	**12,720**

5.3.4.4 Summary

A summary of projected water demand for the commercial sector in the Bow Basin is provided in Table 5-23. This summary and projections are based on the water use estimates for the three activities listed above and assuming water use for the other activities remains constant over the forecast period. Under the Low Growth Scenario, water demand is projected to rise to 28,070 dam^3, a 13 percent increase from current levels by 2025. Under the High Growth Scenario, water demand is projected to rise to 66,149 dam^3 by 2025 which is about 2.7 times higher than current levels.

Table 5-23 Projected Water Demand for the Commercial Sector in the Bow Basin.
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	19,092	20,098	20,782	21,327	21,731
	Groundwater	5,650	5,882	6,057	6,210	6,339
	Total	**24,743**	**25,979**	**26,839**	**27,537**	**28,070**
Medium Growth	Surface	19,092	22,357	25,471	28,433	31,202
	Groundwater	5,650	6,391	7,118	7,830	8,522
	Total	**24,743**	**28,748**	**32,589**	**36,262**	**39,724**
High Growth	Surface	19,092	27,255	35,805	44,444	53,052
	Groundwater	5,650	7,391	9,239	11,146	13,098
	Total	**24,743**	**34,646**	**45,043**	**55,590**	**66,149**

5.4 PETROLEUM SECTOR

In the Bow River Basin there are 29 active licences which allocate 9,556 dam^3 of water to the petroleum sector. Petroleum licences account for almost five percent of total allocations in the basin. The majority of the water allocations for the petroleum sector (99 percent) are for surface water (9,414 dam^3). As shown in Figure 5-13, the petroleum sector includes water allocations for oilfield injection, gas and petrochemical plants, and other petroleum related activities.

Figure 5-13 Petroleum Water Allocation by Use in the Bow Basin

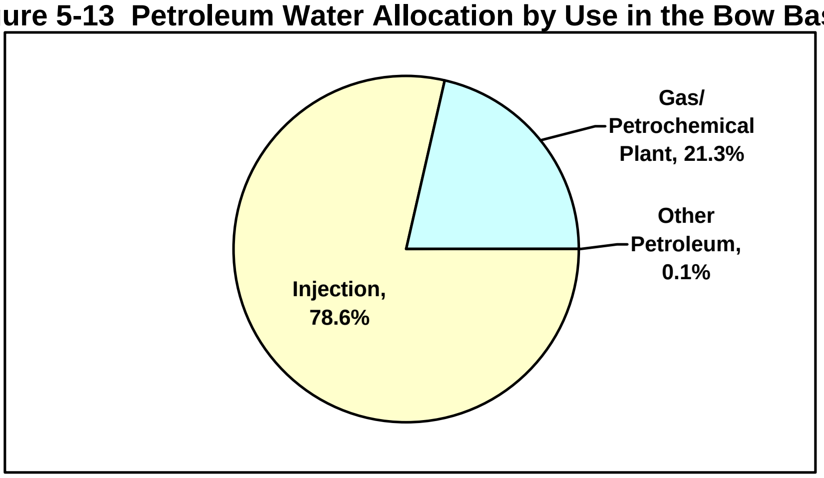


Figure 5-13 illustrates the water use by petroleum sector activities in the Bow Basin. Table 5-24 summarizes the water allocation, use, and return flow associated with the licences for each activity in the Bow Basin.

Table 5-24 Licensed Allocations for the Petroleum Sector and Estimated Water Use, Bow River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Injection	Surface	15	7,508.2	7,508.2	0.0	791.2	10.5%	10.5%
	Groundwater	1	1.2	1.2	0.0	97.9	7958.9%	7958.9%
	Subtotal	**16**	**7,509.4**	**7,509.4**	**0.0**	**889.1 ***	**11.8%**	**11.8%**
Gas/Petrochemical Plant	Surface	6	1,904.2	1,780.9	123.4	452.1	25.4%	23.7%
	Groundwater	5	128.3	128.3	0.0	54.1	42.2%	42.2%
	Subtotal	**11**	**2,032.5**	**1,909.2**	**123.4**	**506.2 ******	**26.5%**	**24.9%**
Other petroleum	Surface	1	1.2	1.2	0.0	1.2	100.0%	100.0%
	Groundwater	1	12.3	12.3	0.0	12.3	100.0%	100.0%
	Subtotal	**2**	**13.6**	**13.6**	**0.0**	**13.6 *******	**100.0%**	**100.0%**
Total	Surface	22	9,413.7	9,290.3	123.4	1,243.3	13.4%	13.2%
	Groundwater	7	141.8	141.8	0.0	152.0	107.2%	107.2%
	Subtotal	**29**	**9,555.5**	**9,432.1**	**123.4**	**1,395.3**	**14.8%**	**14.6%**

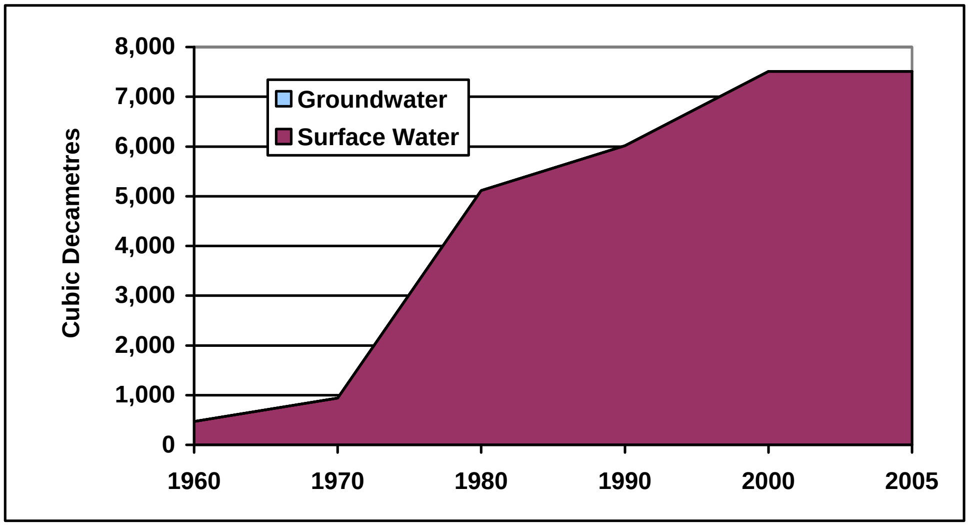
* EUB water use data provided by Geowa.
** Estimates based on WURS data.
*** Estimates assume 100 percent consumption of licensed use.

5.4.1 Injection

5.4.1.1 Water Allocations

About 79 percent of the allocations are for injection purposes for enhanced oil and gas recovery (7,509 dam^3). Almost all of these allocations are for surface water, with only 1.2 dam^3 from groundwater. Figure 5-14 shows the history of allocations for injection purposes in the Bow River Basin. It shows that water use for injection commenced in the 1960s, grew rapidly starting in the 1970s and has remained constant since 2000.

Figure 5-14 Historical Trends in Water Allocations for Injection



5.4.1.2 Licensed Water Use

As shown in Table 2-24, the licences issued for injection purposes assume that 100 percent of allocations will be used.

5.4.1.3 Actual Water Use

Detailed summary of reported water used for injection have been prepared by Geowa based on EUB data. In 2005, reports to the EUB recorder that 890 dam^3 of fresh water was diverted for injection purposes. This volume includes 790 dam^3 of surface water and 100 dam^3 of groundwater. While actual use of surface water amounted to only 11 percent of licensed use, reported groundwater use for injection purposes exceeded the total licensed groundwater by 96 dam^3. Based on the reported water use, injection activities in the Basin are currently diverting and using approximately 12 percent of their licensed allocations and use.

5.4.1.4 Forecasts of Future Water Use

The general trend in Alberta is for conventional crude oil production to decline as existing fields

mature and there are fewer new finds. The most recent forecast from the EUB and CAPP have oil production decreasing by between 30 and 38 percent between 2005 and 2015, and a further decline of about 23 percent by 2020. Oil production in the Bow Basin is expected to follow the overall Alberta production trend since most of the basin's production is from existing wells. The forecast of future water use for injection in the Bow Basin in Table 5-25 assumes declining rates of water use required that match the rates at which oil production in Alberta is expected to decline. No petroleum forecasts are available for 2010 and 2020, so for the purposes of this analysis it is assumed that production for these time periods is the same as the previous five years. Forecasts also assume that the current ratio of surface to groundwater consumption will remain the same.

Table 5-25 Forecast of Injection Water Use in the Bow Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
High Decline	Surface	791	791	464	464	277
	Groundwater	98	98	57	57	34
	Total	**889**	**889**	**521**	**521**	**311**
Medium Decline	Surface	791	791	488	488	291
	Groundwater	98	98	60	60	36
	Total	**889**	**889**	**548**	**548**	**327**
Low Decline	Surface	791	791	554	554	331
	Groundwater	98	98	69	69	41
	Total	**889**	**889**	**623**	**623**	**372**

Under the low decline scenario, water use for injection in 2025 will decline by 65 percent from current levels. Under the high decline scenario, the decline will be 58 percent.

5.4.2 Gas/Petrochemical Plants

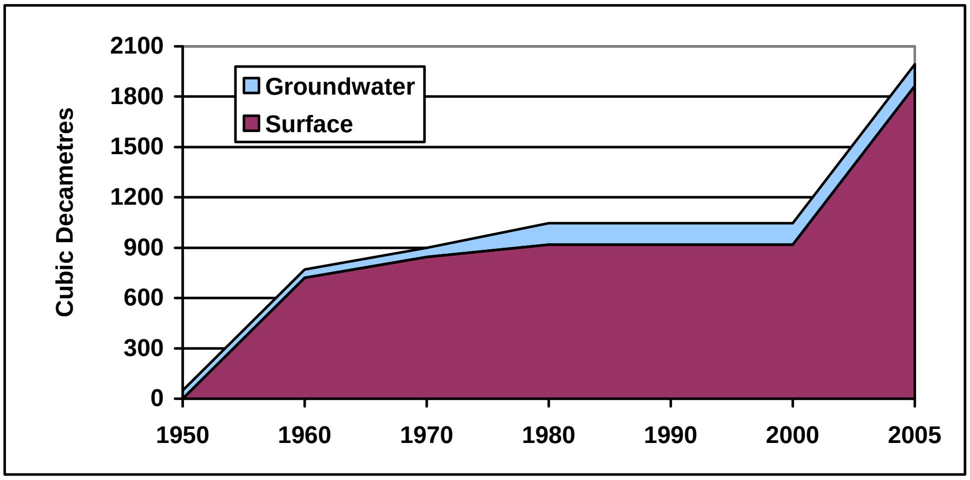
5.4.2.1 Water Allocations

About 21 percent of the allocations for the petroleum sector in the Bow Basin are for gas/petrochemical plants (2,033 dam^3). Five licences are for groundwater and allocate a small amount of water (128 dam^3). There are six surface water allocations and they allow maximum withdrawals of 1,904 dam^3. Figure 5-15 shows that allocations of surface water for gas/petrochemical plants commenced in the 1960s, remained relatively constant until 2000 and have almost doubled since then.

5.4.2.2 Licensed Water Use

As shown in Table 5-24, the licences issued to gas/petrochemical plants assume that 94 percent of surface water allocations and 100 percent of groundwater allocations will be consumed.

Figure 5-15 Historical Trends in Water Allocations for Gas/Petrochemical Plants



5.4.2.3 Actual Water Use

The WURS database has water use information for six of the 11 water licences issued for gas/petrochemical plants in the Bow River Basin. Licensees that submitted water use reports account for 95 percent of licensed allocations and licensed use. Analysis of the WURS database indicates that plants with surface water allocations reported using an average of 25 percent of the water that they are entitled to consume. Plants with groundwater allocations reported withdrawing and consuming 43 percent of the amounts specified in their licences. The water use estimates for gas/petrochemical plants were calculated assuming that these percentages apply to all gas/petrochemical plants in the Bow River Basin. Based on this assumption, the total water use by gas/petrochemical plants in 2005 is estimated to be 506 dam^3, consisting of 452 dam^3 of surface water and 54 dam^3 of groundwater.

5.4.2.4 Forecasts of Future Water Use

Applications for new surface water licences in the Bow, Oldman, and South Saskatchewan river basins are no longer being accepted. Consequently it is assumed that there will be no change in the amount of water allocated to the petroleum sector unless plants obtain water rights from other activities within the Basin or switch to groundwater. It is forecasted that gas and petrochemical plants will continue to use the same amount of water for the duration of the forecast period.

5.4.3 Other Petroleum Use

Two licences have been issued for other petroleum use. They allow withdrawals of up to 1.2 dam^3 of surface water and 12.3 dam^3 of groundwater. Licensees are expected to consume all the water they withdraw. There is no information on actual water diversions and consumption for these other petroleum uses and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this

component of the petroleum sector, it is assumed that water used by other petroleum activities in the Bow River Basin will remain constant for the forecast period.

5.4.4 Summary

The petroleum sector in the Bow Basin is dominated by water allocated for injection purposes. These activities account for 79 percent of allocations but 63 percent of actual water use in 2005. Water use data shows that although water licences allow up to 9,432 dam^3 of water to be consumed for petroleum purposes, licensees are only using 15 percent of this amount.

In the future, the amount of water used by the petroleum sector is expected to decline as the amount of water required for injection activities decreases. For gas and petrochemical plants and other petroleum use, it is assumed that their water use will remain the same over the forecast period. Forecasts also assume that the current ratio of surface to groundwater consumption will remain the same. The resulting forecasts of water use by the petroleum sector are provided in Table 5-26.

Table 5-26 Forecast of Water Use by Petroleum Activities in the Bow Basin
(dam^3)

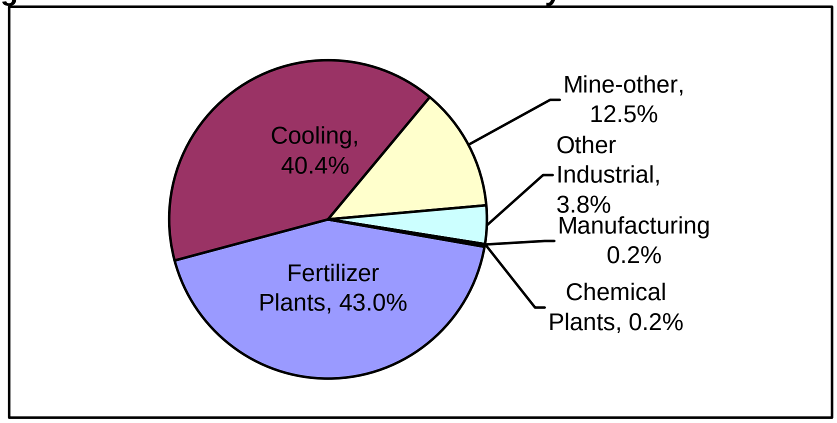
Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,243	1,243	916	916	729
	Groundwater	152	152	111	111	88
	Total	**1,395**	**1,395**	**1,027**	**1,027**	**817**
Medium Growth	Surface	1,243	1,243	940	940	743
	Groundwater	152	152	114	114	90
	Total	**1,395**	**1,395**	**1,054**	**1,054**	**833**
High Growth	Surface	1,243	1,243	1,006	1,006	783
	Groundwater	152	152	123	123	95
	Total	**1,395**	**1,395**	**1,129**	**1,129**	**878**

5.5 INDUSTRIAL SECTOR

In the Bow Basin there are 34 active licences which allocate 34,100 dam^3 of water to the industrial sector, 39 percent of which is required to be returned. Industrial water licences account for less than one percent of the total allocations in the basin. The majority (89 percent) of all water allocated is for surface water (30,312 dam^3).

As shown in Figure 5-16, the industrial sector includes water allocations for cooling, chemical plants, fertilizer plants, manufacturing, mining other than coal, hydroelectric, and other industrial activities.

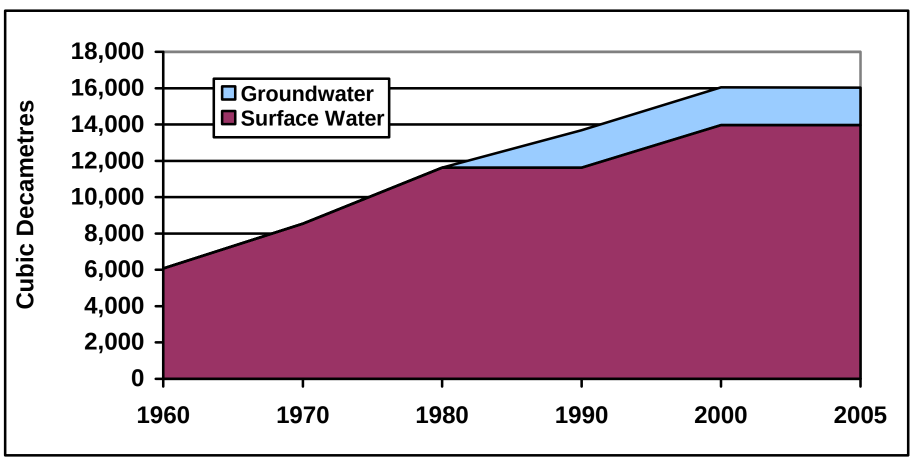
Figure 5-16 Industrial Water Allocation by Use in the Bow Basin



5.5.1 Cooling

Almost 41 percent of the allocations are for cooling purposes for thermal power generation or cooling such as air conditioning (13,772 dam^3). Details of the licences issued to the industrial sector in the Bow Basin are provided in Table 5-17. The table shows that 11 licences have been issued for cooling purposes, with nearly 45 percent of these for surface water. Six licences have been issued for groundwater (2,074 dam^3). Water use for cooling commenced in the 1960s and grew substantially over the years. Figure 5-17 shows that there has actually been sizeable increase in groundwater licences since the 1980s.

Figure 5-17 Historical Trends in Water Allocations for Cooling



As shown in Table 5-27, the licences issued for cooling purposes assume that 22 percent of surface water allocations and less than one percent of groundwater allocations will be used. Return flow allowances in licences amount to 9,141 dam^3 for surface water and 2,061 dam^3 for groundwater. There is no information on actual water diversions and consumption for the cooling sector and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is

assumed that water used by forestry activities in the Bow River Basin will remain constant for the forecast period.

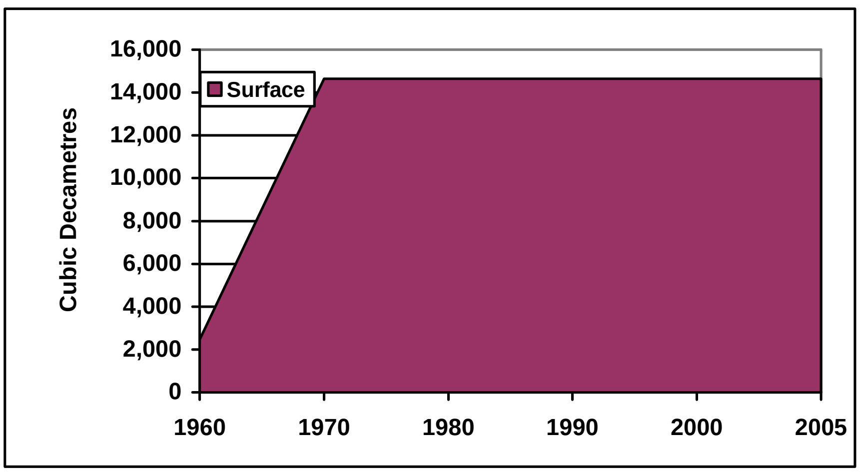
5.5.2 Chemical Plants

One licence has been issued for chemical plants in the Bow Basin allowing withdrawals of up to 58 dam^3 of groundwater. Chemical plant water allocation commenced in the 1980s and has remained the same since. Licensee is assumed to consume 100 percent of groundwater allocations. There is no information on actual water diversions and consumption for chemical plants and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by chemical plants in the Bow Basin will remain constant for the forecast period.

5.5.3 Fertilizer Plants

Almost 43 percent of the allocations for the industrial sector in the Bow Basin are for fertilizer plants (14,649 dam^3). This includes two surface water licences. Fertilizer plant water allocation commenced in the 1960s, increased rapidly in the 1970s, and has remained the same since.

Figure 5-18 Historical Trends in Water Allocations for Fertilizer Plants



As shown in Table 5-26, the licences issued to fertilizer plants include a return flow allowance of 247 dam^3 which represents less than two percent allocation. There is no information on actual water diversions and consumption for fertilizer plants and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by fertilizer plants in the Bow Basin will remain constant for the forecast period.

Table 5-27 Licensed Industrial Allocations and Estimated Water Use, Bow River Basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Cooling	Surface	5	11,697.8	2,556.4	9,141.3	2,556.4	100%	100%
	Groundwater	6	2,073.8	12.7	2,061.1	12.7	100%	100%
	Subtotal	**11**	**13,771.6**	**2,569.1**	**11,202.5**	**2,569.1**	**100%**	**100%**
Chemical Plants	Surface	0	0.0	0.0	0.0	0.0	100%	100%
	Groundwater	1	58.0	58.0	0.0	58.0	100%	100%
	Subtotal	**1**	**58.0**	**58.0**	**0.0**	**58.0**	**100%**	**100%**
Fertilizer Plants	Surface	2	14,648.8	14,402.1	246.7	14,402.1	100%	100%
	Groundwater	0	0.0	0.0	0.0	0.0	100%	100%
	Subtotal	**2**	**14,648.8**	**14,402.1**	**246.7**	**14,402.1**	**100%**	**100%**
Manufacturing	Surface	1	49.3	49.3	0.0	49.3	100%	100%
	Groundwater	2	21.0	21.0	0.0	21.0	100%	100%
	Subtotal	**3**	**70.3**	**70.3**	**0.0**	**70.3**	**100%**	**100%**
Mine-other	Surface	2	3,823.8	3,129.4	694.5	3,129.4	100%	100%
	Groundwater	4	424.8	424.8	0.0	424.8	100%	100%
	Subtotal	**6**	**4,248.6**	**3,554.2**	**694.5**	**3,554.2**	**100%**	**100%**
Hydro	Surface	5	0.1	0.1	0.0	0.1	100%	100%
	Groundwater	0	0.0	0.0	0.0	0.0	100%	100%
	Subtotal	**5**	**0.1**	**0.1**	**0.0**	**0.1**	**100%**	**100%**
Other Industrial	Surface	1	92.5	92.5	0.0	92.5	100%	100%
	Groundwater	5	1,210.4	178.8	1,031.6	178.8	100%	100%
	Subtotal	**6**	**1,303.0**	**271.3**	**1,031.6**	**271.3**	**100%**	**100%**
Total	Surface	16	30,312.0	20,230.0	10,082.0	20,230.0	100%	100%
	Groundwater	18	3,788.0	695.0	3,093.0	695.0	100%	100%
	Total	**34**	**34,100.0**	**20,925.0**	**13,175.0**	**20,925.0**	**100%**	**100%**

5.5.4 Manufacturing

Three licences has been issued for manufacturing activities in the Bow River Basin allowing withdrawals of up to 21 dam^3 of groundwater and 49 dam^3 of surface water. Manufacturing water allocation commenced in the 1970s and has remained the same since for surface water. Groundwater allocations commenced in the 1970s, grew in the 1980s, and have remained the same since. Licensees are expected to consume 100 percent of the water they are allocated. There is no information on actual water diversions and consumption for manufacturing and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by manufacturing in the Bow Basin will remain constant for the forecast period.

5.5.5 Mining Other Than Coal

Almost 13 percent of the allocations for the industrial sector in the Bow Basin are for mining other than coal (4,249 dam^3). This includes two surface water licences (3,824 dam^3) and four groundwater licences (425 dam^3). Mining other than coal water allocation commenced in the 1900s and have remained the same since for surface water. Groundwater allocations commenced in the 1980s, increased slightly in the 1990s, and have remained the same since. There is no information on actual water diversions and consumption for mining other than coal and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by mining other than in the Bow Basin will remain constant for the forecast period.

5.5.6 Hydroelectricity

Five licences have been issued for hydroelectricity (hydro) use. They allow withdrawals of up to 0.1 dam^3 of surface water and no groundwater. Hydro water allocations commenced in the 1920s, increased slightly over time. Licensees are assumed to consume 100 percent of the surface water they are allocated. There is no information on actual water diversions and consumption for the hydro sector and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by hydro activities in the Bow Basin will remain constant for the forecast period.

5.5.7 Other Industrial

Six licences have been issued for other industrial purposes. They allow withdrawals of up to 93 dam^3 of surface water and 1,210 dam^3 groundwater. Other industrial water allocations commenced in the 1970s and remained the same since for surface water. Groundwater licences commenced in the 1980s and increased slightly over time. Licensees are assumed to consume 100 percent of surface water and 15 percent of groundwater allocations. There is no information on actual water diversions and consumption for the other industrial activities and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water

used by other industrial activities in the Bow Basin will remain constant for the forecast period.

5.5.8 Summary

The industrial sector in the Bow Basin is dominated by water allocated for fertilizer plants and cooling activities. Fertilizer plants account for 43 percent of allocations and 69 percent of estimated water use in 2005.

Applications for new water licences are not longer being accepted in the Bow, Oldman, and South Saskatchewan river basins. As no new surface water licences can be issued for these basins it is assumed that there will be no change in the amount of water allocated to the industrial sector unless they acquire water rights from other users in the Basin or switch to groundwater. The sector is assumed to be using the full capacity of their licences (Table 5-28). Forecasts assume that the current use will continue for the forecasted period.

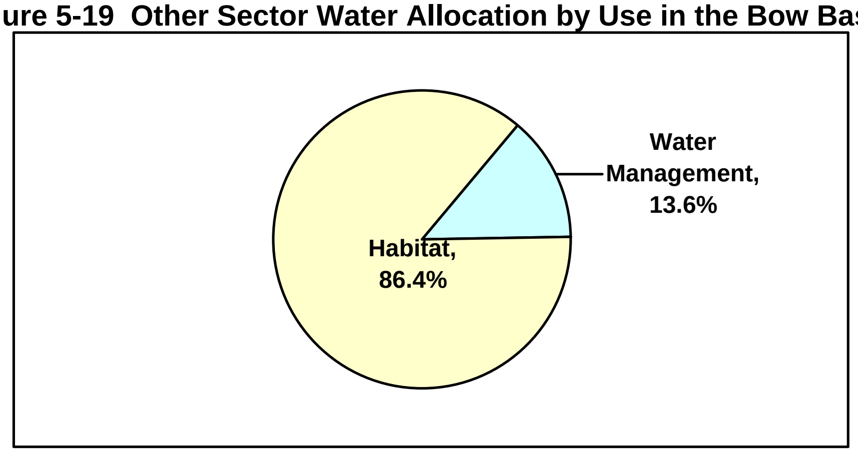
Table 5-28 Forecast of Industrial Water Use in the Bow Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Medium	Surface	20,230	20,230	20,230	20,230	20,230
	Groundwater	695	695	695	695	695
	Total	**20,925**	**20,925**	**20,925**	**20,925**	**20,925**

5.6 OTHER SECTOR

In the Bow Basin there are 88 active licences which allocate 30,666 dam^3 of water to the other sector, 91 percent of which is required to be returned. Other sector activities account for about one percent of licensed water use in the Bow Basin.

Figure 5-19 Other Sector Water Allocation by Use in the Bow Basin.



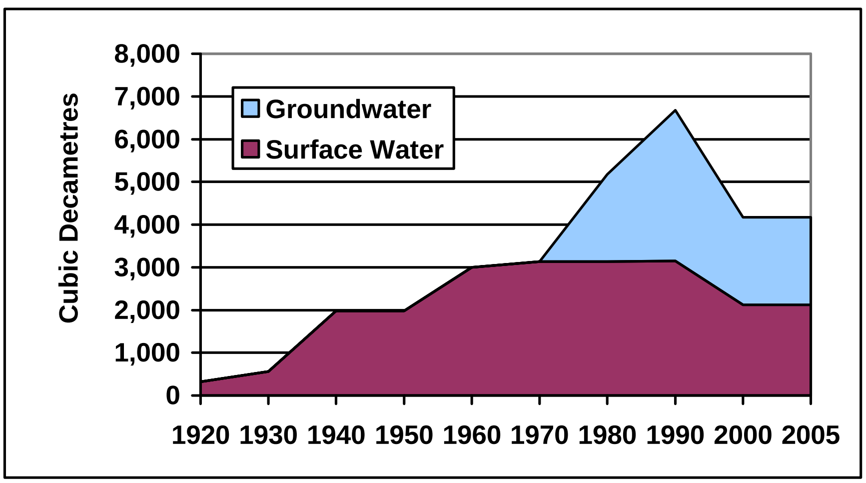
The majority (75 percent) of all water allocated is for surface water (22,945 dam^3) accounting for 82 percent of the other licences. Other sector uses include water management for flood control

and lake stabilization, and fish, wildlife and habitat enhancement (Figure 5-20). Table 5-29 summarizes the water allocation, use, and return flows associated with the licences for each activity in the Bow Basin.

5.6.1 Water Management

About 14 percent of the allocations are for water management purposes such flood control and lake stabilization (4,169 dam^3). Details of the licences issued to the other sector in the Bow Basin are provided in Table 9-29. The table shows that 88 licences have been issued for water management purposes, with just over 88 percent of these for surface water. Two licences have been issued for groundwater, with total allocations of 2,045 dam^3. Surface water use for water management commenced in the 1920s and increased slightly in the 1940s and the 1960s. However, since the 1990s there has been a decline in the amount of surface water allocated to water management. As illustrated in Figure 5-20, groundwater allocations commenced in the 1980s, grew in 1990s and has also declined since 1990.

Figure 5-20 Historical Trends in Water Allocations for Water Management



As shown in Table 5-29, licences issued for water management purposes assume that 45 percent of surface water allocations and five percent of groundwater allocations will be used. Return flow allowances in licences amounted to 1,172 dam^3 for surface water and 1,934 dam^3 for groundwater. There is no information on actual water diversions and consumption for water management activities and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the other sector, it is assumed that water used for water management in the Bow River Basin will remain constant over the forecast period.

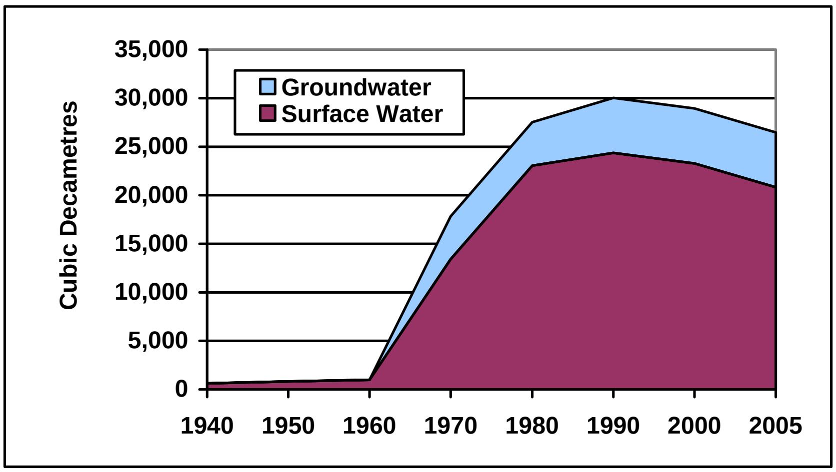
Table 5-29 Licensed Allocations and Estimated Water Use for the Other Sector, Bow River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Allocation	Percent of Allocation
Water Management	Surface	15	2,124.1	952.3	1,171.8	952.3	100%	44.8%
	Groundwater	2	2,044.5	111.0	1,933.5	111.0	100%	5.4%
	Subtotal	**17**	**4,168.6**	**1,063.3**	**3,105.3**	**1,063.3**	**100%**	**25.5%**
Habitat	Surface	55	20,817.3	1,786.3	19,031.0	1,786.3	100%	8.6%
	Groundwater	14	5,676.3	58.7	5,617.6	58.7	100%	1.0%
	Subtotal	**69**	**26,493.6**	**1,845.0**	**24,648.6**	**1,845.0**	**100%**	**7.0%**
Specified	Surface	2	3.4	3.4	0.0	3.4	100%	100.0%
	Groundwater	0	0.0	0.0	0.0	0		
	Subtotal	**2**	**3.4**	**3.4**	**0.0**	**3.4**	**100%**	**100.0%**
Total	Surface	72	22,944.8	2,742.0	20,202.8	2,742.0	100%	12.0%
	Groundwater	16	7,720.8	169.7	7,551.1	169.7	100%	2.2%
	Total	**88**	**30,665.6**	**2,911.7**	**27,753.9**	**2,911.7**	**100%**	**9.5%**

5.6.2 Habitat

About 86 percent of the allocations for the other sector are are for fish, wildlife and habitat enhancement (26,494 dam^3). Details of the licences issued to the other sector in Alberta are provided in Table 5-29. The table shows that 88 licences have been issued for habitat projects, with nearly 80 percent of these for surface water. Fourteen licences have been issued for groundwater, with allocations totalling 5,676 dam^3. Surface water use for habitat commenced in the 1940s but grew rapidly from the 1970s to the 1990s. Figure 5-21 shows that there has actually been a slight decline in licensed allocations for surface water since the 1990s. Groundwater use for habitat commenced in the 1970s, grew rapidly between the 1950s and the 1990s, but has remained the same since.

Figure 5-21 Historical Trends in Water Allocations for Habitat Enhancement



As shown in Table 5-29, the licences issued for habitat enhancement purposes assume nine percent of surface water allocations and one percent of groundwater allocations will be used. Return flow allowance in licences amounted to 19,031 dam^3 for surface water and 5,618 dam^3 for groundwater. There is no information on actual water diversions and consumption for habitat enhancement activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement and will continue to do so for the duration of the forecast period.

5.6.3 Summary

The other sector in the Bow is dominated by water allocated for habitat enhancement. These projects account for 86 percent of licensed allocation and 68 percent of the licensed water use. In the absence of information about the other sector, it is assumed that water used for these projects in the Bow Basin will remain constant for the forecast period.

5.7 SUMMARY

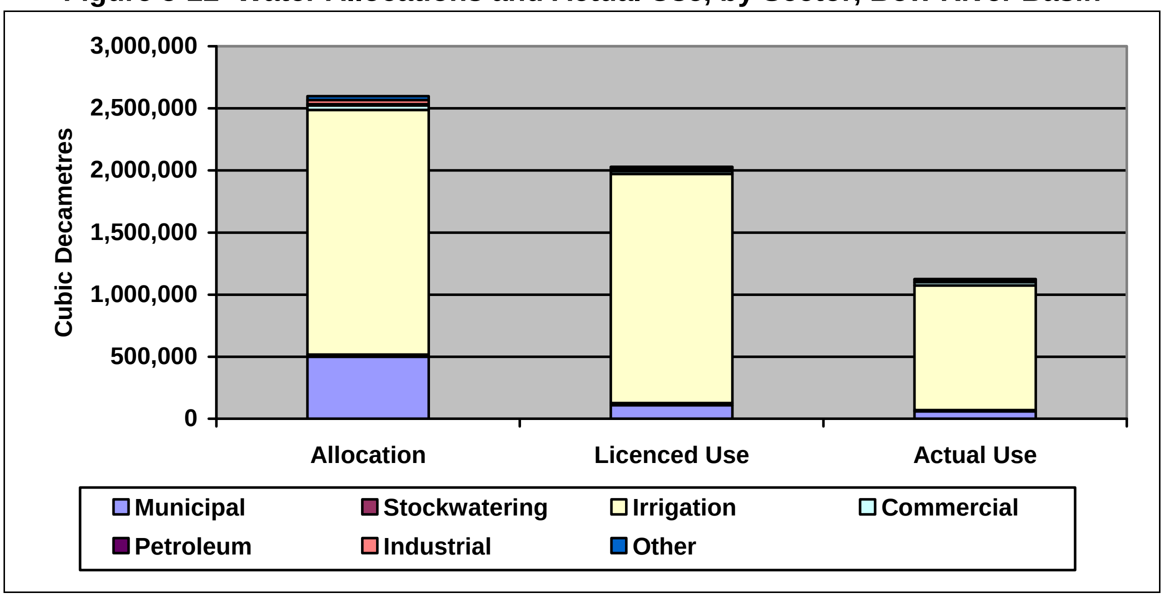
Table 5-30 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the Bow River Basin. In total, existing licence and registrations allow a

maximum of 2,597,894 dam^3 of water to be withdrawn for use. Of this, up to 2,030,257 dam^3 (78 percent) can be used and 567,636 dam^3 (22 percent) is to be returned to surface water.

Water allocations for the agricultural sector, specifically irrigation, are by far the largest in the Bow River Basin (77 percent of total). Irrigation accounts for 76 percent of allocations, 91 percent of licensed use, and 89 percent of actual use. Existing licences assume that 78 percent of water that is withdrawn will be consumed or lost, with 22 percent being returned to a surface water body.

With respect to actual use, the exact volumes withdrawn and used in 2005 are not precisely known because not all major water users filed few water use reports with Alberta Environment. However, based on the information and assumptions used in the previous sections, it is estimated that 1,124,097 dam^3 were actually used in 2005. This represents 55 percent of water use allowed in existing licences and registrations. Figure 5-22 shows how actual use compares to licensed allocations and use for each of the water use sectors.

Figure 5-22 Water Allocations and Actual Use, by Sector, Bow River Basin



Forecasts of future water use in the Bow River Basin are provided in Tables 5-31 to 5-33 for the Low, Medium and High growth scenarios. Predicted water use under the Medium growth scenario is shown in Figure 5-23. This figure shows that most of the growth in water use will occur in the agricultural sector, with water used for stockwatering and irrigation accounting for 89 percent of total water use by 2025. Under the medium scenario, water demand in 2025 will be about 18 percent higher than at present. For the other scenarios, the increase in water demand over 20 years will range from 1.0 percent for low growth and 26.7 percent for high growth. For all scenarios, actual water use will be less than the amount that can be consumed under the terms of existing licences.

Figure 5-23 Forecast Water Use in the Bow River Basin: Medium Scenario

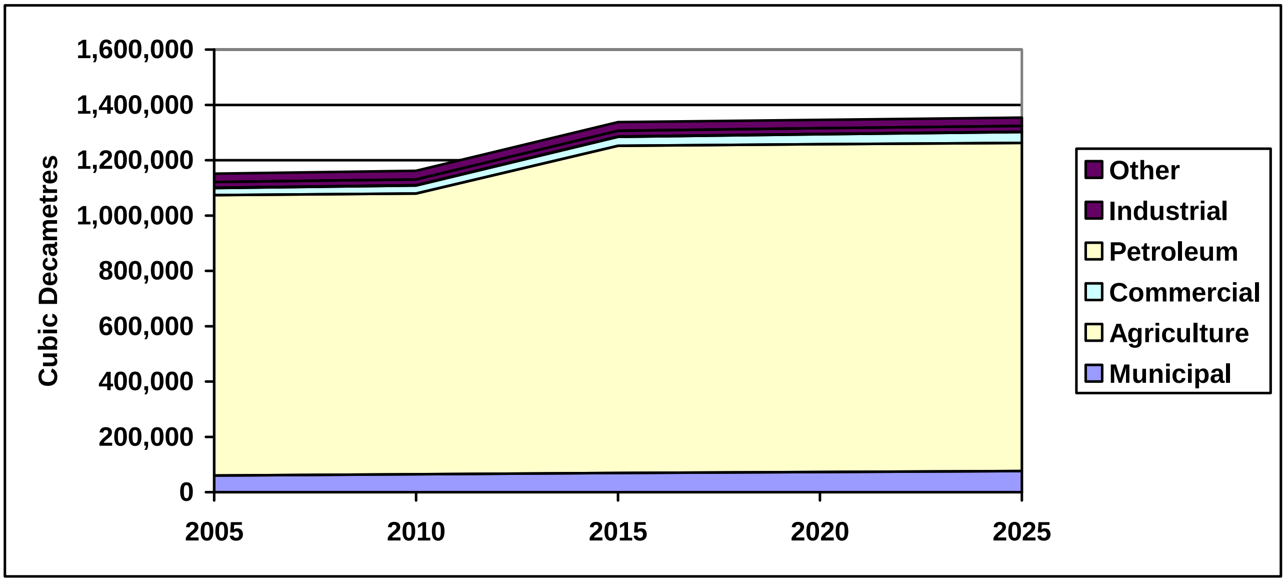


Table 5-30 Summary of Allocations and Estimated Water Use, Bow River Basin

Sector		Licensed Allocation and Use (dam^3)				Estimated Water Use (dam^3)		
		Allocation	Water Use	Return	Percent of Total Use	Use	Percent of Licensed use	Percent of Total Use
Municipal		500,472	109,303	391,170	5%	60,321	55%	5%
Agricultural	Stockwatering	17,243	16,133	1,110	1%	8,007	50%	1%
	Irrigation	1,970,210	1,846,811	123,399	91%	1,005,794	54%	89%
Commercial		35,648	24,742	10,905	1%	24,743	100%	2%
Petroleum		9,556	9,432	123	0%	1,395	15%	0%
Industrial		34,100	20,925	13,175	1%	20,925	100%	2%
Other		30,666	2,912	27,754	0%	2,912	100%	0%
Total		**2,597,894**	**2,030,257**	**567,636**	**100%**	**1,124,097**	**55%**	**100%**

Table 5-31 Forecast Water Use, By Sector, Bow River Basin: Low Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	58,881	61,612	63,224	64,342	64,958
	Agricultural	1,011,540	1,011,905	1,012,292	1,012,702	1,013,138
	Commercial	19,092	20,098	20,782	21,327	21,731
	Petroleum	1,243	1,243	916	916	729
	Industrial	20,230	20,230	20,230	20,230	20,230
	Other	22,945	22,945	22,945	22,945	22,945
	Total	1,133,931	1,138,033	1,140,389	1,142,462	1,143,731
Groundwater	Municipal	1,440	1,507	1,546	1,574	1,589
	Agricultural	2,260	2,388	2,523	2,667	2,820
	Commercial	5,650	5,882	6,057	6,210	6,339
	Petroleum	152	152	111	111	88
	Industrial	695	695	695	695	695
	Other	7,721	7,721	7,721	7,721	7,721
	Total	17,918	18,345	18,653	18,978	19,252
Total	Municipal	60,321	63,119	64,770	65,916	66,547
	Agricultural	1,013,800	1,014,293	1,014,815	1,015,369	1,015,958
	Commercial	24,742	25,980	26,839	27,537	28,070
	Petroleum	1,395	1,395	1,027	1,027	817
	Industrial	20,925	20,925	20,925	20,925	20,925
	Other	30,666	30,666	30,666	30,666	30,666
	Total	1,151,849	1,156,378	1,159,042	1,161,440	1,162,983

Table 5-32 Forecast Water Use, By Sector, Bow River Basin: Medium Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	58,881	63,342	67,470	71,255	74,624
	Agricultural	1,011,540	1,012,222	1,180,504	1,181,352	1,182,297
	Commercial	19,092	22,357	25,471	28,433	31,202
	Petroleum	1,243	1,243	940	940	743
	Industrial	20,230	20,230	20,230	20,230	20,230
	Other	22,945	22,945	22,945	22,945	22,945
	Total	1,133,931	1,142,339	1,317,560	1,325,155	1,332,041
Groundwater	Municipal	1,440	1,549	1,650	1,743	1,825
	Agricultural	2,260	2,499	2,765	3,061	3,392
	Commercial	5,650	6,391	7,118	7,830	8,522
	Petroleum	152	152	114	114	90
	Industrial	695	695	695	695	695
	Other	7,721	7,721	7,721	7,721	7,721
	Total	17,918	19,007	20,063	21,164	22,245
Total	Municipal	60,321	64,891	69,120	72,998	76,449
	Agricultural	1,013,800	1,014,721	1,183,269	1,184,413	1,185,689
	Commercial	24,742	28,748	32,589	36,263	39,724
	Petroleum	1,395	1,395	1,054	1,054	833
	Industrial	20,925	20,925	20,925	20,925	20,925
	Other	30,666	30,666	30,666	30,666	30,666
	Total	1,151,849	1,161,346	1,337,623	1,346,319	1,354,286

Table 5-33 Forecast Water Use, By Sector, Bow River Basin: High Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	58,881	66,668	74,712	82,658	90,346
	Agricultural	1,011,540	1,012,552	1,241,287	1,242,673	1,244,296
	Commercial	19,092	27,255	35,805	44,444	53,052
	Petroleum	1,243	1,243	1,006	1,006	783
	Industrial	20,230	20,230	20,230	20,230	20,230
	Other	22,945	22,945	22,945	22,945	22,945
	Total	1,133,931	1,150,893	1,395,985	1,413,956	1,431,652
Groundwater	Municipal	1,440	1,630	1,827	2,022	2,210
	Agricultural	2,260	2,614	3,029	3,514	4,082
	Commercial	5,650	7,391	9,239	11,146	13,098
	Petroleum	152	152	123	123	95
	Industrial	695	695	695	695	695
	Other	7,721	7,721	7,721	7,721	7,721
	Total	17,918	20,203	22,634	25,221	27,901
Total	Municipal	60,321	68,298	76,539	84,680	92,556
	Agricultural	1,013,800	1,015,166	1,244,316	1,246,187	1,248,378
	Commercial	24,742	34,646	45,044	55,590	66,150
	Petroleum	1,395	1,395	1,129	1,129	878
	Industrial	20,925	20,925	20,925	20,925	20,925
	Other	30,666	30,666	30,666	30,666	30,666
	Total	1,151,849	1,171,096	1,418,619	1,439,177	1,459,553

South Saskatchewan River Basin

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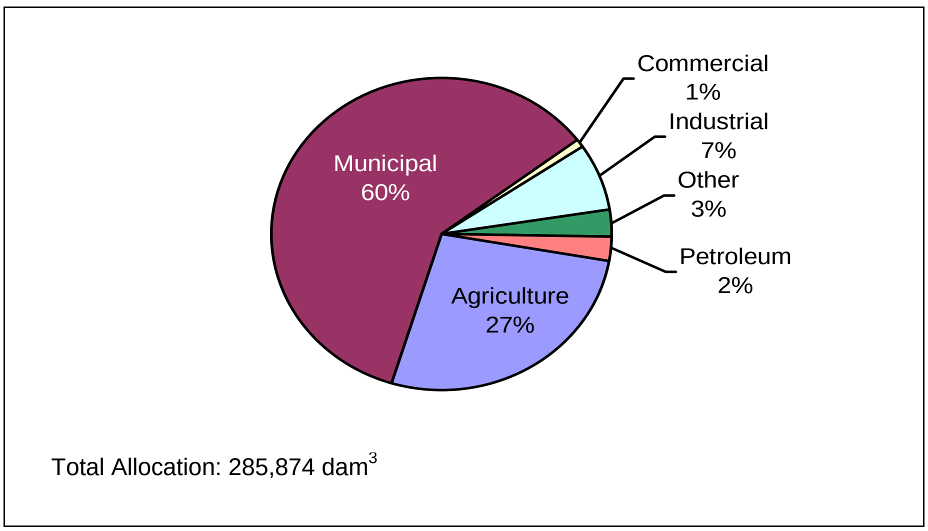
6.0 SOUTH SASKATCHEWAN RIVER BASIN

The South Saskatchewan River Basin is about 14,000 km^2 in area and occupies approximately two percent of Alberta by area. The Basin starts below the confluence of the Bow and Oldman rivers and drains the area east to the Alberta- Saskatchewan border. In 2001 the Basin had a population of 65,451 people, which translates into about 4.7 people per square kilometre. The South Saskatchewan River Basin is comprised of all or parts of Cypress County, the counties of Forty Mile No. 8 and Warner No. 5, the municipality districts of Taber and Acadia No. 34, and Special Areas (2, 3, and 4). Major population centres include the City of Medicine Hat, the towns of Redcliff and Bow Island, and the Village or Foremost. Parts of Canadian Forces Base Suffield are situated in the basin.

An overview of current surface and groundwater water allocations in the Basin is provided in Figure 6-1. It shows that the majority of allocations are for municipal purposes (60 percent), with agriculture accounting for 27 percent, seven percent for industry, and less than three percent of each of the other major water use sectors. Total allocations as of 2005 amounted to 285,874 dam^3.

Figure 6-1 Distribution of Active Water Allocations in the South Saskatchewan Basin, 2005



Figures 6-2 and 6-3 show the location, allocation and sector of all active surface and groundwater licences in the South Saskatchewan River Basin. Figure 6-4 shows the location of registrations issued for the basin.

6.1 MUNICIPAL AND RESIDENTIAL SECTOR

6.1.1 Population

The population living in the South Saskatchewan River Basin is predominantly urban, with about 88 percent living in City of Medicine Hat (51,249 residents), the Town of Redcliff (4,372) and the Town of Bow Island (1,704), and the Village of Foremost (531). As shown in Table 6-1, the other 12 percent of the population were rural residents primarily living in Cypress County (4,643 residents) and the County of Forty Mile No. 8 (1,929). Compared to other parts of Alberta, the population in the South Saskatchewan River Basin is growing fairly slowly. Between 1996 and 2001, the population of the Basin increase by 8.3 percent or 1.6 percent per year. The population growth rate in the urban areas was more than double the growth rate for the rural population.

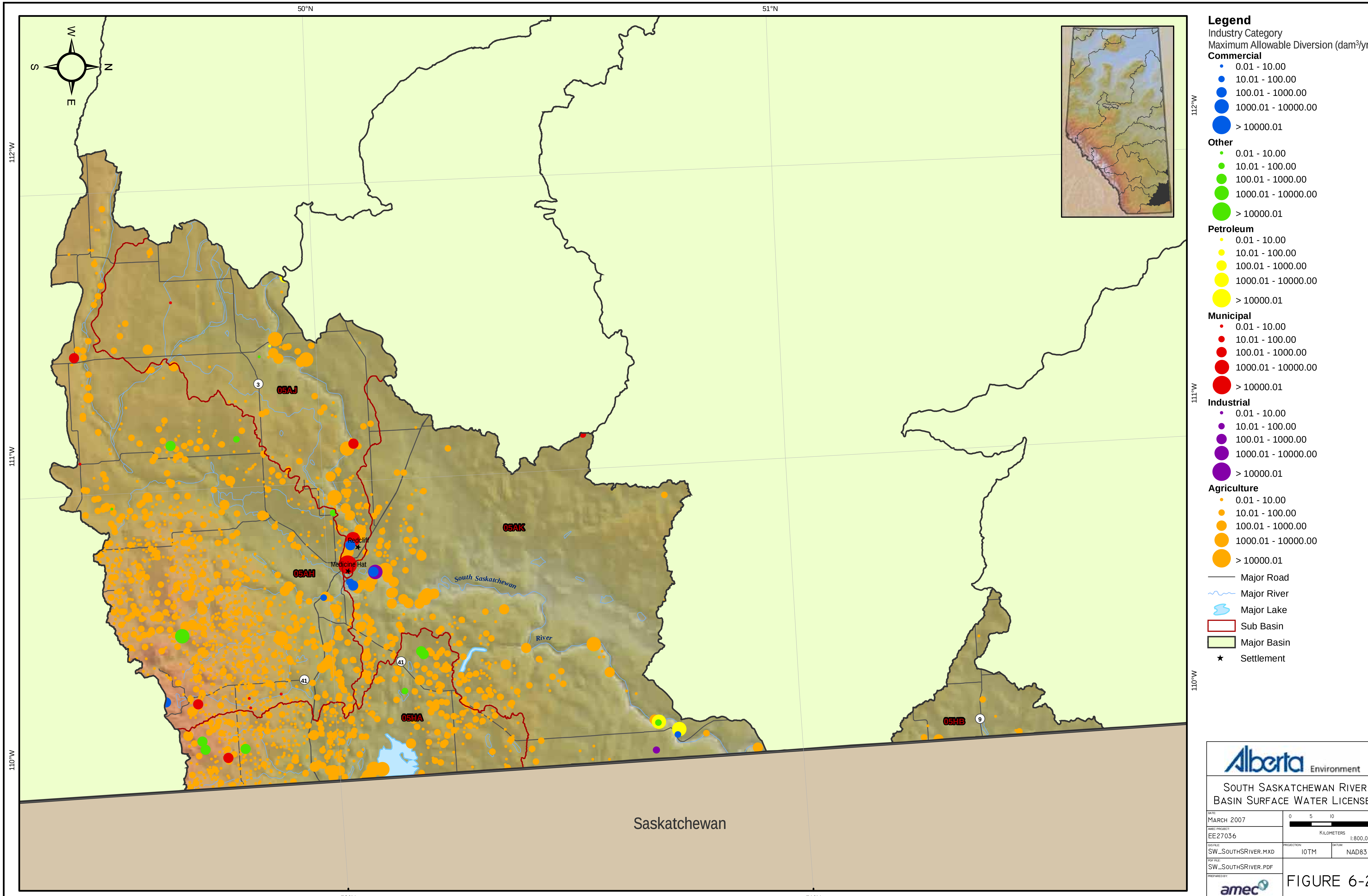
Table 6-1 Population Distribution and Growth in South Saskatchewan River Basin, 2001

	2001		1996	1996 to 2001 Population Change
	Population	**Percent**	**Population**	**Percent**
Urban Municipality	57,856	88.4%	53,131	8.9%
Rural or Regional Municipality	7,595	11.6%	7,312	3.9%
First Nations and Métis Settlements	0	0.0%	0	0.0%
Total	**65,451**	**100%**	**60,443**	8.3%

Table 6-2 lists all the municipalities located in the South Saskatchewan River Basin, their estimated 2001 population, and a summary of water licence information for those communities that have water licences for 100 dam^3 or more.

6.1.2 Water Allocations

As of 2005, there were 77 active municipal water licences for 33 licensees in the South Saskatchewan River Basin. These licences allow up to 169,613 dam^3 to be diverted for municipal purposes, and this represents 60 percent of all licensed water allocations in the basin. Urban users account for 99 percent of this allocation while the other one percent has been allocated to rural users (cooperatives, farmsteads, single-multi homes and Hutterite colonies).



Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Petroleum
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Municipal
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Industrial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Agriculture
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
05AJ
05AK
05AH
05HA
05HB
Redcliff
Medicine Hat
South Saskatchewan River
Saskatchewan
50°N
51°N
112°W
111°W
110°W
Alberta Environment
South Saskatchewan River Basin Surface Water Licenses
March 2007
EE27036
SW_SouthSRiver.mxd
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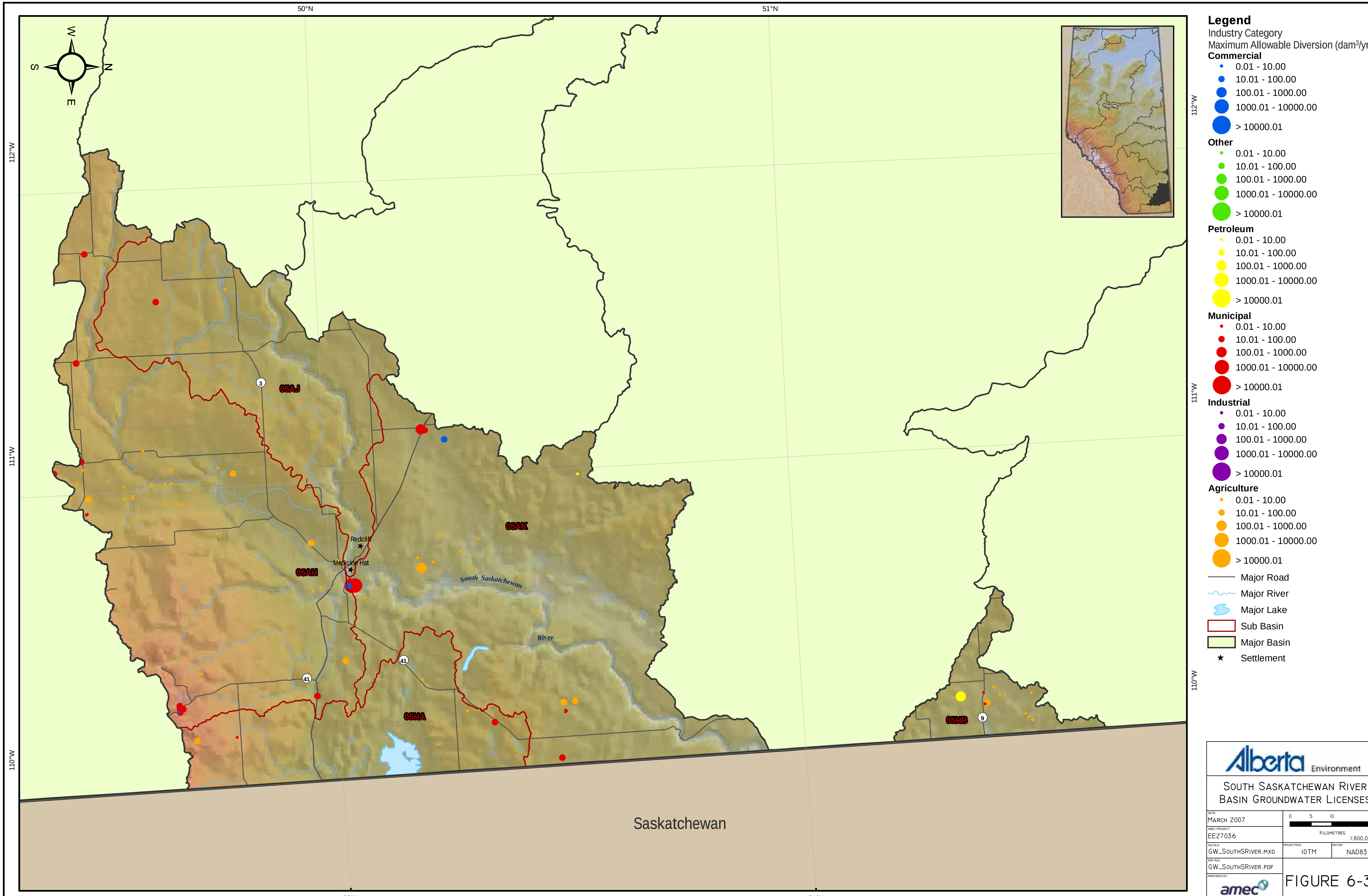
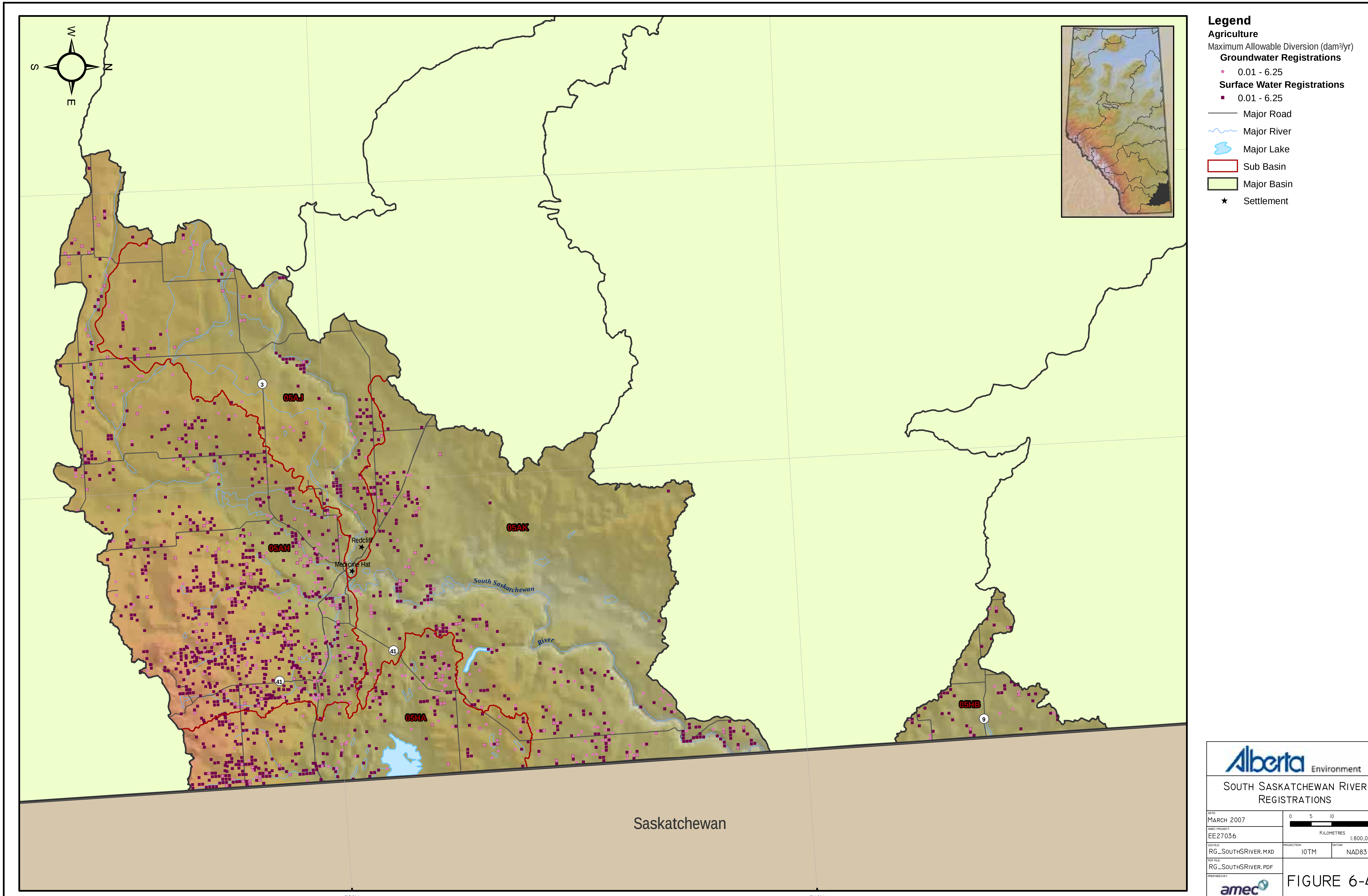
10TM
NAD83
Kilometers
1:800,000
amec
FIGURE 6-2



Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Petroleum
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Municipal
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Industrial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Agriculture
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
05AJ
05AK
05AH
05HA
05HB
Redcliff
Medicine Hat
South Saskatchewan
River
Saskatchewan
50°N
51°N
112°W
111°W
110°W
Alberta Environment
South Saskatchewan River Basin Groundwater Licenses
March 2007
EE27036
GW_SouthSRiver.mxd
GW_SouthSRiver.pdf
10TM
NAD83
Kilometres
1:800,000
amec
FIGURE 6-3



Legend
Agriculture
Maximum Allowable Diversion (dam³/yr)
Groundwater Registrations
0.01 - 6.25
Surface Water Registrations
0.01 - 6.25
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
05AJ
05AK
05AH
05HA
05HB
Redcliff
Medicine Hat
South Saskatchewan River
Saskatchewan
50°N
51°N
Alberta Environment
South Saskatchewan River Registrations
March 2007
EE27036
RG_SouthSRiver.mxd
RG_SouthSRiver.pdf
10TM
NAD83
Kilometres
1:800,000
amec
FIGURE 6-4

Table 6-2 2001 Urban and Rural Populations and Water Allocations in the South Saskatchewan River Basin

Municipality Name		2001 Population	Source	2005 Allocation (dam^3)
City	CITY OF MEDICINE HAT	51,249	Surface	162,820
Towns	TOWN OF REDCLIFF	4,372	Surface	2,545
	TOWN OF BOW ISLAND	1,704		
Villages	VILLAGE OF FOREMOST	531	Surface Groundwater	185 74
Rural Municipalities	CYPRESS COUNTY	4,643	Surface Groundwater	384 180
	COUNTY OF FORTY MILE NO. 8	1,929		
	M.D. OF TABER	668		
	SPECIAL AREAS (2, 3 AND 4)	218		
	COUNTY OF WARNER NO. 5	117		
	M.D. OF ACADIA NO. 34	19		
Total		65,451		166,188

A total of 167,503 dam^3 of surface water has been allocated for municipal purposes and this represents 99 percent of municipal allocations. Ten surface water licences allowing withdrawals of up to 165,871 dam^3 have been issued to urban municipalities. Municipal allocations include 2,111 dam^3 of groundwater and accounts for one percent of allocations. Nineteen groundwater licences have been issued to urban users and allow withdrawals of up to 1,982 dam^3.

Table 6-3 shows identifies other municipal water licences that are allowed to withdraw large amounts of water (100 dam^3 or more) from the South Saskatchewan River Basin. These include the Department of National Defence and various water cooperatives.

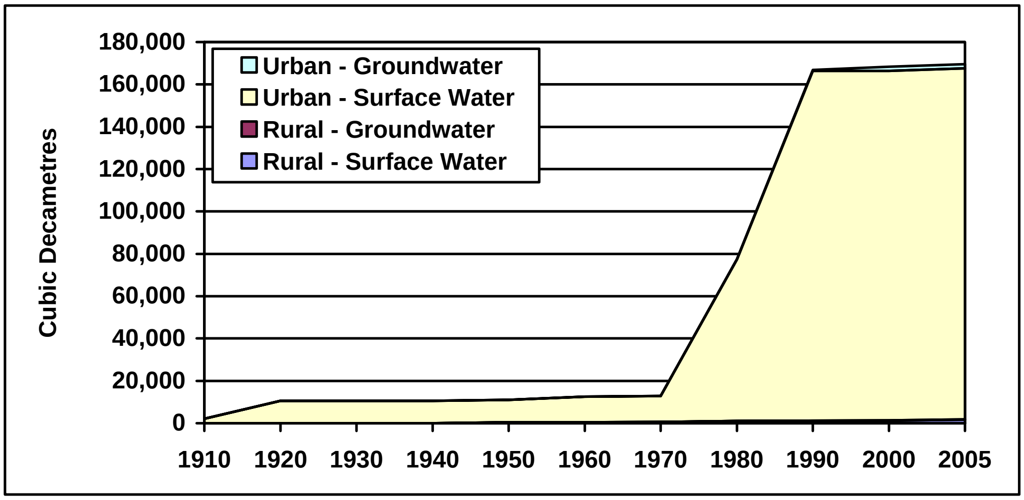
Table 6-3 Other Large Municipal Licence Holders in the South Saskatchewan Basin

Approval Holder	Water Source	Allocation (dam^3)
DEPARTMENT OF NATIONAL DEFENCE	Groundwater	1,462
	Surface	704
BULLSHEAD WATER CO-OP LTD.	Surface	250
WATER OPERATIONS BRANCH, LETHBRIDGE	Surface	247
HILDA WATER PIPELINE CO-OP LTD.	Surface	183
CONOCOPHILLIPS CANADA RESOURCES CORP.	Surface	142
CYPRESS/MILK RIVER DISTRICT	Groundwater	120

It should be noted that although the Town of Bow Island is located in the South Saskatchewan River Basin, it draws its water from the Oldman Basin (678 dam^3). In addition the allocation for the City of Medicine Hat is larger than allocations of other cities of similar size because the City has its own power plant which draws water under the municipal licence.

Figure 6-5 shows the history of water allocations for municipal water use in the South Saskatchewan Basin. Although the initial allocations were made in 1910, there was little expansion of this sector until the 1970s. Municipal allocations of surface water increased substantially between 1970 and 1990 and have remained constant since then. Some small licences allowing groundwater use have been issued since 1990.

Figure 6-5 South Saskatchewan Basin Historical Water Allocations for Municipal Purposes



6.1.3 Licensed Water Use

Table 6-4 summarizes current water licence information for the municipal sector in the South Saskatchewan River Basin. These licences, assume that up to 101,772 dam^3 will be used (60 percent) and a return flow allowance of 67,841 $dam^{3.}$ Return flow allowances range between 35 and 40 percent for urban and rural municipalities using surface water. For users of groundwater, return flow allowances range from 74 percent for urban users to less than one percent for rural users.

6.1.4 Actual Water Use

In 2005, three licensees reported their water diversions to the provincial government through the WURS. These licences had combined allocations of 163,545 dam^3, which accounts for 96 percent of total municipal allocations in the basin. The three licensees reported water diversions of 7,910 dam^3 in 2005, and this represents 4.8 percent of their allocation.

Table 6-4 Licensed Municipal Allocations and Use and Reported Actual Water Use for South Saskatchewan River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Diversion	Water Use	Return
Urban*	Surface	10	165,871	100,114	65,757	7,890	7,890	0
	Groundwater	19	1,982	525	1,458	89	N/A	N/A
	Subtotal	**29**	**167,853**	**100,638**	**67,214**	**7,853**	**7,890**	**N/A**
Rural**	Surface	16	1,632	1,007	625	57	N/A	N/A
	Groundwater	31	127	126	1	N/A	N/A	N/A
	Subtotal	**47**	**1,759**	**1,133**	**626**	**57**	**N/A**	**N/A**
Other	Surface	0	0	0	0	N/A	N/A	N/A
	Groundwater	1	1	1	0	N/A	N/A	N/A
	Subtotal	**1**	**1**	**1**	**0**	**N/A**	**N/A**	**N/A**
Total	Surface	26	167,503	101,120	66,382	7,890	N/A	N/A
	Groundwater	51	2,111	652	1,459	89	N/A	N/A
	Subtotal	**77**	**169,613**	**101,772**	**67,841**	**7,979**	**N/A**	**N/A**

* Urban includes villages, summer villages, towns, cities, hamlets;

** Rural includes condominiums / townhouses / mobile homes / complexes, hotels / motels, cooperatives, farmsteads, single-multi homes, colonies and subdivisions

This suggests that municipalities are withdrawing substantially less than the amount that they are entitled to withdraw. Only one licensee provided return flow information for 2005. The City of Medicine Hat reported that it returned none of the water it diverted. Environment Canada's Municipal Water Use database includes information for three municipalities that accounted for 94 percent of South Saskatchewan Basin's 2001 population. While these municipalities reported their diversions in 2001, none of them reported return flow.

Based on available information it is not possible to definitively determine actual water consumption by municipalities in the basin. Compared to other major urban centres, it seems unlikely that the City of Medicine Hat is diverting so little of its allocation and returning none, especially some of the water is used for thermal power production. The more likely scenario is that the reported use is actually net consumption (i.e. diversions minus return flow). In the absence of other information, estimates of water use by the rest of the municipal sector are based on the assumption that smaller municipalities and rural users are also using only a small portion of their allocations. Consequently, the estimates of total withdrawals probably underestimate actual municipal withdrawals but the estimates of use are likely more accurate. The resulting estimates of municipal water use for the South Saskatchewan River are provided in Table 6-5.

Table 6-5 Estimated Municipal Water Use in the South Saskatchewan River Basin

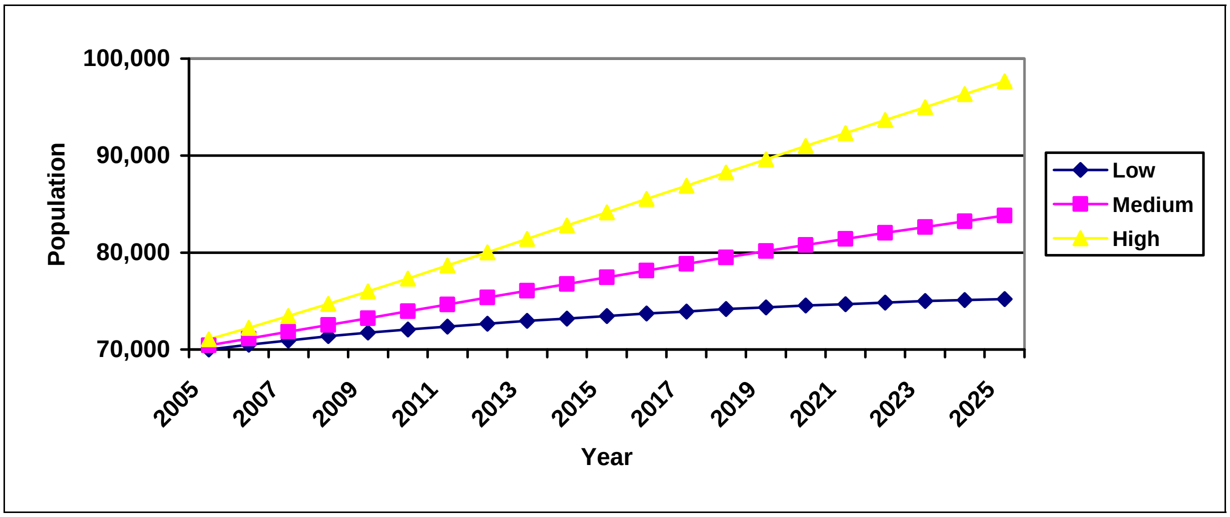
Municipal Use	Source	Withdrawals (dam^3)	Use (dam^3)	Return Flow (dam^3)
Urban	Surface	8,022	8,022	0
	Groundwater	96	96	0
	Subtotal	8,118	8,118	0
Rural	Surface	79	79	0
	Groundwater	6	6	0
	Subtotal	85	85	0
Other	Surface	0	0	0
	Groundwater	0	0	0
	Subtotal	0	0	0
Total Use	Surface	8,101	8,101	0
	Groundwater	102	102	0
	Total	8,203	8,203	0
Licensed Use	Surface	167,503	101,120	66,382
	Groundwater	2,111	652	1,459
	Total	169,613	101,772	67,841
Percent of Licensed Use	Surface	4.8%	8.0%	0.0%
	Groundwater	4.8%	15.7%	0.0%
	Total	**4.8%**	**8.1%**	**0.0%**

Table 6-5 shows that, in 2005, municipalities are estimated to have used eight percent of their surface water use allocations and 16 percent of their groundwater allocations.

6.1.5 Future Water Use Forecasts

Figure 6-6 shows the low, medium and high population projection scenarios for South Saskatchewan Basin based on Alberta Finance Census Division projections. These population forecasts have been used to predict future municipal surface and groundwater use. The resulting forecasts of water use are provided in Table 6-6, and are based on the estimated per capita water use in 2005.

Figure 6-6 South Saskatchewan Basin Population Growth Forecast



Under the low population growth scenario, municipal water use in 2025 is expected to be 7 percent greater than at present and actual diversions and use will be well below current allocations and licensed water use in 2025. Under the high population growth scenario, water use will increase by 37 percent over current levels, total diversions (GW and SW) are expected to be less than 10 percent of current municipal allocations and actual use will be 11 percent of licensed water use in 2025.

Table 6-6 Projected Water Use for the Municipal Sector in the South Saskatchewan Basin (dam^3)

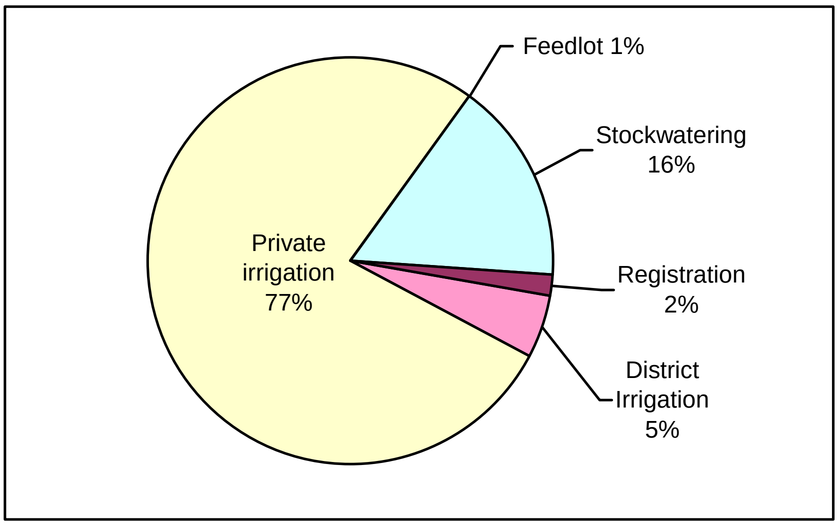
Scenario	Source	2005	2010	2015	2020	2025
Low Population Growth	Surface	8,101	8,343	8,502	8,626	8,705
	Groundwater	102	105	107	109	110
	Total	8,203	8,448	8,609	8,735	8,814
Medium Population Growth	Surface	8,101	8,509	8,911	9,294	9,641
	Groundwater	102	107	112	117	122
	Total	8,203	8,616	9,024	9,411	9,762
High Population Growth	Surface	8,101	8,814	9,593	10,372	11,132
	Groundwater	102	111	121	131	140
	Total	8,203	8,925	9,714	10,502	11,272

6.2 AGRICULTURAL SECTOR

As of December 2005 a total of 74,961 dam^3 had been allocated to the agricultural sector in the South Saskatchewan River Basin. This includes 2,277 registrations representing 1,230 dam^3 and 2,289 licences representing 73,731 dam^3 of water. Water allocated to agriculture accounts for 27 percent of all allocations in the South Saskatchewan River Basin.

Figure 6-7 shows how this water is distributed among the different agricultural uses in the Basin. The largest allocation is for private irrigation (77 percent). District irrigation accounts for five percent, stockwatering accounts for 16 percent and feedlot and registrations together account for three percent of the total allocation.

Figure 6-7 Water Allocations for Agricultural Activities in the South Saskatchewan Basin



A total of 1,619 registrations and 2,213 licences allow withdrawals of up to 74,008 dam^3 of surface water; this accounts for about 98 percent of all water allocated to the agricultural sector. There are 48 licences and 8,372 registrations for groundwater, with total allocations of 953 dam^3 which represents two percent of total agricultural allocations.

6.2.1 Overview of Agriculture in the South Saskatchewan River Basin

Based on estimates derived from the 2001 Census of Agriculture, there were about 1,144 farms (two percent of Alberta total) with an average size of 2,447 acres in the South Saskatchewan Basin. At the provincial level there are about 53,000 farms with an average size of 970 acres. Farms in the South Saskatchewan Basin cover an area of nearly 2.8 million acres; this is equivalent to about 11, 000 km^2 or about 80 percent of the basin.

Table 6-7 shows about 25 percent of the land in the Basin is used to raise crops. About 10 per cent of agricultural land is summer fallowed. Most of the remaining land, about 63 percent is pasture.

Table 6-7 Agricultural Land Use in the South Saskatchewan River Basin, 2001

Land Use	Acres	Percent
Crop Land	689,256	24.6%
Summerfallow	295,344	10.6%
Tame/Seeded Pasture	143,837	5.1%
Natural Pasture	1,634,829	58.4%
Other	35,702	1.3%
Total	**2,798,968**	**100.0%**

The types of farming activity vary within the South Saskatchewan Basin. Table 6-8 shows the classification of farms based on the commodity groups that accounted for 51 per cent or more of total gross farm receipts. The table shows that about 40 percent of the farms in the Basin raise beef cattle and about 25 percent of the farms are wheat farms. Grain and oilseed farms and field crop farms each account for about 10 percent of farms. Specialty and field crops, including vegetables, potatoes, silage corn and alfalfa, are grown on about seven percent of total farms.

Table 6-8 Classifications of Farms in the South Saskatchewan Basin and Alberta, 2001

Farm Type (Gross Receipts Greater that $2500)	South Saskatchewan River Basin	Alberta	Percent of Alberta
Dairy Farms	0.6%	0.9%	1.5%
Cattle (Beef) Farms	39.8%	1.9%	45.4%
Hog Farms	1.5%	1.9%	1.7%
Poultry & Egg Farms	0.4%	1.1%	0.9%
Wheat Farms	25.8%	7.8%	7.4%
Grain & Oilseed Farms	10.7%	1.3%	18.4%
Field Crop Farms	9.1%	2.2%	9.3%
Fruit Farms	0.1%	1.2%	0.1%
Miscellaneous Specialty Farms	6.8%	1.4%	10.9%
Sum of Livestock Combination Farms	1.7%	1.6%	2.3%
Sum of Vegetable Farms	0.5%	7.4%	0.1%
Sum of Other Combination Farms	3.1%	3.5%	2.0%
Total	**100.0%**	**2.2%**	**2.1 %**

The South Saskatchewan Basin accounts for less than three percent of total farms in Alberta. However, as noted above, the average size of the farms in the South Saskatchewan Basin is larger (2,447 acres) than the provincial average (970 acres). Although cattle (beef) farms are the most common type of farm in the basin, they comprise a smaller proportion of farms than found in Alberta. Compared to Alberta, the Basin has a higher percentage of wheat farms and vegetable farms than Alberta.

6.2.2 Stockwatering

As noted in Table 6-8, about 40 percent of the farms in the South Saskatchewan Basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species in 2001 are provided in Table 6-8. The table shows that there about 224,000 cattle and

calves which, together, accounted for about 90 percent of livestock population in the South Saskatchewan River Basin. This is about 3.5 times the human population of the basin. Other livestock in the South Saskatchewan Basin included pigs, sheep and lamb, horses and ponies, bison and elk.

Table 6-9 Estimated Livestock Populations in the South Saskatchewan Basin and Alberta, 2001

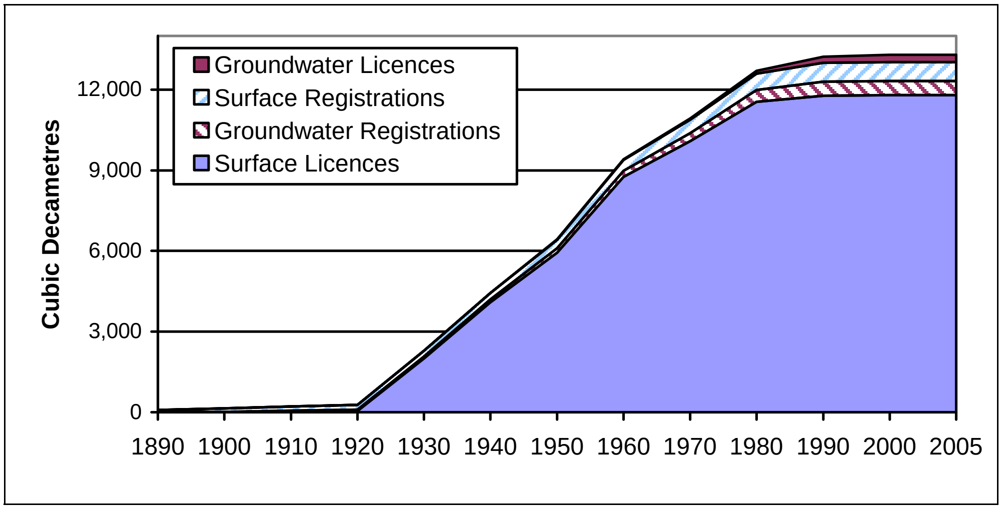
Livestock Species	Basin Total	Alberta	% Alberta
Hens and Chicken	149,803	12,175,246	1.2%
Turkey	253	864,438	0.0%
Cattle	168,350	6,615,201	2.5%
Calves	55,817	2,169,607	2.6%
Pigs	56,353	2,027,533	2.8%
Sheep and Lamb	6,094	307,302	2.0%
Horse and Ponies	1,920	159,962	1.2%
Bison	49	79,731	0.1%
Deer	0	8,331	0.0%
Elk	8	31,304	0.0%

6.2.2.1 Water Allocation

Overall 4,035 licences and registrations have been issued for livestock watering with total allocation amounting to of 13,297 dam^3. Registrations account for 1.6 percent of the allocation. In addition to these allocations, farmers are able to obtain up to 1,250 m^3 of water for household purposes. The numbers of such households in the Basin is not known. Furthermore, the numbers of “exempted agricultural” users are also not known in the South Saskatchewan Basin. Table 6-10 summarizes current water licences and registrations issued for livestock according to the water source. It shows that surface water accounts for about 93 percent of allowable diversions for livestock and that registrations account for 1.3 percent of the allocations.

A historical perspective on water used for livestock is provided in Figure 6-8. The figure shows that some registrations were issued with priority dates in the 1890s while licences for stockwatering began to be issued from the early 1900s. Allocations for stockwatering have risen steadily since the 1920s, with substantial increases occurring in surface water allocations. Registrations are spilt almost equally between groundwater and surface water. Water allocations since 1990 have remained relatively steady at around 16,000 dam^3. Over the last few decades there has been a trend in Alberta to develop intensive livestock operations like feedlots. In the South Saskatchewan Basin water allocations for feedlots were first issued in the 1990s and currently account for about one percent of total livestock water allocation.

Figure 6-8 Historical Trends in Water Allocation for Livestock in the South Saskatchewan Basin



6.2.2.2 Licensed Water Use

Table 6-10 shows that none of the licences or registrations for livestock watering has any allowances for return flow. Thus, farmers are expected to withdrawn and use up to 13,287 dam^3 of water.

6.2.2.3 Actual Water Use

There is no information in Alberta Environment's WURS that indicates the extent to which water allocations are actually used in the South Saskatchewan Basin. However, a reasonable estimate of water use can be derived using the actual animal population in the Basin as shown in Table 6-9. Based on livestock populations for the South Saskatchewan Basin in 2001, the total water required for livestock was estimated to be 1,965 dam^3, or about 15 percent of the licensed allocation.[1] The calculations for this estimate are provided also in Table 6-11 which shows livestock populations in the Basin and the daily water requirements for various livestock species as provided by Alberta Environment in its "Guide to Calculate Quantities for Water for Raising Animals".[2]

1 This approach to estimating water use for stockwatering was employed in the 1986 Battle River Basin water use study undertaken by Stanley Associates in 1985.

2 http://www3.gov.ab.ca/env/water/Legislation/Approvals_Licences/CalculationChart.doc.

Table 6-10 Summary of Water Licences and Registrations Issued for Livestock Watering in the South Saskatchewan Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensee Reporting	Reported Use
Feedlot	Surface	0	0.0	0.0	0.0	0	N/A
	Groundwater	2	40.4	40.4	0.0	0	N/A
	Subtotal	**2**	**40.4**	**40.4**	**0.0**	**0**	**N/A**
Stock watering	Surface	1,712	11,792.5	11,792.5	0.0	0	N/A
	Groundwater	44	234.1	234.1	0.0	0	N/A
	Subtotal	**1,756**	**12,026.5**	**12,026.5**	**0.0**	**0**	**N/A**
Registration	Surface	1,619	704.9	704.9	0.0	0	N/A
	Groundwater	658	525.5	525.5	0.0	0	N/A
	Subtotal	**2,277**	**1,230.4**	**1,230.4**	**0.0**	**0**	**N/A**
Total	Surface	3,331	12,497.3	12,497.3	0.0	0	N/A
	Groundwater	704	800.0	800.0	0.0	0	N/A
	Total	**4,035**	**13,297.3**	**13,297.3**	**0.0**	**0**	**N/A**

In terms of water requirements by species, cattle account for about 90 per cent of the total, about eight percent is required by pigs, and all other species accounted for the remaining two per cent.

Table 6-11 Estimated Livestock Water Requirements for 2001

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chickens	149,803	0.045	11.2
Turkey	253	0.15	0.1
Bulls	3,199	9.0	47.7
Milk Cows	1,474	30.0	73.3
Beef Cows	54,558	9.0	814.3
Heifers	30,647	6.0	304.9
Steers	22,657	6.0	225.4
Calves	55,817	3.0	277.7
Boars	281	6.5	3.0
Sows and Gilts - Breeding	5,835	6.5	62.9
Nursing and Weaner Pigs	19,664	0.5	16.3
Grower and Finishing Pigs	30,522	1.5	75.9
Sheep and Lambs	6,094	2.0	20.2
Horse and Ponies	1,920	10.0	31.8
Bison	49	2.0	0.2
Deer	0	10.0	0.0
Elk	8	3.5	0.0
Total			**1,965.1**

While the estimated actual consumption based on livestock populations (1,965 dam^3**)** appears to be significantly less than the amount of water allocated (13,297 dam^3), the data in 6-11 do not include an allowance for the evaporative and seepage losses associated with storing water for livestock use. Typically, licensed consumption accounts for only 35 per cent of surface water allocated for livestock use while losses account for 65 per cent (Watrecon 2005). Since six percent of livestock water consumption comes from groundwater (no losses) and the balance comes from surface water with 65 percent losses, a total allocation of about 2,960 dam^3 would be required to support the animal populations in Table 6-11. This water requirement is about 22 percent of the water allocation through licences and registrations. Consequently, it is assumed that actual water use is less than the amount of water allocated for livestock. It is also assumed that surface water withdrawals occurred during April when dugouts and storage dams were filled and flows were at their peak.

6.2.2.4 <u>Forecasts of Future Stockwatering Water Use</u>

The key factor affecting future livestock water demand is changes in cattle populations in the basin. Cattle accounts for about 90 percent of livestock water demand in the South Saskatchewan Basin, so changes in the populations of other livestock species will have a minimal overall impact on future water demand for livestock. The historical trend analysis in

Figure 6-9 shows that the amount of water allocated for livestock has been increasing over time, suggesting an increasing livestock population, although between the last two Census years (1996 – 2001) cattle populations actually decreased by three percent.

Some indication of the potential for expansion of cattle populations in the South Saskatchewan River Basin can be determined by examining applications for new and expanded confined feeding operations, which must be approved by the NRCB in accordance with *AOPA*. Information from the NRCB indicates that, as of December 31, 2005, there had only been one application from farmers throughout the Basin for cattle and dairy operations.

A study undertaken by AAFRD in the late 1990s also provides some insights regarding the potential for expansion of the beef industry in the province. That study identified several criteria – manure, odour and population densities, local silage supplies, water supply, landscape characteristics and land for manure spreading – to be considered in evaluating the capability of supporting a 5,000-head back grounding operation and a 20,000-head operation. Townships suitable for livestock expansions are shown in Figures 2-2 and 2-3 in Section 2.3. The figure shows that no townships meet all of the criteria for backgrounding or finishing operations. For townships that meet some of the criteria limiting factors include groundwater, silage and landscape for both backgrounding and finishing operations. Based on AAFRD's assessment, it would appear that significant livestock expansion in the South Saskatchewan River Basin is not likely and the few applications filed with the NRCB corroborate this finding.

Projections are based on the expectations that cattle populations will increase at annual rates somewhere between 0.5 percent (Low Growth) and 2.2 percent (High Growth) which reflects average annual growth rate in cattle populations in Alberta between 1958 and 2005. As the Base Growth scenario, the annual growth rate is assumed to be 1.2 percent. This forecast also assumes that the current mix of livestock (90 percent cattle) and balance of surface and groundwater use will remain unchanged over the forecast period. The resulting projections, based on actual use are shown in Table 6-12.

Table 6-12 Water Use for Livestock in the South Saskatchewan River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	2,780	2,849	2,922	2,995	3,071
	Groundwater	180	185	189	194	198
	Total	**2,960**	**3,034**	**3,111**	**3,189**	**3,270**
Medium Growth	Surface	2,780	2,950	3,132	3,324	3,528
	Groundwater	180	191	203	215	229
	Total	**2960**	**3,141**	**3,335**	**3,539**	**3,757**
High Growth	Surface	2,780	3,099	3,456	3,853	4,295
	Groundwater	180	200	224	249	278
	Total	**2,960**	**3,299**	**3,680**	**4,102**	**4,573**

Under the Low Scenario, water use is projected to increase to 3,270 dam^3 by 2025; this represents a 10 percent increase over current use and is within the current allocations. Under the High Scenario, livestock water use would increase to 4,574 dam^3 by 2025. Although this increase is 50 percent higher than current livestock use it is within current allocations. Although water allocations exceed water use, livestock expansion is likely to be constrained. As will be explained in Section 7.2.5.4, there are limited opportunities to expand irrigation to support additional forage production for livestock. Therefore, the Low Growth scenario is probably the most likely to occur.
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6.2.3 Irrigation

The other major use of water for agricultural purposes is irrigation or crop watering. The crop water allocation can be divided into licences for district irrigation and private irrigation. When aggregate information from the 2001 Census of Agriculture for individual counties and municipal districts is modified to reflect river Basin boundaries, the resulting estimates suggest that 135,000 acres of land in the South Saskatchewan River Basin were irrigated in 2001. This number is incorrect however, because irrigation acres are not evenly distributed throughout each county that make up the South Saskatchewan River Basin so the exact number of irrigated acres in the Basin is not known.

For the district irrigation, the Ross Creek Irrigation District is licensed to divert up to 3,701 dam^3 for 1,210 acres. The exact number of privately irrigated acres is not known. However, based on water allocations to private irrigators and irrigation requirements of about 450 mm (18 inches), it is estimated that water allocations are sufficient to support irrigation on 47,663 acres. Consequently it is estimated that water allocations are sufficient to support 48,873 irrigated acres, 98 percent of which are private irrigation.

A summary characteristic of district irrigation is provided in Table 6-13. The table shows that average yearly diversion for the Ross Creek Irrigation District is about 1,500 dam^3, or about 40 percent of its licensed allocation. Actual diversions in 2005 were consistent with this average. About 95 percent of the irrigated acres are for forage crops.

Table 6-13 District Irrigation Characteristics for the South Saskatchewan Basin

District Name	Assessed acres (2005)	Licensed allocation (dam^3)	Average diversion, 1976-2005 (dam^3)	Average percent diversion of licensed allocation	Percent of Licence(2005)	Percent crop mix
Ross Creek	1,210	3,701	1,497	40.5%	39.7%	95% forage

Although there is no information on the mix of crops grown by private irrigators; AAFRD[3] has indicated that most private irrigation in Alberta is used to raise supplemental forages to feed livestock.

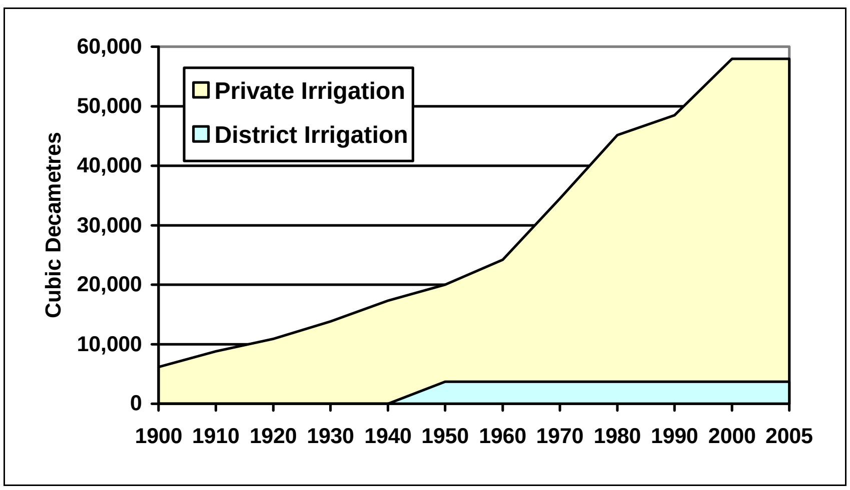
6.2.3.1 Water Allocation

There is one district licence that allocates about 3,700 dam^3, which represents about six percent of total allocation in the South Saskatchewan Basin. All of this district allocation is from surface water sources. The South Saskatchewan Basin accounts for less than one percent of total district allocation and about five percent of the district licences issued in the province.

There are 520 licences that allocate approximately 57,963 dam^3 to private irrigators; this represents about 98 percent of the total allocation for irrigation. The South Saskatchewan River Basin accounts for about eight percent of total private allocation and about 19 percent of the private licences issued in the province. Overall, total allocations for irrigation currently amount to 61,663 dam^3.

A historical perspective on water used for irrigation is provided in Figure 6-9. The licence for district irrigation has a priority date from 1950. Allocations for district irrigation have remained relatively stable since the 1950s. Some allocations for private irrigation date back to the 1900s. Allocations for private irrigation have increased substantially since that time but have remained constant since 2000.

Figure 6-9 Historical Trends in Surface Water Allocation for Irrigation in the South Saskatchewan



[3] Cited in Watrecon (2005) as Personal communication, Wally Chinn, Head - Irrigation Development Section, Irrigation Branch, AAFRD, January 7, 2005.

6.2.3.2 Licensed Water Use

Table 6-14 summarizes the water licences issued for irrigation according to water source. The table shows that irrigations are expected to consume 99 percent of surface water allocations and licences contain a return flow allowance of five percent (3,752 dam^3). Irrigation licence for groundwater does not include an allowance for return flows.

6.2.3.3 Actual Water Use

For district irrigation, actual water use varies from year to year depending on moisture conditions. As noted in Table 6-13 an average of about 40 percent of allocation has been diverted, and this number (1,500 dam^3) will be used as the estimated of actual water use in 2005.

For the private irrigation neither Alberta Agriculture nor Alberta Environment has any information on actual water use. However, a reasonable estimate of use can be made by assuming that private irrigators, on average divert the same proportion of the licensed volume as district irrigation over the 30 year period (40 percent). Given that both types of irrigators would face similar climatic conditions, and assuming a similar mix of crops between the two irrigators, similar rates of diversion seem reasonable. The diversion for private irrigation is about 23,185 dam^3 of surface water (40 percent of allocations from Table 6-14). For the purposes of this study it is assumed there is no return flow. It is noteworthy that actual water use for irrigation in the Basin (24,685 dam^3) is 8.3 times the amount of water used for livestock (2,960 dam^3).

6.2.3.4 Forecasts of Future Irrigation Water Use

Future water demand will be influenced largely by forage production. As noted in Table 6-13, 95 percent of district irrigation is for forage production and private irrigators are assumed to largely grow forage. With little expansion of livestock, additional demand for livestock forage is expected. The historical trend provided in Figure 6-9 shows that water allocation for irrigation has increased over time, particularly for private irrigation, suggesting that past increases in livestock have led to increased water demand for expansion in irrigated crop areas.

The ability to expand irrigated acres is limited by the fact that applications for new surface water licences in the South Saskatchewan Basin are no longer being accepted. Thus, water needed for increased forage production will have to be accommodated within the existing allocations or by switching to groundwater. Although the potential for additional irrigation could be enhanced by construction of storage, a recent assessment of the Meridian Dam on the mainstem of the South Saskatchewan River near the provincial boundary was found to be uneconomic. Therefore, water use for private irrigation is expected to remain unchanged at 24,685 dam^3 over the forecast period.

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Table 6-14 Irrigation Allocations and Use and Reported Actual Water Use, South Saskatchewan River Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
District irrigation	Surface	1	3,700.5	3,453.8	246.7	0	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Subtotal	**1**	**3,700.5**	**3,453.8**	**246.7**	**0**	**N/A**
Private irrigation	Surface	518	57,810.4	54,710.8	3,099.6	0	N/A
	Groundwater	2	153.0	153.0	0.0	0	N/A
	Subtotal	**520**	**57,963.3**	**54,863.7**	**3,099.6**	**0**	**N/A**
Total	Surface	519	61,510.9	58,164.6	3,346.3	0	N/A
	Groundwater	3	153.0	153.0	0.0	0	N/A
	Total	**521**	**61,663.9**	**58,317.6**	**3,346.3**	**0**	**N/A**

The expansion of district irrigation is limited by the *1991 South Saskatchewan Basin Water Allocation Regulation*. Although the *Regulation* capped the number of irrigated acres, recent changes to the *Irrigation Districts Act* allow the districts to add more acres if approved by district members. This means that acres can expand within existing allocations through efficiency improvements and more effective water use. A variety of scenarios were studied by the Irrigation Water Management Study Committee (2002). However, Ross Creek is a small irrigation district where the capital costs required to acquire equipment to irrigate additional land is likely less than the returns, especially considering that 95 percent of the crop mix is for forage production with low economic returns (Watrecon 2005). Therefore, water use for district irrigation is also expected to remain unchanged at 1,500 dam^3 over the forecast period.

6.2.4 Summary

In summary, current agricultural water use in the South Saskatchewan Basin is estimated to be 27,645 dam^3, 89 percent of which is for irrigation. Since surface water allocations in the Basin are “capped” any future demand for water will have to be accommodated through existing allocations or by switching to groundwater. Although available allocations are sufficient to meet future demands, significant expansion of the agricultural sector is unlikely because of the biophysical and forage constraints on livestock expansion. Water use for irrigation is expected to remain constant.

A summary of future agricultural water demand is provided in Table 6-15, and all of the growth is related to increased water demands for growing livestock populations. Under the Low Growth scenario water use in 2025 would be about 27.955 dam^3, which represents a 1.1 percent increase over current levels. Under High Growth, water use is projected to be 29,258 dam^3 which is 5.8 percent higher than in 2005.

Table 6-15 Projected Average Water Use for Agriculture in the South Saskatchewan River Basin

(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	27,465	27,534	27,607	27,680	27,756
	Groundwater	180	185	189	194	198
	Total	**27,645**	**27,719**	**27,796**	**27,874**	**27,955**
Medium Growth	Surface	27,465	27,635	27,817	28,009	28,213
	Groundwater	180	191	203	215	229
	Total	**27,645**	**27,826**	**28,020**	**28,224**	**28,442**
High Growth	Surface	27,465	27,784	28,141	28,538	28,980
	Groundwater	180	200	224	249	278
	Total	**27,645**	**27,984**	**28,365**	**28,787**	**29,258**

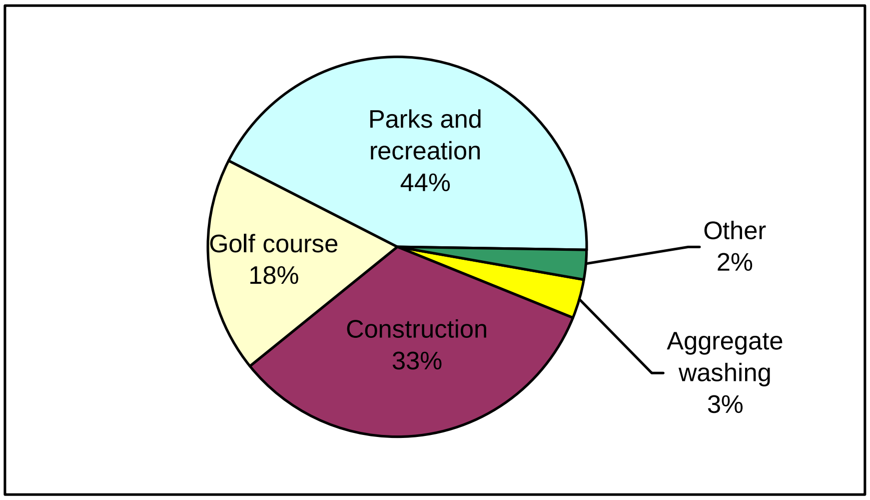
6.3 COMMERCIAL SECTOR

There are 14 licences that allow diversion of about 2,034 dam^3 of water for commercial purposes in the South Saskatchewan River Basin. This allocation accounts for 0.7 percent of total allocation in the Basin.

6.3.1 Water Allocations

As shown in Figure 6-10, the three largest allocations - parks and recreation (44 percent), construction (36 percent) and golf course (18 percent) - together account for about 95 percent of the total allocation.

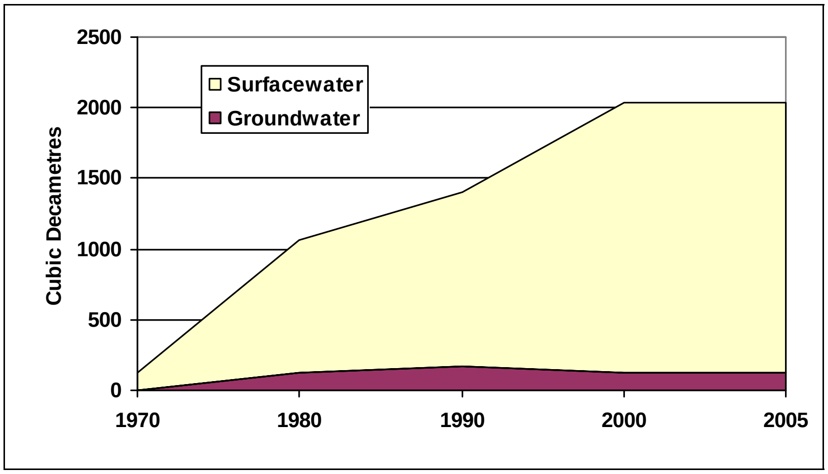
Figure 6-10 Water Allocation by Volume for Commercial Activities in the North Saskatchewan Basin



Licences issued for the commercial sector allow maximum withdrawals of about 1,916 dam^3 of surface water (94 percent of allocation). The largest allocation is for parks and recreation which accounts for about 40 percent of the total surface water allocation. Licences issued for the commercial sector allow maximum withdrawals of 119 dam^3 of groundwater (six percent of allocation). The largest allocation is for parks and recreation which accounts for about 70 percent of the total groundwater allocation.

A historical trend of commercial sector allocation in the South Saskatchewan Basin is provided in Figure 6-11. The earliest allocation began in the 1970s for surface water. Since that time surface water allocations have increased, driven largely by parks and recreation, construction and golf course activities. Surface water allocations have remained unchanged since 2000. Groundwater allocations were issued from the 1970s and have remained relatively unchanged. Overall, groundwater allocations make up a small proportion of total water allocations.

Figure 6-11 Historical Trend in Commercial Sector Water Allocation in the South Saskatchewan Basin



6.3.2 Licensed Water Use

Table 6-16 provides a summary of licensed water allocations, use and return for various activities within the commercial sector in the South Saskatchewan Basin. The table shows that there are no allowances for return flow in licences issued for all activities except parks and recreation. For parks and recreation, the licences expect 583 dam^3 (67 percent of allocation) to be returned.

6.3.3 Actual Water Use

At the present time Alberta Environment's Water Use Reporting System (WURS) contains no information on actual water use in 2005 by the any of the licensees in the commercial sector in the South Saskatchewan Basin. For purposes of this assessment it is assumed that all licensees are withdrawing and using the full amounts of water to which they are entitled. While this assumption may overstate actual water use in the basin, the commercial sector accounts for 0.7 percent of total allocations so it will not appreciably affect overall water use estimate for the South Saskatchewan Basin.

6.3.4 Forecasts of Future Water Use

Forecasts have been prepared for those activities that comprise a majority of the current use. These activities include parks and recreation, construction and golf course. A review of the licence data shows that construction water use is allocated through one licence which will expire in 2007. Since construction activity typically is for short, finite duration and that licence will expire soon, water allocation for the construction activity is not included in water demand forecasts.

Table 6-16 Licensed Commercial Allocations and Reported Actual Water Use, South Saskatchewan Basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Licensees Reporting	Reported Use	Percent of Allocation
Aggregate washing	Surface	2	66.7	66.7	0.0			
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**2**	**66.7**	**66.7**	**0.0**	**0**	**N/A**	**N/A**
Construction	Surface	1	675.9	675.9	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**1**	**675.9**	**675.9**	**0.0**	0	N/A	N/A
Golf course	Surface	3	372.5	372.5	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**3**	**372.5**	**372.5**	**0.0**	**0**	**N/A**	**N/A**
Parks and Recreation	Surface	4	800.5	273.8	526.7	0	N/A	N/A
	Groundwater	3	69.1	12.8	56.2	0	N/A	N/A
	Subtotal	**7**	**869.6**	**286.7**	**582.9**	**0**	**N/A**	**N/A**
Other	Surface	0	0.0	0.0	0.0	0	N/A	N/A
	Groundwater	1	49.6	49.6	0.0	0	N/A	N/A
	Subtotal	**1**	**49.6**	**49.6**	**0.0**	**0**	**N/A**	**N/A**
Total	Surface	10	1,915.6	1,388.9	526.7	0	N/A	N/A
	Groundwater	4	118.6	62.4	56.2	0	N/A	N/A
	Total	**14**	**2,034.3**	**1,451.3**	**582.9**	**0**	**N/A**	**N/A**

6.3.4.1 Parks and Recreation

As shown in Table 6-16, actual use information for parks and recreation activity in the South Saskatchewan Basin is not available. Most of the licensees are municipalities who are operating recreational facilities. For 2005 it is assumed that licensees are withdrawing their full entitlement and returning 67 percent, resulting in net use of 287 dam^3. Future use is expected to increase as a result of regional population growth. Projections are based on 0.2 percent annual growth for the Low Growth scenario), 0.7 percent for the Medium Growth scenario and 1.7 percent for the High Growth scenario. The resulting forecasts are shown in Table 6-17.

Table 6-17 Forecast of Parks and Recreation Water Use in South Saskatchewan
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	274	277	279	282	285
	Groundwater	13	13	13	13	13
	Total	**287**	**290**	**293**	**295**	**298**
Medium Growth	Surface	274	285	297	309	321
	Groundwater	13	13	14	15	15
	Total	**287**	**298**	**310**	**323**	**336**
High Growth	Surface	274	298	324	353	384
	Groundwater	13	14	15	17	18
	Total	**287**	**312**	**339**	**369**	**402**

Under the Low Growth scenario water use is projected to increase to 298 dam^3 by 2025, a four percent increase from current levels. Water use under High Growth is predicted to increase to 402 dam^3 which is a 40 percent increase over current use.

6.3.4.2 Golf Courses

The water demand forecast for golf courses follows the approach outlined in Watrecon (2005) which assumes that water demands will increase based on expansion of golf courses which will occur as a result of population growth. This method assumes that the proportion of surface and groundwater use will not change over the forecast period relative to 2005. The resulting projections are shown in Table 6-18 which shows that water use under the Low Growth scenario is expected to increase to 543 dam^3 by 2025, a 45 percent increase from current use. Using the High Growth scenario, water demand for golf courses is projected to increase to 2,976 dam^3 by 2025 which is almost eight times the current water use.

Table 6-18 Projected Water Use for Golf Course, South Saskatchewan Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	373	441	486	521	543
	Groundwater	0	0	0	0	0
	Total	**373**	**441**	**486**	**521**	**543**
Medium Growth	Surface	373	604	832	1049	1246
	Groundwater	0	0	0	0	0
	Total	**373**	**604**	**832**	**1049**	**1246**
High Growth	Surface	373	985	1654	2323	2976
	Groundwater	0	0	0	0	0
	Total	**373**	**985**	**1654**	**2323**	**2976**

6.3.4.3 Summary

A summary of projected water demand for the commercial sector in the South Saskatchewan Basin is provided in 6-19. It includes the projections parks and recreation and golf courses, as provided in Tables 6-17 and 6-18, and assumes that water use for all other activities remains at current rates. As noted previously, the forecast makes no allowance for water used for construction because the one existing licence for that use expires in 2007. The projections in Table 6-19 represent water demand and may not translate into actual water use because the South Saskatchewan River Basin is a “capped” Basin such that water demands in excess of existing surface water licences can only be addressed by improved water use efficiencies, the purchase of existing licences, or by switching to groundwater.

Table 6-19 Projected Water Use for Commercial Sector in the South Saskatchewan Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,389	1,460	1,507	1,545	1,570
	Groundwater	62	62	62	62	62
	Total	**1,451**	**1,522**	**1,570**	**1,607**	**1,632**
Medium Growth	Surface	1,389	1,631	1,871	2,100	2,309
	Groundwater	62	62	63	64	64
	Total	**1,451**	**1,693**	**1,933**	**2,163**	**2,373**
High Growth	Surface	1,389	2,025	2,720	3,418	4,102
	Groundwater	62	63	64	66	67
	Total	**1,451**	**2,088**	**2,784**	**3,483**	**4,169**

6.4 PETROLEUM SECTOR

In South Saskatchewan Basin, there are six active licences which allocate 6,881 dam^3 of water to the petroleum sector. Petroleum licences account for about two percent of total allocations in the basin. A very small amount of water has been allocated for injection (1.2 dam^3) but the vast majority has been allocated for gas/petrochemical plants. The majority (99.8 percent) of the licences are for surface water (6,869 dam^3) accounting for 67 percent of the licences. Table 6-

20 summarizes the water allocation, use, and return associated with the licences for each activity in the South Saskatchewan Basin.

6.4.1 Injection

Only one groundwater licence has been issued for injection purposes in the South Saskatchewan Basin allowing withdrawals of up to 1.2 dam^3. The single licence was issued in the 1970s and assumes the licence holder will consume all of the water they withdraw. Although the WURS database has no information on actual water use for the one licence in 2005, estimates of water used for oilfield injection activities prepared by Geowa based on the EUB data found that about 364 dam^3 of water were used for injection purposes in 2005. This includes 202 dam^3 of surface water and 162 dam^3 of groundwater. The EUB data also show that about 178 dam^3 of saline water was injected. The source of the water used for injection purposes in the Basin is not specified.

In forecasting future use for injection purposes, it is assumed that current demands for water in the Basin will decline. The general trend in Alberta is for conventional crude oil production to decline as existing fields mature and there are fewer new finds. The most recent forecast from the EUB and CAPP have oil production decreasing by between 30 and 38 percent between 2005 and 2015, and a further decline of about 23 percent by 2020. Oil production in the South Saskatchewan River Basin is expected to follow the overall Alberta production trend since most of the basin's production is from existing wells.

The forecast of future water use for injection in the Bow Basin in Table 6-21 assumes declining rates of water use required that match the rates at which oil production in Alberta is expected to decline. No petroleum forecasts are available for 2010 and 2020, so for the purposes of this analysis it is assumed that production for these time periods is the same as the previous five years. Forecasts also assume that the current ratio of surface to groundwater consumption will remain the same.

While Table 6-21 identifies water demand, the source of this water is unclear because current levels of use exceed licensed allocations from sources inside the South Saskatchewan River Basins.

Table 6-20 Water Allocations and Use and Estimated Water Use for the Petroleum Sector, South Saskatchewan River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Injection*	Surface	0	0.0	0.0	0.0	201.6		
	Groundwater	1	1.2	1.2	0.0	162.1	1,350.8%	1,350.8%
	Subtotal	**1**	**1.2**	**1.2**	**0.0**	**363.6**		
Gas and Petrochemical Plants **	Surface	4	6,869.3	6,097.1	772.2	4,069.0	66.7%	59.2%
	Groundwater	1	10.0	10.0	0.0	10.0	100.0%	100.0%
	Subtotal	**5**	**6,879.3**	**6,107.1**	**772.2**	**4,079.0**	66.8%	59.3%
Total	Surface	4	6,869.3	6,097.1	772.2	4,270.6	70.0%	62.2%
	Groundwater	2	11.2	11.2	0.0	172.1	1,532.2%	1,532.2%
	Total	**6**	**6,880.5**	**6,108.3**	**772.2**	**4,442.6**	**72.7%**	**64.6%**

* Water use based on EUB data (Geowa, 2006).
** Estimated water use based on WURS data.

Table 6-21 Forecast of Water Use for Injection in the South Saskatchewan River Basin

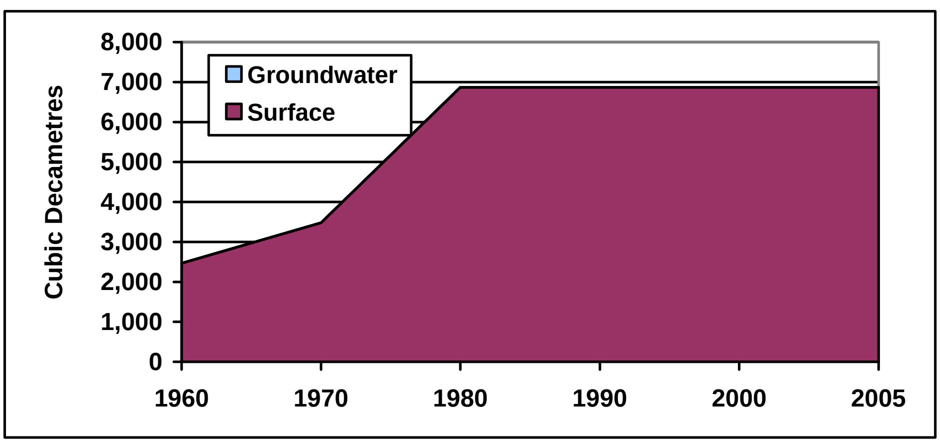
Scenario	Source	2005	2010	2015	2020	2025
Low Decline	Surface	202	202	118	118	70
	Groundwater	162	162	95	95	57
	Total	**364**	**364**	**213**	**213**	**127**
Medium Decline	Surface	202	202	124	124	74
	Groundwater	162	162	100	100	60
	Total	**364**	**364**	**224**	**224**	**134**
High Decline	Surface	202	202	141	141	84
	Groundwater	162	162	113	113	68
	Total	**364**	**364**	**255**	**255**	**152**

Under the Low Decline scenario, water use for injection in 2025 will decline by 65 percent from current levels. Under the High Decline scenario, water requirements for injection in 2025 will only amount to 58 percent of current requirements.

6.4.2 Gas and Petrochemical Plants

Almost all of the allocations for the petroleum sector in the South Saskatchewan River Basin are for gas/petrochemical plants (6,879 dam^3). This includes four surface water licences which account for almost all of the petroleum allocations (6,869 dam^3). There is one groundwater licence for 10 dam^3. As shown in Figure 6-12, allocations of surface water for gas/petrochemical plants commenced in the 1960s, increased significantly until 1980 and has remained constant since then. The licences issued to gas/petrochemical plants assumes that 89 percent of surface water and 100 percent of groundwater will be consumed.

Figure 6-12 Historical Trends in Water Allocations for Gas/ Petrochemical Plants



Based on the available WURS data for the South Saskatchewan River Basin, a number of gas and petrochemical plants reported using approximately 59 percent of their surface water allocations, and 67 percent of their total licensed water use in 2005. Although there was no information on groundwater use, it was assumed that the single licensee was using the full amount of their allocation (10 dam^3). The water use estimates for 2005 in Table 6-20 were

calculated assuming that these percentages apply to all gas/petrochemical plants in the South Saskatchewan River Basin. Based on this assumption, the total water use by gas and petrochemical plants in 2005 is estimated to be 4,080 dam^3 consisting of 4,070 dam^3 of surface water and 10 dam^3 of ground water.

It is assumed that future water use for gas/petrochemical plants will remain at current levels. No applications for new water licences are being accepted for the Bow, Oldman, and South Saskatchewan River Basins so any new demands for this activity will have to be achieved by making more efficient use of existing allocations or by purchasing existing water licences.

6.4.3 Summary

The petroleum sector in the South Saskatchewan River Basin is dominated by water allocated for gas/petrochemical plants which are estimated to have used 73 percent of licensed use in 2005. Although a very small amount of water has been licensed for injection purposes, EUB data suggests that 364 dam^3 of water were actually used in 2005.

Future water use forecasts for the petroleum sector are based on the assumptions that water requirements for injection will decline as production from existing oilfields decreases and that water use by gas/petrochemical plants will remain at current levels. The resulting water use forecasts are provided in Table 6-22. The forecast assumes that the current mix of surface to groundwater consumption will be maintained.

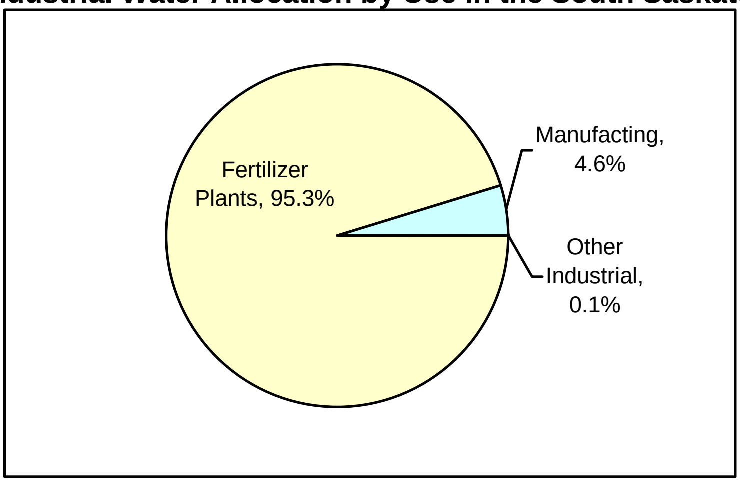
Table 6-22 Forecast of Water Use by Petroleum Activities in the South Saskatchewan River Basin

Scenario	Source	2005	2010	2015	2020	2025
Low Decline	Surface	4,271	4,271	4,187	4,187	4,139
	Groundwater	172	172	105	105	67
	Total	**4,443**	**4,443**	**4,292**	**4,292**	**4,206**
Medium Decline	Surface	4,271	4,271	4,193	4,193	4,143
	Groundwater	172	172	110	110	70
	Total	**4,443**	**4,443**	**4,303**	**4,303**	**4,213**
High Declines	Surface	4,271	4,271	4,210	4,210	4,153
	Groundwater	172	172	123	123	78
	Total	**4,443**	**4,443**	**4,334**	**4,334**	**4,231**

6.5 INDUSTRIAL SECTOR

In the South Saskatchewan Basin there are seven active licences which allocate 19,803 dam^3 of water to the industrial sector. Industrial allocations account for about seven percent of total allocations in the basin. The majority (95 percent) of all water allocated is for surface water (18,894 dam^3). As shown in Figure 6-13, the industrial sector includes water allocations for fertilizer plants, manufacturing and other industrial activities.

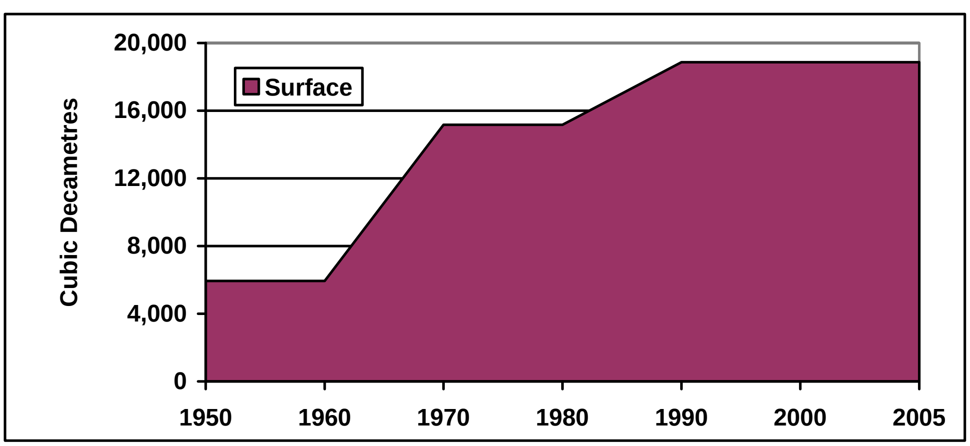
Figure 6-13 Industrial Water Allocation by Use in the South Saskatchewan Basin



6.5.1 Fertilizer Plants

Just over 95 percent of the allocations for the industrial sector in the South Saskatchewan Basin are for fertilizer plants. Four surface water licences have been issued and allow withdrawals of up to 18,869 dam^3. As shown in Figure 6-14, allocations for fertilizer plant waters were issued in the 1950s, the 1970s, and again in the 1990s.

Figure 6-14 Historical Trends in Water Allocations for Fertilizer Plants



As shown in Table 6-23, the licences issued to fertilizer plants include a return flow allowance of 1,727 dam^3 which amounts to nine percent of maximum withdrawals. There is no information

on actual water diversions and consumption for fertilizer plants and, for purposes of this analysis, it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by fertilizer plants in the South Saskatchewan Basin will remain constant for the forecast period.

6.5.2 Manufacturing

Two licences have been issued for manufacturing activities in the Bow Basin allowing withdrawals of up to 909 dam^3 of groundwater. Manufacturing water allocations were issued in the 1960s and have remained the same overtime. Licensees are assumed to consume 20 percent of the water they are allocated. The return flow allowances in licences amount to 727 dam^3. There is no information on actual water diversions and consumption for manufacturing and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by manufacturing in the South Saskatchewan Basin will remain constant for the forecast period.

6.5.3 Other Industrial

One licence has been issued for other industrial purposes and allows withdrawals of up to 25 dam^3 of surface water. The licences for other industrial water use were issued in the 1970s and have remained unchanged since then. Licensees are assumed to consume 100 percent of the surface water they are allocated. There is no information on actual water diversions and consumption for the other industrial activities and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by other industrial activities in the South Saskatchewan Basin will remain constant for the forecast period.

6.5.4 Summary

The industrial sector in the South Saskatchewan Basin is dominated by water allocated for fertilizer plants. Licensees in this sector are assumed to be using the full capacity of their licences and they are expected to continue to do so for the duration of the forecast period. Fertilizer plants account for 95 percent of allocations and 98 percent of estimated water use in 2005. Should water demand for industrial purposes increase over time, water licences will have to be obtained from other existing licensees because applications for new surface water licences are no longer being accepted in the Bow, Oldman, and South Saskatchewan River basins.

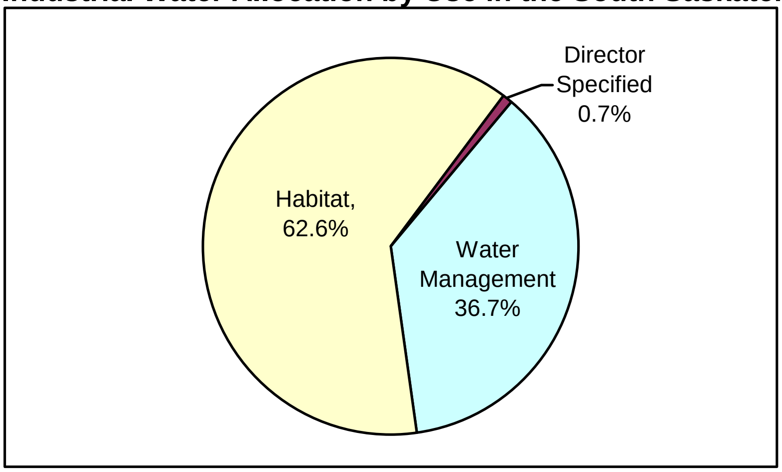
Table 6-23 Licensed Allocations and Estimated Water Use for the Industrial Sector, South Saskatchewan Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Fertilizer Plants	Surface	4	18,868.9	17,142.0	1,726.9	17,142.0	100.0%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0	100.0%	100.0%
	Subtotal	**4**	**18,868.9**	**17,142.0**	**1,726.9**	**17,142.0**	100.0%	100.0%
Manufacturing	Surface	0	0.0	0.0	0.0	0.0	100.0%	100.0%
	Groundwater	2	909.1	181.8	727.3	181.8	100.0%	100.0%
	Subtotal	**2**	**909.1**	**181.8**	**727.3**	**181.8**	100.0%	100.0%
Other Industrial	Surface	1	24.7	24.7	0.0	24.7	100.0%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0	100.0%	100.0%
	Subtotal	**1**	**24.7**	**24.7**	**0.0**	**24.7**	100.0%	100.0%
Total	Surface	5	18,893.6	17,166.7	1,726.9	17,166.7	100.0%	100.0%
	Groundwater	2	909.1	181.8	727.3	181.8	100.0%	100.0%
	Total	**7**	**19,802.6**	**17,348.5**	**2,454.1**	**17,348.5**	100.0%	100.0%

6.6 OTHER SECTOR

In the South Saskatchewan River Basin 21 licences allocating 8,680 dam^3 have been issued for activities in the other sector. These allocations account for about three percent of licensed water allocations in all of Alberta. All of the licences are for surface water. Other sector uses include water management for flood control and lake stabilization, fish, wildlife and habitat enhancement, and uses specified by a director with AENV (Figure 6-15).

Figure 6-15 Industrial Water Allocation by Use in the South Saskatchewan Basin



6.6.1 Water Management

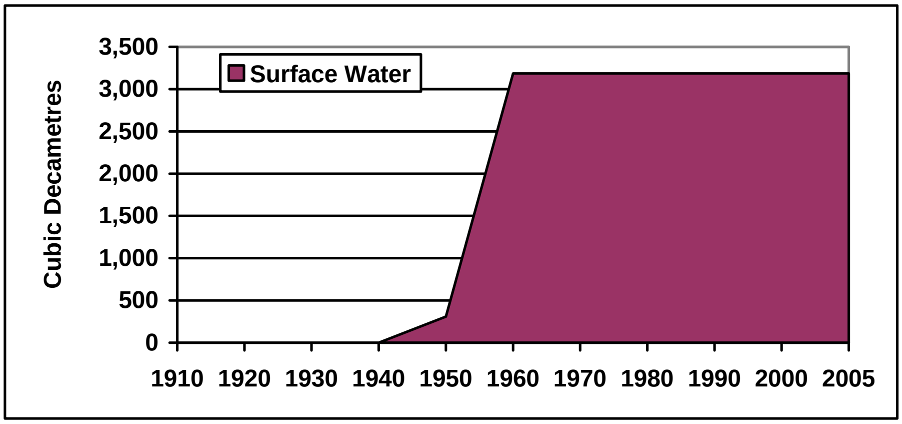
About 37 percent of the allocations are for water management purposes such flood control and lake stabilization (3,185 dam^3). Details of the licences issued to the other sector in South Saskatchewan are provided in Table 6-24. The table shows that seven licences have been issued for water management purposes, all for surface water. The surface water licences for water management were first issued in the 1940s and allocations increased significantly in the 1950s but have remained constant since the 1960s (Figure 6-16).

As shown in Table 6-24, licences issued for water management purposes assume that about 48 percent of surface water allocations will be used. Return flow allowances in licences amounted to 1,659 dam^3 for surface water. There is no information on actual water diversions and consumption for water management activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement and will continue to do so for the duration of the forecast period.

Table 6-24 Licensed Allocations and Estimated Water User for the Other Sector, South Saskatchewan River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Water Management	Surface	7	3,184.7	1,525.8	1,658.9	1,525.8	100%	47.9%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**7**	**3,184.7**	**1,525.8**	**1,658.9**	**1,525.8**	**100%**	**47.9%**
Habitat	Surface	13	5,434.7	5,434.7	0.0	5,434.7	100%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**13**	**5,434.7**	**5,434.7**	**0.0**	**5,434.7**	**100%**	**100.0%**
Specified	Surface	1	60.5	60.5	0.0	60.5	100%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**1**	**60.5**	**60.5**	**0.0**	**60.5**	**100%**	**100.0%**
Total	Surface	21	8,679.8	7,020.9	1,658.9	7,020.9	100%	80.9%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**21**	**8,679.8**	**7,020.9**	**1,658.9**	**7,020.9**	**100%**	**80.9%**

Figure 6-16 Historical Trends in Water Allocations for Water Management



6.6.2 Habitat

About 63 percent of the allocations are for fish, wildlife and habitat enhancement (5,435 dam^3). Table 6-24 shows that 13 licences have been issued for habitat projects, all of these are for surface water. The first surface water licences for habitat were issued in the 1930s and allocations rapidly increased between the 1940s to the 1980s. Figure 6-17 shows water allocations have remained the same since 1980s.

Figure 6-17 Historical Trends in Water Allocations for Habitat Enhancement

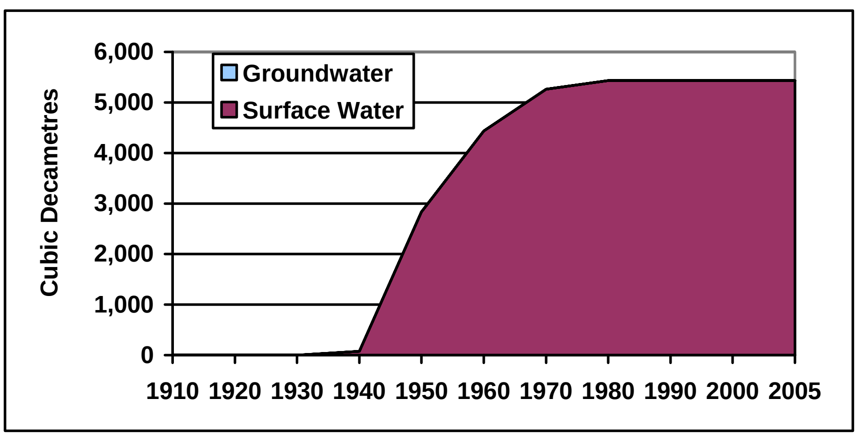


Table 10-24 shows that licences issued for habitat enhancement purposes assume 100 percent of surface water allocations will be consumed or lost. There is no information on actual water diversions and consumption for habitat enhancement activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement and will continue to do so for the duration of the forecast period.

6.6.3 Specified Activities

One surface water licence has been issued for director-specified purposes allowing withdrawals of up to 61 dam^3. The licence was issued in the 1910s and assumes 100 percent of surface water allocations will be used. There is no information on actual water diversions and consumption for specified activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement and will continue to do so for the duration of the forecast period.

6.6.4 Summary

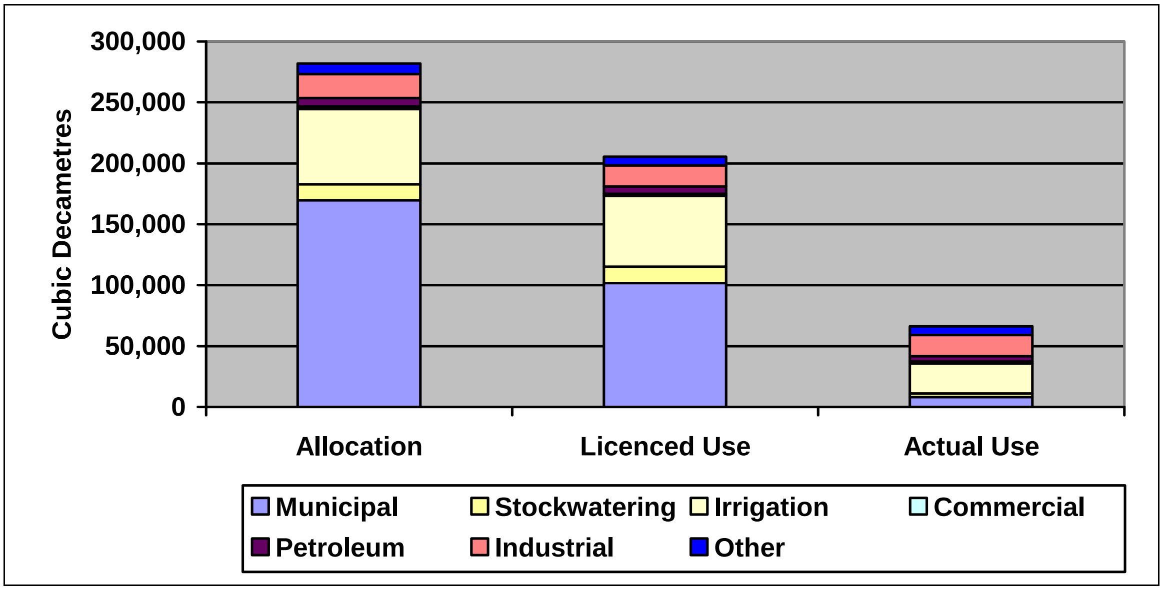
The other sector in the South Saskatchewan is dominated by water allocations for habitat enhancement. These projects account for 63 percent of the water allocation and 77 percent of the licensed water use. In the absence of information about the other sector, it is assumed that water used for these projects in the South Saskatchewan Basin will remain constant for the forecast period.

6.7 SUMMARY

Table 6-25 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the North Saskatchewan River Basin. In total, existing licence and registrations allow a maximum of 281,971 dam^3 of water to be withdrawn for use. These licences assume that up to 205,316 dam^3 will be used and include a return flow allowance of 76,655 dam^3. As noted previously, 60 percent of water allocations are for the municipal sector, and municipal users are licensed to use 50 percent of all the water that can be consumed in the basin. Irrigation is the second most important water user, accounting for 22 percent of allocations and 28 percent of licensed consumption.

With respect to actual use, the exact volumes withdrawn and used in 2005 are not known because very few water use reports have been filed with Alberta Environment. However, based on the assumptions used in the previous sections, it is estimated that 66,112 dam^3 were actually used in 2005. This represents 32 percent of water use allowed in existing licences and registrations. Based on estimated use, the agricultural sector accounted for 41 percent of total water use in the South Saskatchewan River Basin in 2005, while industrial use accounted for 27 percent. Figure 6-18 shows how actual use compares to licensed allocations and use for each of the water use sectors.

Figure 6-18 Water Allocations and Actual Use, by Sector, South Saskatchewan River Basin



Forecasts of future water use in the South Saskatchewan River Basin are provided in Tables 6-26 to 6-28 for the low, medium and high growth scenarios. Predicted water use under the Medium growth scenario is shown in Figure 6-19. This figure shows very little growth, with the municipal and commercial sectors accounting for most of the increase, while industrial water use declines. Under the medium scenario, water demand in 2025 will be about 4.7 percent higher than at present. For the other scenarios, the increase in water demand over 20 years will range from 1.3 percent for low growth and 11.0 percent for high growth. For all scenarios, actual water use will be less than the amount that can be consumed under the terms of existing licences.

Figure 6-19 Forecast Water Use in the South Saskatchewan River Basin: Medium Scenario

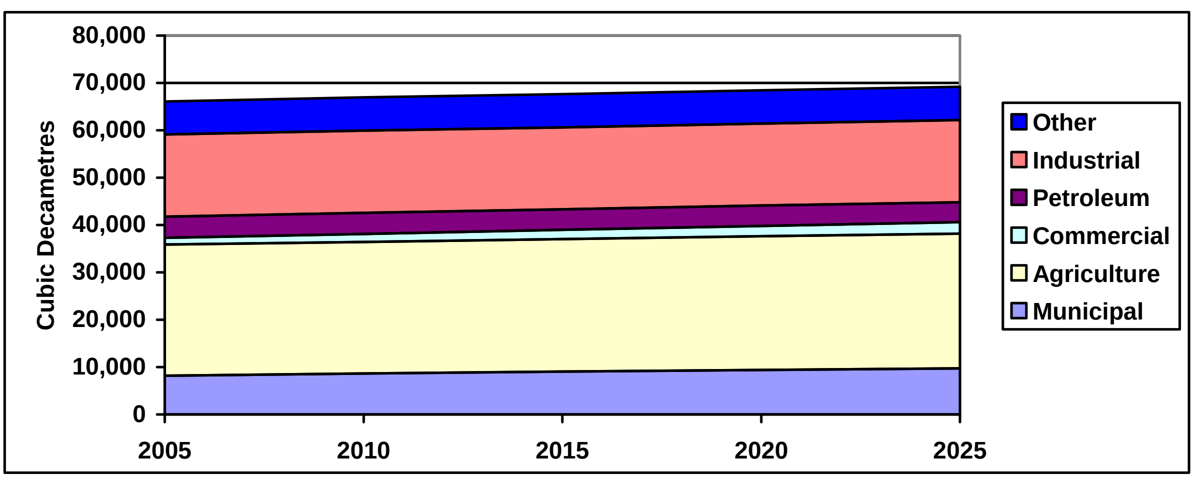


Table 6-25 Summary of Allocations and Estimated Water Use, South Saskatchewan River Basin

Sector		Licensed Allocation and Use (dam^3)				Estimated Water Use (dam^3)		
		Allocation	Water Use	Return	Percent of Total Use	Use	Percent of Licensed use	Percent of Total Use
Municipal		169,613	101,772	67,841	50%	8,203	8%	12%
Agricultural	Stockwatering	13,297	13,297	0	6%	2,960	22%	4%
	Irrigation	61,664	58,318	3,346	28%	24,685	42%	37%
Commercial		2,034	1,451	583	1%	1,451	100%	2%
Petroleum		6,881	6,108	772	3%	4,443	73%	7%
Industrial		19,803	17,349	2,454	8%	17,349	100%	26%
Other		8,680	7,021	1,659	3%	7,021	100%	11%
Total		**281,971**	**205,316**	**76,655**	**100%**	**66,112**	**32%**	**100%**

Table 6-26 Forecast Water Use, By Sector, South Saskatchewan River Basin: Low Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	8,101	8,343	8,502	8,626	8,705
	Agricultural	27,465	27,534	27,607	27,680	27,756
	Commercial	1,389	1,460	1,507	1,545	1,570
	Petroleum	4,271	4,271	4,187	4,187	4,139
	Industrial	17,167	17,167	17,167	17,167	17,167
	Other	7,021	7,021	7,021	7,021	7,021
	Total	65,414	65,796	65,991	66,226	66,358
Groundwater	Municipal	102	105	107	109	110
	Agricultural	180	185	189	194	198
	Commercial	62	62	62	62	62
	Petroleum	172	172	105	105	67
	Industrial	182	182	182	182	182
	Other	0	0	0	0	0
	Total	698	706	645	652	619
Total	Municipal	8,203	8,448	8,609	8,735	8,815
	Agricultural	27,645	27,719	27,796	27,874	27,954
	Commercial	1,451	1,522	1,569	1,607	1,632
	Petroleum	4,443	4,443	4,292	4,292	4,206
	Industrial	17,349	17,349	17,349	17,349	17,349
	Other	7,021	7,021	7,021	7,021	7,021
	Total	66,111	66,501	66,635	66,877	66,976

Table 6-27 Forecast Water Use, By Sector, South Saskatchewan River Basin: Medium Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	8,101	8,509	8,911	9,294	9,641
	Agricultural	27,465	27,635	27,817	28,009	28,213
	Commercial	1,389	1,631	1,871	2,100	2,309
	Petroleum	4,271	4,271	4,193	4,193	4,143
	Industrial	17,167	17,167	17,167	17,167	17,167
	Other	7,021	7,021	7,021	7,021	7,021
	Total	65,414	66,234	66,980	67,784	68,494
Groundwater	Municipal	102	107	112	117	122
	Agricultural	180	191	203	215	229
	Commercial	62	62	63	64	64
	Petroleum	172	172	110	110	70
	Industrial	182	182	182	182	182
	Other	0	0	0	0	0
	Total	698	714	670	688	667
Total	Municipal	8,203	8,616	9,023	9,411	9,763
	Agricultural	27,645	27,826	28,020	28,224	28,442
	Commercial	1,451	1,693	1,934	2,164	2,373
	Petroleum	4,443	4,443	4,303	4,303	4,213
	Industrial	17,349	17,349	17,349	17,349	17,349
	Other	7,021	7,021	7,021	7,021	7,021
	Total	66,111	66,947	67,649	68,471	69,160

Table 6-28 Forecast Water Use, By Sector, South Saskatchewan River Basin: High Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	8,101	8,814	9,593	10,372	11,132
	Agricultural	27,465	27,784	28,141	28,538	28,980
	Commercial	1,389	2,025	2,720	3,418	4,102
	Petroleum	4,271	4,271	4,210	4,210	4,153
	Industrial	17,167	17,167	17,167	17,167	17,167
	Other	7,021	7,021	7,021	7,021	7,021
	Total	65,414	67,082	68,852	70,726	72,555
Groundwater	Municipal	102	111	121	131	140
	Agricultural	180	200	224	249	278
	Commercial	62	63	64	66	67
	Petroleum	172	172	123	123	78
	Industrial	182	182	182	182	182
	Other	0	0	0	0	0
	Total	698	728	714	751	745
Total	Municipal	8,203	8,925	9,714	10,503	11,272
	Agricultural	27,645	27,984	28,365	28,787	29,258
	Commercial	1,451	2,088	2,784	3,484	4,169
	Petroleum	4,443	4,443	4,333	4,333	4,231
	Industrial	17,349	17,349	17,349	17,349	17,349
	Other	7,021	7,021	7,021	7,021	7,021
	Total	66,111	67,809	69,565	71,476	73,299

Red Deer River Basin

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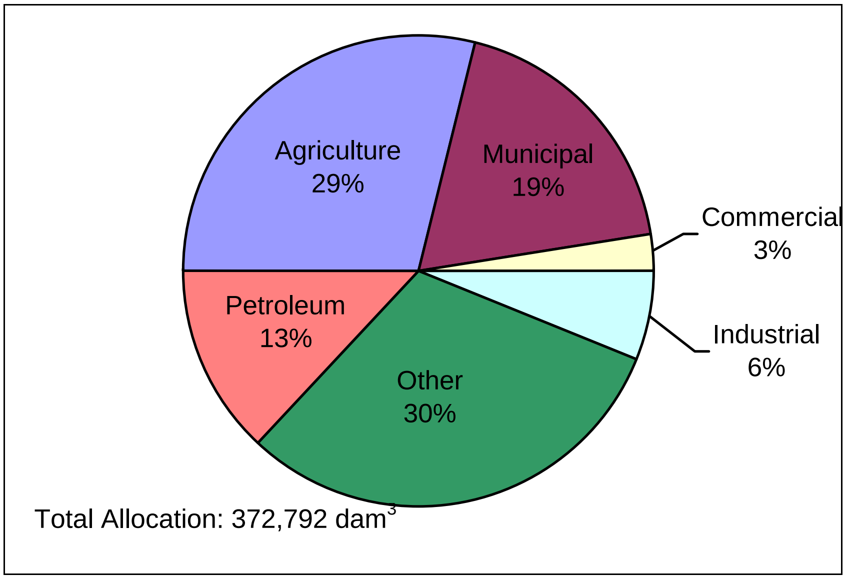
7.0 RED DEER RIVER BASIN

The Red Deer Basin, which is at 49,000 km^2 in area, occupies eight percent of Alberta. The Red Deer River flows into the South Saskatchewan River and forms part of the Nelson River system, which eventually drains into Hudson Bay. In 2001, the Basin had a population of 234,965 people, or eight percent of the provincial population. This indicates a population density of five people per square kilometre. The Red Deer Basin comprises all or parts of 57 urban municipalities, 17 rural or regional municipalities and one First Nation.

An overview of current surface and groundwater allocations is provided in Figure 7-1. It shows that in 2005 the other sector accounts for the largest percentage of water allocations in the Basin (30 percent). Allocations to the agricultural, municipal and petroleum sectors account for 24 percent, 19 percent and 13 percent, respectively. Total allocations in the Basin in 2005 were 372,792 dam^3.

Figure 7-1 Distribution of Active Water Allocations in the Red Deer Basin



Figures 7-2 and 7-3 show the location, allocation and sector of all active surface and groundwater licences in Red Deer Basin. Figure 7-4 shows the location of all registrations issued for the Red Deer River Basin.

7.1 MUNICIPAL AND RESIDENTIAL SECTOR

7.1.1 Population

In 2001 about 62 percent of the population of the Red Deer River Basin lived in an urban area, with 38 percent in total communities. There was a very small Aboriginal community in the Basin (see Table 7-1). Between 1996 and 2001 the population of the Basin grew by 11.4 percent or about 2.2 percent per year. The highest rates of population growth were observed in the urban communities.

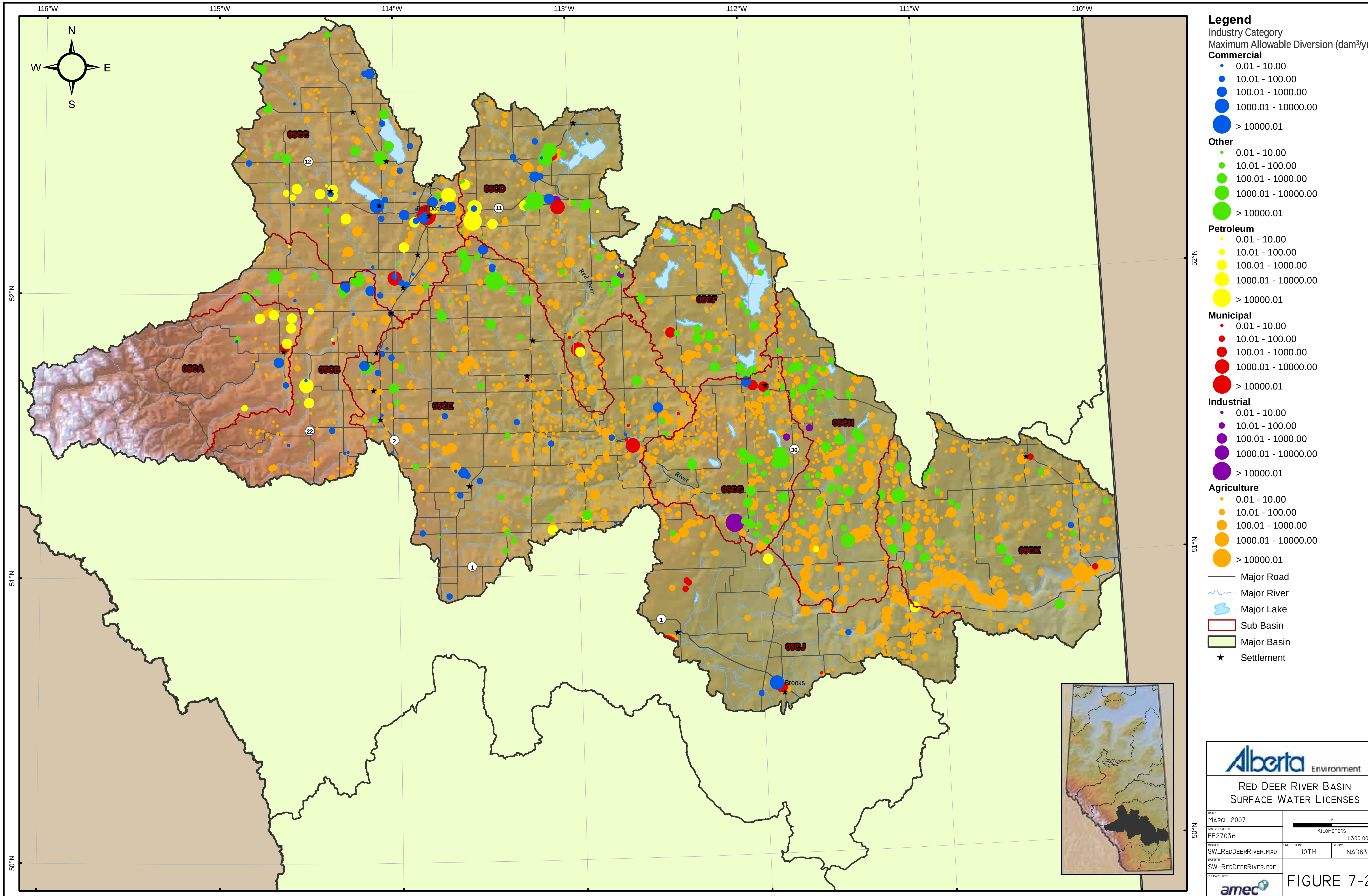
Table 7-1 Population Distribution and Growth in Red Deer River Basin, 2001

	2001		1996	1996 to 2001 Population Change
	Population	**Percent**	**Population**	**Percent**
Urban Municipality	146,061	62.2%	128,842	13.4%
Rural or Regional Municipality	88,859	37.8%	81,984	8.4%
First Nations and Métis Settlements	45	0.0%	41	9.8%
Total	**234,965**	**100%**	**210,867**	**11.4%**

Table 7-2 lists all the urban municipalities located in the Red Deer River Basin, their estimated 2001 population, and a summary of water licence information for those communities that have water licences for 100 dam^3 or more. The major urban centres include the City of Red Deer (67,707 residents) and the City of Brooks (11,604). Table 7-3 lists the populations of the all the rural or regional municipalities within the Red Deer River Basin. The largest rural populations are found in Red Deer County (18,639), the Municipal District of Rocky view No. 44 (13,006) and Mountain View County (12,096).

7.1.2 Water Allocations

As of 2005, there were 342 active municipal water licences for 133 licensees in Red Deer Basin. These licences allow maximum withdrawals of 69,340 dam^3, and this accounts for 19 percent of all licensed water allocations in the basin. Allocations to urban communities (cities, towns, villages, summer villages) account for 96 percent of total allocations. Rural users (subdivisions, cooperatives, farmsteads, single-multi homes and colonies) account for three percent of total allocations while other municipal uses (institutions, senior/correctional centres, nursing/children's homes, hospitals, schools and training centres) account for the remaining one percent.


Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Petroleum
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Municipal
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
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Industrial
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Agriculture
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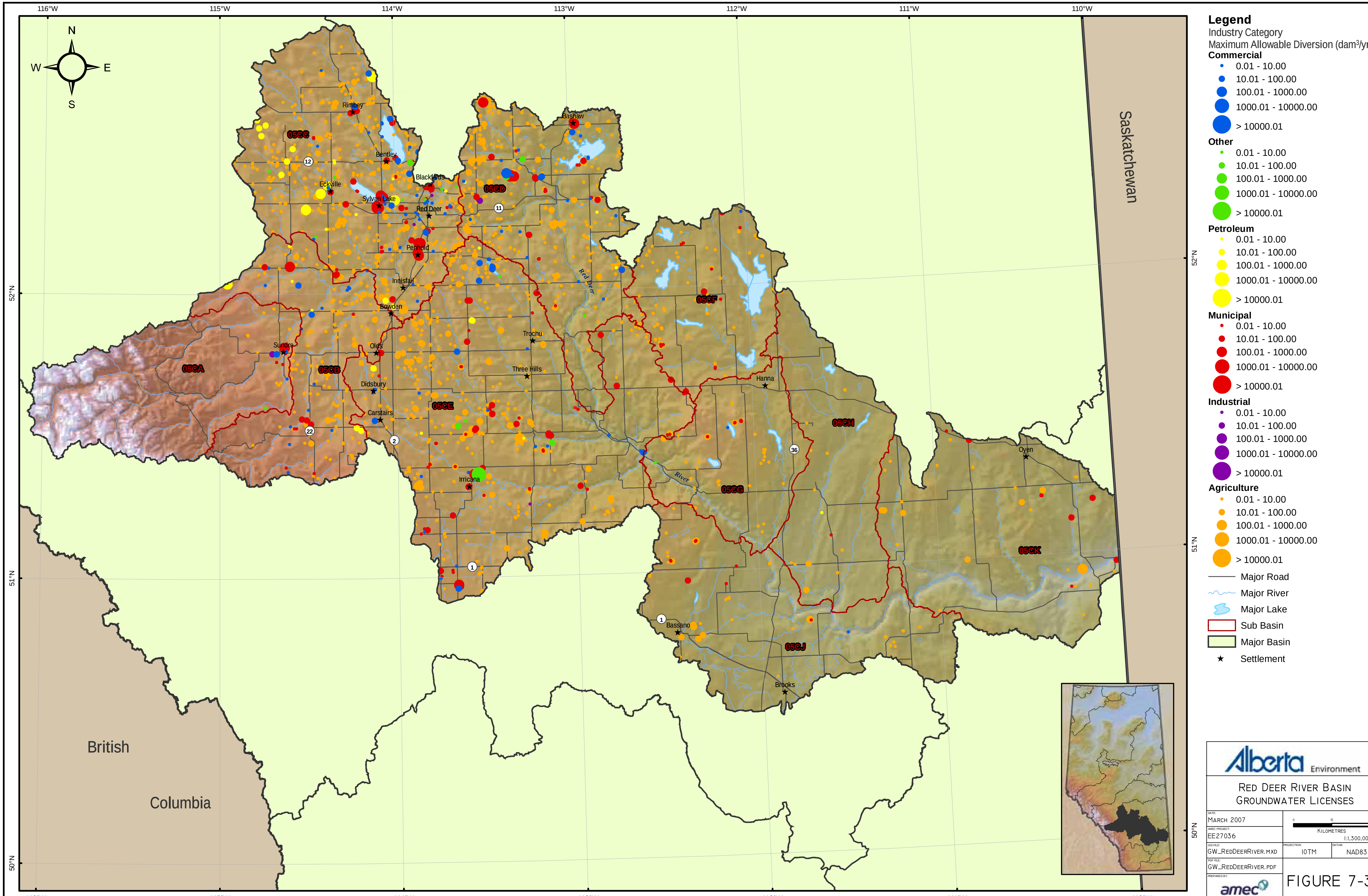
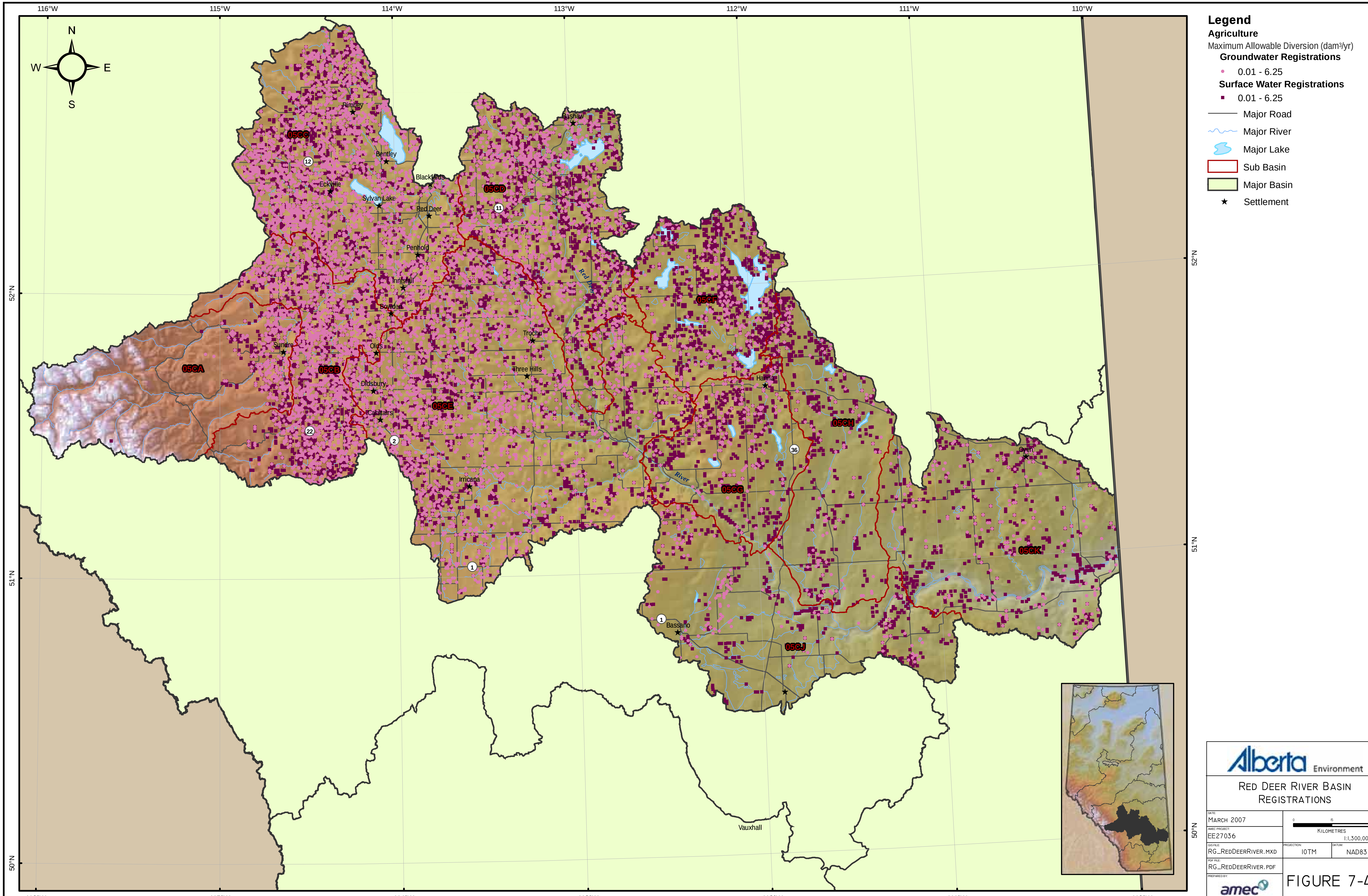
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
N
S
E
W
116°W
115°W
114°W
113°W
112°W
111°W
110°W
52°N
51°N
50°N
05CA
05CB
05CC
05CD
05CE
05CF
05CG
05CH
05CJ
05CK
Red Deer
Brooks
Red Deer
River
Alberta Environment
Red Deer River Basin
Surface Water Licenses
March 2007
EE27036
Kilometers
1:1,300,000
SW_RedDeerRiver.mxd
10TM
NAD83
SW_RedDeerRiver.pdf
amec
FIGURE 7-2



Red Deer River Basin Groundwater Licenses

FIGURE 7-3



Red Deer River Basin Registrations

FIGURE 7-4

Table 7-2 2001 Urban Municipal Population and Water Allocations within the Red Deer River Basin

Urban Municipality Name		2001 Population	Source	2005 Allocation (dam^3)
Cities	RED DEER	67,707	Surface	20,970
	BROOKS	11,604		
	CALGARY	1,754		
Towns	BASHAW	825	Groundwater	236
	BASSANO	1,320		
	BENTLEY	1,035	Groundwater	116
	BLACKFALDS	2,358	Groundwater	427
	BOWDEN	1,174		
	CARSTAIRS	935		
	CROSSFIELD	361		
	DIDSBURY	3,932		
	DRUMHELLER	7,785	Surface	4,107
	ECKVILLE	1,019	Groundwater	210
	HANNA	2,986	SW	802
	INNISFAIL	6,928	Surface	617
	IRRICANA	1,038	Groundwater	212
	OLDS	6,607		
	OYEN	1,020		
	PENHOLD	1,729	Groundwater	399
	RIMBEY	2,118	Groundwater	375
	STRATHMORE	1,363		
	SUNDRE	2,267	Surface Groundwater	249 739
	SYLVAN LAKE	7,493	Groundwater	1,847
	THREE HILLS	2,902	Surface	1,579
	TROCHU	1,033	Surface	358

Urban Municipality Name		2001 Population	Source	2005 Allocation (dam^3)
Villages	ACME	648	Groundwater	143
	ALIX	825	Groundwater	1,235
	BEISEKER	838	Groundwater	201
	BIG VALLEY	340	Groundwater	104
	CARBON	530		
	CAROLINE	556	Groundwater	215
	CEREAL	175		
	CLIVE	591		
	CREMONA	415	Groundwater	197
	DELBURNE	719	Groundwater	146
	DELIA	215		
	DUCHESS	836		
	ELNORA	290		
	EMPRESS	171		
	LINDEN	636		
	MIRROR	492		
	MORRIN	252		
	MUNSON	222		
	ROCKYFORD	375		
	ROSEMARY	366		
	YOUNGSTOWN	2		
Summer Villages	BIRCHCLIFF	105		
	BURNSTICK LAKE	10		
	GULL LAKE	143		
	HALF MOON BAY	37		
	JARVIS BAY	124		
	NORGLENWOLD	267		
	PARKLAND BEACH	97		
	ROCHON SANDS	58		
	SUNBREAKER COVE	86		
	WHITE SANDS	73		
TOTAL		**149,787**		**35,484**

Table 7-3 2001 Rural Municipal Population and Water Allocations within the Red Deer River Basin

Urban Municipality Name	2001 Population	Source	2005 Allocation (dam^3)
CAMROSE COUNTY	374		
CLEARWATER COUNTY	4,206		
COUNTY OF NEWELL NO. 4	4,127		
COUNTY OF PAINTEARTH NO. 18	294		
COUNTY OF STETTLER NO. 6	3,106		
COUNTY OF WETASKIWIN NO. 10	227		
CYPRESS COUNTY	193		
KNEEHILL COUNTY	5,319	Groundwater	273
LACOMBE COUNTY	8,680	Surface	107
MOUNTAIN VIEW COUNTY	12,096		
MD OF ACADIA NO. 34	493	Groundwater	128
MD OF BIGHORN NO. 8	652		
MD OF ROCKY VIEW NO. 44	13,006		
PONOKA COUNTY	4,370		
RED DEER COUNTY	18,639	Groundwater	769
SPECIAL AREAS (2, 3 AND 4)	3,080		
STARLAND COUNTY	2,210	Surface	370
WHEATLAND COUNTY	4,059		
Total	**85,131**		**1,647**

The municipal sector is allowed to withdraw up to 59,234 dam^3 of surface water from the Red Deer River Basin. Surface water licences represent 85 percent of total municipal water allocations and urban users have 21 licences that allow total withdrawals of 58,588 dam^3 (99 percent). Surface water allocations to rural uses only amount to 616 dam^3 (14 licences).

Municipal users are allowed to withdraw up to 10,105 dam^3 of groundwater. Groundwater licences account for 15 percent of total municipal water allocations and urban users account for 79 percent of these allocations (8,023 dam^3 over 141 licences). Another 1,628 dam^3 of groundwater has been allocated to rural users (over 124 licences).

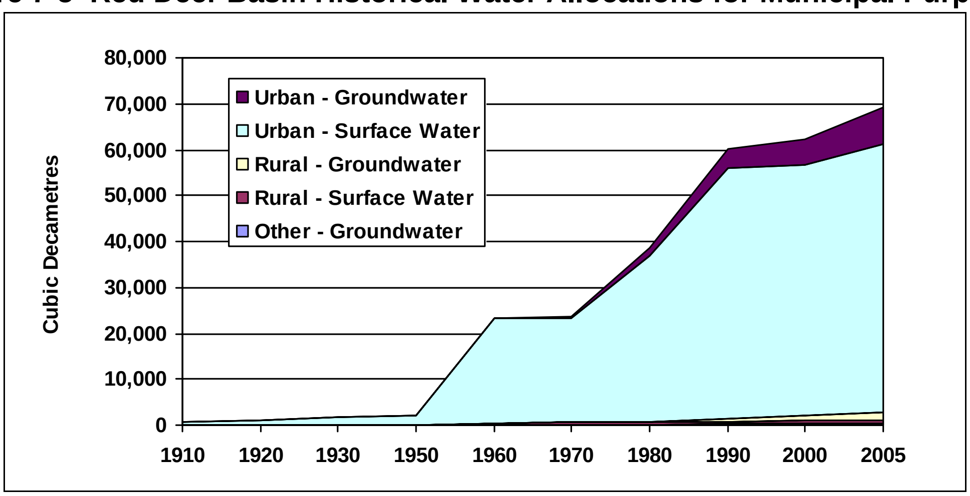
Table 7-3 identifies the other municipal water licensees that are allowed to withdraw large amounts of water (100 dam^3 or more) from the Red Deer River Basin. The combined allocations for large urban, rural and other municipal water licensees account for almost 97 percent of the total municipal allocation. It should be noted that the City of Brooks and the Town of Bassano draw their water from the Bow Basin but are located in the Red Deer Basin. The Town of Stettler is located in the Battle Basin but is drawing water from the Red Deer Basin.

Table 7-4 Other Large Municipal Water Licensees in the Red Deer River Basin

Approval Holder	Water Source	Allocation (dam3)
MOUNTAIN VIEW REGIONAL WATER SERVICES COMMISSION	Surface	9,954
KNEEHILL REGIONAL WATER SERVICES COMMISSION	Surface	2,350
TOWN OF STETTLER	Surface	1,696
LANGDON WATERWORKS LIMITED	Groundwater	400
BOWDEN INSTITUTION	Groundwater	205
JEWAL INVESTMENTS LTD.	Groundwater	112
Total		**14,717**

Figure 7-4 shows how allocations for municipal water use in Red Deer Basin have changed since 1910. Municipal uses accounting for less than 0.1 percent of MAD are not shown. Most municipal allocations have been for urban surface water through time, with rapid growth in allocations occurring in the 1950's, 1970's and 1980's. Rural and urban groundwater allocations have grown steadily since 1990. Municipal water allocations increased by 12 percent between 2000 and 2005.

Figure 7-5 Red Deer Basin Historical Water Allocations for Municipal Purposes



7.1.3 Licensed Water Use

Table 7-5 summarizes licensed water use for the municipal sector in the Red Deer River Basin. These licensees assume that a maximum of 33,733 dam^3 will be used (i.e. 49 percent of withdrawals can be consumed and/or lost), and the remainder (35,606 dam^3 or 51 percent) will be returned to surface water sources. The licences issued to surface water users include 54 percent of diversions, but there are no return flow allowances for rural or other municipal users licensed to use surface water. Municipal users of groundwater are assumed to return 38 percent of their withdrawals, although this proportion ranges from 40 percent of the urban groundwater users to 26 percent for rural groundwater users.

7.1.4 Actual Water Use

In 2005, only five percent of municipal licensees reported their water diversions to the provincial government through the WURS. These seven licensees were allowed to divert 28,374 dam^3 which represents 41 percent of total allocations for all municipal users in the basin. For 2005 they reported actual diversions of 21,367 dam^3 or 75 percent of their allocations. Only three of the seven licensees reported return flows; these flows totalled 1,506 dam^3 in 2005. Additional information on municipal water use was available from Environment Canada's Municipal Use database. MUD contains diversion information for 18 municipalities representing 65 percent of the basin's 2001 population, but only two reported return flow. The two data sets were combined to calculate ratios of allocation to actual diversion and actual diversion and licensed use to actual use, and these ratios were used to develop water use estimates for all municipalities.

Table 7-5 Estimated Municipal Water Use in the Red Deer River Basin

Municipal Use	Source	Withdrawals (dam^3)	Use (dam^3)	Return Flow (dam^3)
Urban	Surface	43,212	20,914	22,298
	Groundwater	2,612	823	1,789
	Subtotal	**45,824**	**21,737**	**24,087**
Rural	Surface	455	455	0
	Groundwater	592	434	158
	Subtotal	**1,046**	**888**	**158**
Other	Surface	22	22	0
	Groundwater	165	105	60
	Subtotal	**187**	**127**	**60**
Total Use	Surface	43,689	21,391	22,298
	Groundwater	3,369	1,362	2,007
	Total	**47,058**	**22,752**	**24,305**
Licensed Use	Surface	59,234	27,449	31,785
	Groundwater	10,105	6,284	3,821
	Total	**69,339**	**33,733**	**35,606**
Percent of Licensed Use	Surface	73.8%	77.9%	70.2%
	Groundwater	33.3%	21.7%	52.5%
	Total	**67.9%**	**67.4%**	**68.3%**

Table 7-6 Licensed and WURS Reported Diversions, Water Use and Returns by Type of Municipal Use for Red Deer Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Use (dam^3)		
			Allocation	Water Use	Return	Diversion	Water Use	Return)
Urban*	Surface	21	58,588	26,803	31,785	17,589	2,830	1,492
	Groundwater	141	8,023	4,790	3,233	115	15	14
	Subtotal	**162**	**66,611**	**31,593**	**35,018**	**17,704**	**2,845**	**1,506**
Rural**	Surface	14	616	616	0	N/A	N/A	N/A
	Groundwater	124	1,628	1,204	424	3,663	N/A	N/A
	Subtotal	**138**	**2,244**	**1,820**	**424**	**3,663**	**N/A**	**N/A**
Other***	Surface	5	30	30	0	N/A	N/A	N/A
	Groundwater	37	454	290	164	N/A	N/A	N/A
	Subtotal	**42**	**484**	**320**	**164**	**N/A**	**N/A**	**N/A**
Total	Surface	40	59,234	27,449	31,785	17,589	2,830	1,492
	Groundwater	302	10,105	6,284	3,821	3,779	15	14
	Total	**342**	**69,339**	**33,733**	**35,606**	**21,367**	**2,845**	**1,506**

* Urban includes villages, summer villages, towns, cities, hamlets;

** Rural includes condominiums / townhouses / mobile homes / complexes, hotels / motels, cooperatives, farmsteads, single-multi homes, colonies and subdivisions

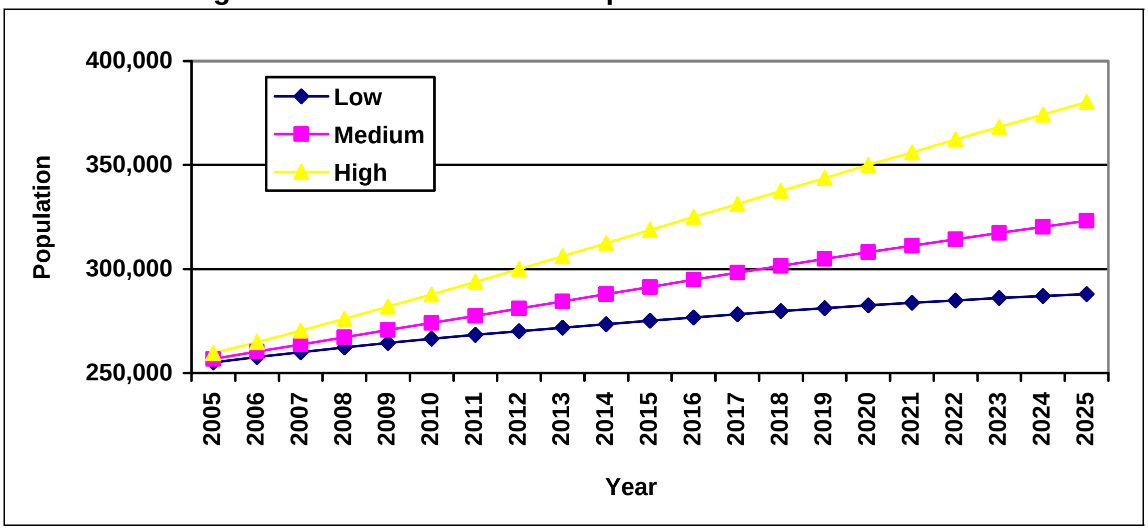
*** Other includes camps, institutions, senior/correctional centres, nursing/children's homes, hospitals

As shown in Table 7-5, municipalities are withdrawing about 68 percent of their licensed allocations. This ranges from 74 percent for surface water users to 33 percent for groundwater users. Surface water utilization is 78 percent and groundwater utilization is approximately 22 percent of the licensed water use amounts. Overall, municipal water use is estimated to be 67 percent of the municipal use allocation within Red Deer Basin.

7.1.5 Future Water Use Forecasts

Figure 7-6 shows low, medium and high population projection scenarios for Red Deer Basin based on Alberta Finance Census Division projections. The population forecasts in Figure 7-6 have been used to predict future municipal surface and groundwater use. The resulting forecasts of water use are provided in Table 7.7 and are based on the estimated per capita water use in 2005.

Figure 7-6 Red Deer Basin Population Growth Forecast



Under the low population growth scenario, municipal water use in 2025 is expected to be 13 percent greater than at present and diversions will be approximately 77 percent of current allocations in 2025. Water use is expected to be 76 percent of current licensed use under the low population growth scenario in 2025. Under the high population growth scenario, water use will increase by 47 percent over current levels and total diversions of groundwater and surface water are expected to be 99 percent of current municipal allocations. Water use is expected to be 99 percent of current licensed use under the high population growth scenario in 2025.

Table 7-7 Projected Water Use for the Municipal Sector in the Red Deer Basin
(dam^3)

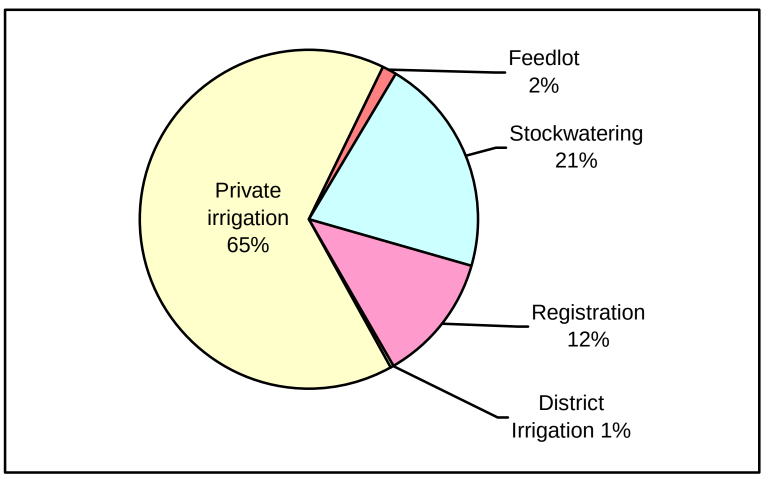
Scenario	Source	2005	2010	2015	2020	2025
Low Population Growth	Surface	21,391	22,347	23,066	23,690	24,144
	Groundwater	1,362	1,422	1,468	1,508	1,537
	Total	22,752	23,769	24,534	25,199	25,680
Medium Population Growth	Surface	21,391	22,826	24,270	25,662	26,920
	Groundwater	1,362	1,453	1,545	1,633	1,714
	Total	22,752	24,279	25,814	27,296	28,634
High Population Growth	Surface	21,391	23,727	26,276	28,850	31,342
	Groundwater	1,362	1,511	1,672	1,837	1,995
	Total	22,752	25,238	27,948	30,686	33,337

7.2 AGRICULTURAL SECTOR

As of December 2005 a total of 107,448 dam^3 had been allocated to the agricultural sector in the Red Deer River Basin. This includes 19,023 registrations representing 13,047 dam^3 and 4,243 licences representing 94,400 dam^3 of water. Water allocated to agriculture accounts for 29 percent of all allocations in the Red Deer River Basin.

Figure 7-6 shows how this water is distributed among the different agricultural uses in the Basin. The largest allocation is for private irrigation (65 percent). Stockwatering accounts for 21 percent, registration accounts for 12 percent, and feedlot and district irrigation together account for two percent of the total allocation.

Figure 7-7 Water Allocation for Agricultural Activities in the Red Deer Basin



A total of 9,677 registrations and 2,222 licences allow withdrawals of up to 87,369 dam^3 of surface water; this accounts for 81 percent of all water allocated to the agricultural sector. Groundwater accounts for 19 percent of allocations for agricultural purposes; 2,021 licences and 9,346 registrations have been issued to withdraw up to 20,078 dam^3 of groundwater.

7.2.1 Overview of Agriculture in the Red Deer Basin

Based on estimates derived from the 2001 Census of Agriculture, there were about 13,058 farms in the Red Deer River Basin, with an average size of 922 acres. These are farms account for 25 percent of all farms in Alberta in the Red Deer Basin. At the provincial level there are about 53,000 farms with an average size of 970 acres. Farms in the Red Deer River Basin cover an area of nearly 12 million acres; this is equivalent to about 48,000 km^2 or about 97 per cent of the basin. Table 7-8 shows that about 43 percent of the land in the Basin is used to raise crops. About five per cent of agricultural land is summer fallowed. Most of the remaining land, about 48 percent is pasture.

Table 7-8 Agricultural Land Use in the Red Deer River Basin, 2001

Land Use	Acres	Percent
Crop Land	5,196,795	43.1%
Summerfallow	544,590	4.5%
Tame/Seeded Pasture	1,294,424	10.7%
Natural Pasture	4,526,008	37.6%
Other	483,021	4.0%
Total	**12,044,838**	**100.0%**

The types of farming activity vary within the Red Deer Basin. Table 7-9 shows the classification of farms based on the commodity groups that accounted for 51 per cent or more of total gross farm receipts.

Table 7-9 Classifications of Farms in the Red Deer Basin and Alberta, 2001

Farm Type (Farms with Gross Receipts >$2,500)	Percent of Farms in the Red Deer Basin	Percent Share of Alberta	Alberta Farm Type (Percent)
Dairy Farms	2.1%	33.2%	1.5%
Cattle (beef) Farms	49.2%	26.6%	45.4%
Hog Farms	2.3%	33.3%	1.7%
Poultry & Egg Farms	1.2%	32.7%	0.9%
Wheat Farms	6.1%	20.3%	7.4%
Grain & Oilseed Farms	16.1%	21.4%	18.4%
Field Crop Farms	7.5%	19.5%	9.3%
Fruit Farms	0.1%	24.7%	0.1%
Misc. Specialty Farms	11.4%	25.8%	10.9%
Sum of Livestock Comb. Farms	2.2%	23.7%	2.3%
Sum of Vegetable Farms	0.1%	15.8%	0.1%
Sum of Other Comb Farms	1.7%	21.3%	2.0%
Total	**100.0%**	**24.5%**	**100.0%**

The table shows that 49 percent of the farms in the Basin raise beef cattle and about 16 percent of the farms are grain and oilseed farms. Specialty farms make up about 11 percent of the farms. Like Alberta, cattle (beef) farms are the most common farm type in the basin. However, the Red Deer River Basin contains a higher proportion of dairy, hog and poultry farms.

7.2.2 Stockwatering

As noted in Table 7-9 about 55 percent of the farms in the Red Deer Basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species in 2001 are provided in Table 7-10. The table shows that there about two million cattle and calves which, together, accounted for about 85 percent of livestock population in the Red Deer Basin in 2001. The population of cattle and calves is about 9.6 times the human population of the Basin. Other livestock in the Red Deer Basin included pigs, sheep and lamb, horses and ponies, bison, deer and elk.

Table 7-10 Estimated Livestock Populations in the Red Deer Basin and Alberta, 2001

Livestock Species	Basin Total	Alberta	% Alberta
Hens and Chicken	3,096,101	12,175,246	25.4%
Turkey	134,394	864,438	15.5%
Cattle	1,692,255	6,615,201	25.6%
Calves	555,218	2,169,607	25.6%
Pigs	705,622	2,027,533	34.8%
Sheep and Lamb	73,529	307,302	23.9%
Horse and Ponies	44,529	159,962	27.8%
Bison	12,179	79,731	15.3%
Deer	723	8,331	8.7%
Elk	5,336	31,304	17.0%

7.2.2.1 Water Allocation

Overall 22,766 licences and registrations have been issued for livestock watering with total allocation amounting to 57,096 dam^3. In addition to these allocations, farmers are able to obtain up to 1,250 m^3 of water for household purposes and can also obtain water as “exempted agricultural” users. There is no information on either the numbers of such households or the amount of unlicensed water use in the basin.

A historical perspective on water used for livestock is provided in Figure 7-8. The figure shows that some registrations were issued with priority dates in the 1890s while licences for stockwatering began to be issued in the early 1900s. Allocations for stockwatering have risen steadily since the 1920s, with substantial increases occurring in groundwater registrations which now account for about 50 percent of all allocations. Since 1990 water allocations have remained relatively steady at around 57,000 dam^3. Over the last few decades there has been an increase in the number of intensive livestock operations in Alberta, including feedlots. In the Red Deer Basin, the first allocations for feedlots were issued in the 1980s but are relatively minor, currently accounting for about three percent of total livestock water allocation.

Figure 7-8 Historical Trends in Water Allocation for Livestock in the Red Deer Basin

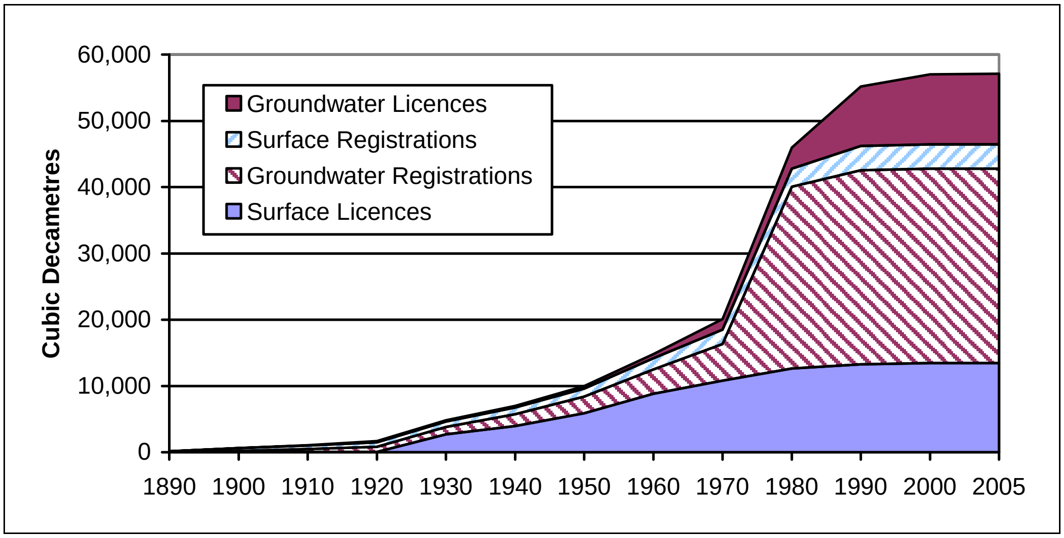


Table 7-11 summarizes current water licences and registrations issued for livestock according to the water source. It shows that surface water accounts for about 30 percent of allowable diversions for livestock and that registrations account for 26 percent of allocations.

7.2.2.2 Licensed Water Use

Table 7-11 shows that for the majority of licences and registrations for stockwatering there are no return flow allowances. There are allowances for return flows of 3.7 dam^3 from some surface water licences, but this represents less than 0.01 percent of total water allocations for livestock.

7.2.2.3 Actual Water Use

There is no information in Alberta Environment's WURS that indicates the extent to which water allocations are actually used in the Red Deer Basin. However, a reasonable estimate of water use can be derived using the actual animal population in the Basin as shown in Table 7-10. Based on livestock populations for the Red Deer Basin in 2001, the total water required for livestock was estimated to be 21,289 dam^3, or about 57 percent of the licensed allocation. The calculations for this estimate are provided also in Table 7-12 which shows livestock populations in the Basin and the daily water requirements for various livestock species as provided by Alberta Environment in its "Guide to Calculate Quantities for Water for Raising Animals". In terms of water requirements by species, cattle account for about 85 percent of the total, about nine percent is required by pigs, one percent is required by poultry and all other species accounted for the remaining five percent.

Table 7-11 Summary of Water Licences and Registrations Issued for Livestock Watering in the Red Deer Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use (dam^3)
Feedlot	Surface	10	355.5	355.5	0.0	0	N/A
	Groundwater	86	1,364.3	1,364.2	0.0	0	N/A
	Subtotal	**96**	**1,719.8**	**1,719.8**	**0.0**		
Stock watering	Surface	1,717	13,078.6	13,074.8	3.7	0	N/A
	Groundwater	1,930	9,285.3	9,285.3	0.0	0	N/A
	Subtotal	**3,647**	**22,363.8**	**22,363.8**	**3.7**		
Registration	Surface	9,676	3,650.4	3,650.4	0.0	0	N/A
	Groundwater	9,347	9,396.6	9,396.6	0.0	0	N/A
	Subtotal	**19,023**	**13,047.0**	**13,047.0**	**0.0**		
Total	Surface	11,403	17,084.5	17,080.7	3.7	0	N/A
	Groundwater	11,363	20,046.2	20,046.1	0.0	0	N/A
	Total	**22,766**	**37,130.6**	**37,126.9**	**3.7**	**0**	**N/A**

Table 7-12 Estimated Livestock Water Requirements for 2001

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chickens	3,096,101	0.045	231.0
Turkey	134,394	0.15	33.4
Bulls	30,990	9.0	462.5
Milk Cows	26,674	30.0	1,327.0
Beef Cows	571,825	9.0	8,534.5
Heifers	235,700	6.0	2,345.2
Steers	262,037	6.0	2,607.3
Calves	555,218	3.0	2,762.2
Boars	2,628	6.5	28.3
Sows and Gilts - Breeding	68,521	6.5	738.6
Nursing and Weaner Pigs	237,768	0.5	197.1
Grower and Finishing Pigs	384,430	1.5	956.3
Sheep and Lambs	73,529	2.0	243.9
Horse and Ponies	44,529	10.0	738.4
Bison	12,179	2.0	40.4
Deer	723	10.0	12.0
Elk	5,336	3.5	31.0
Total			**21,289.3**

While the estimated actual consumption based on livestock populations (21,289 dam^3**)** appears to be less than the amount of water allocated (37,130 dam^3), the data in Table 7-12 do not include an allowance for the evaporative and seepage losses associated with storing water for livestock use. Typically, licensed consumption accounts for only 35 per cent of surface water allocated for livestock use while losses account for 65 percent (Watrecon 2005). Since 54 percent of livestock water consumption comes from groundwater (no losses) and the balance comes from surface water with 65 percent losses, a total allocation of 26,562 dam^3 would be required to support the animal populations in Table 7-10. This water requirement is about is about 70 percent of the water allocation through licences and registrations.

While the analysis suggests that allocations exceed actual livestock requirements, this may not necessarily be the case because many farmers have multiple registrations so that, in dry years, they will have sufficient water even if their dugouts are only half full.

7.2.2.4 Forecasts of Future Stockwatering Water Use

Changing cattle populations in the Basin is the key factor affecting future livestock water demand. Cattle account for about 85 percent of livestock water demand in the Red Deer Basin, so changes in the populations of other livestock species will have a minimal overall impact on future water demand. The historical trend analysis in Figure 7-8 shows that the amount of water allocated for livestock has been increasing over time, suggesting an increasing livestock population. The data from the Census of Agriculture corroborates this finding; it shows that the cattle population increased between 1996 and 2001.

Some indication of the potential for expansion of cattle populations in the Red Deer River Basin can be determined by examining applications for new and expanded confined feeding operations, which must be approved by the NRCB in accordance with *AOPA*. Information from the NRCB in Table 7-13 indicates that, as of December 31, 2005, there had been 41 applications from farmers throughout the Basin for cattle and dairy operations, most of which were approved. Many of the livestock expansions approved in Alberta under *AOPA* have been in the Red Deer River Basin.

Table 7-13 Status of Applications under *AOPA* in the Red Deer Basin

Type of Application	Number	Withdrawn	Approved	Denied
Approval	7	0	5	2
Registrations	14	1	9	4
Authorizations	20	0	19	1
Total	**41**	**1**	**33**	**7**

A study undertaken by AAFRD in the late 1990s also provides some insights regarding the potential for expansion of the beef industry in the province. That study identified several criteria – manure, odour and population densities, local silage supplies, water supply, landscape characteristics and land for manure spreading – to be considered in evaluating the capability of supporting a 5,000-head back grounding operation and a 20,000-head operation. Townships suitable for livestock expansions are shown in Figures 2-2 and 2-3 in Section 2.3. The figures show that more townships meet all of the criteria for backgrounding operations than finishing operations. For most townships that meet some of the criteria limiting factors include groundwater and landscape for backgrounding operations. For finishing operations relatively few townships meet any of the criteria. However, some townships meet some criteria but are limited by groundwater availability and landscape. Based on AAFRD's assessment, it would appear that livestock expansion in the Red Deer River Basin could occur and would most likely consist of 5,000-head operations. This assessment together with the information from the NRCB suggests that future expansion of livestock is likely.

Projections of future water demands for livestock are based on the expectations that cattle populations will increase at annual rates somewhere between 1.2 percent (Low Growth) and 3.2 percent (High Growth). As Base Growth, annual rate is assumed to be 2.2 percent, which reflects average annual growth rate in cattle population in Alberta during 1958-2005. This forecast also assumes that the current mix of livestock (85 percent cattle) and balance of surface and groundwater use will remain unchanged over the forecast period. The resulting projections, based on actual use are shown in Table 7-14.

Table 7-14 Water Use for Livestock in the Red Deer River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	15,066	15,992	16,975	18,018	19,125
	Groundwater	11,496	12,203	12,953	13,749	14,594
	Total	**26,562**	**28,195**	**29,927**	**31,767**	**33,719**
Medium Growth	Surface	15,066	16,798	18,729	20,882	23,282
	Groundwater	11,496	12,818	14,291	15,934	17,765
	Total	**26,562**	**29,615**	**33,020**	**36,815**	**41,047**
High Growth	Surface	15,066	17,636	20,644	24,166	28,287
	Groundwater	11,496	13,457	15,752	18,439	21,585
	Total	**26,562**	**31,093**	**36,397**	**42,605**	**49,872**

Under the Low Scenario, water demand is projected to increase to 33,719 dam^3 by 2025; this represents a 27 percent increase over current use and is about the same as current allocations. Under the High Scenario, livestock water use would increase to 49,872 dam^3 by 2025. This increase is 90 percent higher than current livestock use and exceeds current allocation by 12,000 dam^3. .

The proposed Special Areas Water Supply Project which would provide additional water (76,500 dam^3) to the Special Areas in the Basin is also noted. A socioeconomic assessment conducted by Watrecon (2005b) found that availability of water would allow farmers to grow the forage needed to support and expand livestock herds. However, discussions with Alberta Environment revealed that the project has not yet been initiated and assumptions of the project commencement would be speculative. Therefore, the forecasts exclude any effects from the Special Areas Water Supply Project. Furthermore, as will be explained in Section 8.2.5.4, there are limited opportunities to expand irrigation for forage; therefore, livestock growth is likely to occur only at Low Growth rate.

7.2.3 Irrigation

The other major use of water for agricultural purposes is irrigation or crop watering. Although some licences have been issued for district irrigation in the Red Deer Basin, the acres actually irrigated are located outside the basin. However, these allocations are very small (28 dam^3 or 0.04 percent of allocation for irrigation).

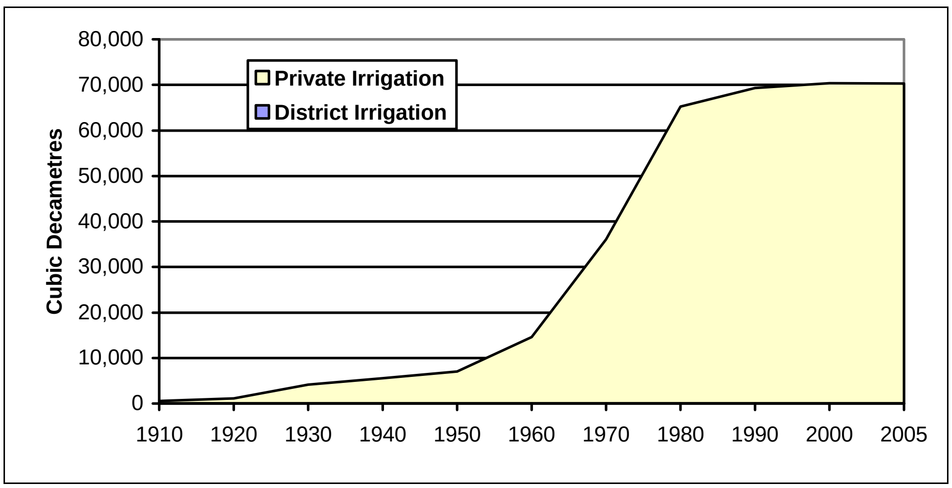
Almost of the irrigation in the Red Deer River Basin is done by private irrigators who have their own water licences and divert water using their own pumps and water distribution equipment. When aggregate information from the 2001 Census of Agriculture for individual counties and municipal districts is modified to reflect river Basin boundaries, the resulting estimates suggest that about 245,000 acres of land in the Red Deer River Basin were irrigated in 2001. This number could be incorrect however, because irrigation acres are not evenly distributed throughout each of the counties that make up the Basin and because of likelihood of inaccuracy in the Census data. A better estimate of the irrigated acres can be made based on water allocations and irrigation requirement of about 450 mm (18 inches). Based on this requirement

it is estimated that water allocations are sufficient to support irrigation on about 58,000 acres. There is no information on the mix of crops grown by private irrigators; AAFRD[1] has indicated that most private irrigation in Alberta is used to raise supplemental forages to feed livestock.

7.2.3.1 Water Allocation

There are 495 private licences that allocate approximately 70,288 dam^3, for irrigation purposes. Over 99 percent of irrigation allocations are from surface water. The Red Deer River Basin accounts for about 10 percent of water allocations for private irrigation and about 20 percent of the private irrigation licences in Alberta. A historical perspective on water used for irrigation is provided in Figure 7-9. The figure shows that allocation for irrigation commenced in about 1910. Water allocations began to increase in the 1920s and grew very rapidly in the 1960s and 1070s. Since the 1980s, allocations have remained stable. As of 2005, about 70,000 dam^3 had been allocated to private irrigation.

Figure 7-9 Historical Trends in Surface Water Allocation for Irrigation in the Red Deer Basin



7.2.3.2 Licensed Water Use

Table 7-15 summarizes the water licences issued for irrigation according to water source. The table shows that licences issued for surface water assume that up to 97 percent of the total allocation will be used and that only three percent (1951 dam^3) will be returned to surface sources. No return flow is associated with groundwater allocation.

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[1] Cited in Watrecon (2005) as Personal communication, Wally Chinn, Head - Irrigation Development Section, Irrigation Branch, AAFRD, January 7, 2005.

Table 7-15 Irrigation Allocations and Use and Reported Actual Water Use, Red Deer River Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
District irrigation	Surface	5	28.4	28.4	0.0	0	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Subtotal	**5**	**28.4**	**28.4**	**0.0**	**0**	**N/A**
Private irrigation	Surface	490	70,256.4	68,305.3	1,951.1	0	N/A
	Groundwater	5	32.0	32.0	0.0	0	N/A
	Subtotal	**495**	**70,288.4**	**68,337.3**	**1,951.1**	**0**	**N/A**
Total	Surface	495	70,284.8	68,333.6	1,951.1	0	N/A
	Groundwater	5	32.0	32.0	0.0	0	N/A
	Total	**500**	**70,316.8**	**68,365.6**	**1,951.1**	**0**	**N/A**

7.2.3.3 Actual Water Use

Neither AAFRD nor AENV has any information on actual water use by private irrigators. For the purposes of this study it is assumed that actual use is equal to licensed water use. However, water use in any given year will depend on how much of the crop water demand can be satisfied by natural precipitation. It is noteworthy that water allocated for crop watering use is 2.6 times the amount of water that can be used for stockwatering.

7.2.3.4 Forecasts of Future Irrigation Water Use

With expansion of livestock, additional demand for livestock forage is expected. The historical trend provided in Figure 7-9 shows that water allocation for irrigation has increased over time, suggesting that past increases in livestock have led to increased water demand for expansion in irrigated crop areas. However, future expansion of irrigated acres is unlikely given limited water supply in the Basin. Irrigation is a capital intensive operation but the net returns from forage production are not great (Watrecon 2005). Although the Special Areas Water Supply Project would provide water (76,500 dam^3) to irrigate additional 25,000 acres, discussions with Alberta Environment revealed that the project has not been initiated and assumptions of the project commencement would be speculative. Therefore, irrigation water use is expected to remain unchanged from current level of 68,366 dam^3 over the forecast period. Additional forage for livestock expansion would have to be accommodated within the existing irrigation allocations

7.2.4 Summary

In summary, current agricultural water use in the Red Deer Basin is estimated to be about 94,900 dam^3, of which 72 percent is for irrigation and 28 percent is for livestock. In the future, agricultural water demand in the Basin is expected to increase as a result of expansion of livestock populations. Demand for irrigation is expected to remain constant. A summary of future agricultural water demand is provided in Table 7-16.

Table 7-16 Projected Water Use for Agriculture in the Red Deer River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	83,371	84,297	85,280	86,323	87,431
	Groundwater	11,528	12,235	12,985	13,781	14,626
	Total	**94,899**	**96,532**	**98,265**	**100,104**	**102,056**
Medium Growth	Surface	83,371	85,103	87,034	89,187	91,587
	Groundwater	11,528	12,850	14,323	15,966	17,797
	Total	**94,899**	**97,953**	**101,357**	**105,152**	**109,384**
High Growth	Surface	83,371	85,941	88,949	92,471	96,593
	Groundwater	11,528	13,489	15,784	18,471	21,617
	Total	**94,899**	**99,430**	**104,734**	**110,942**	**118,209**

According to the forecasts, agricultural water use in 2025 would be about 102,056 dam^3 under the Based Case, which represents an increase of eight percent from 2005. Under High Case,

water use is projected increase by 25 percent over current levels to about 118,209 dam^3.

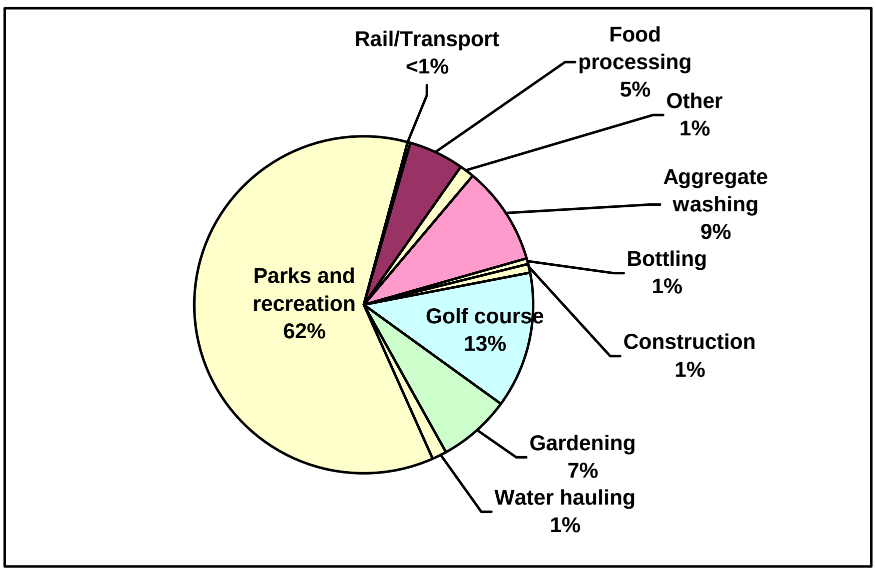
7.3 COMMERCIAL SECTOR

There are 248 licences that allow diversion of about 9,948 dam^3 of water in the Red Deer Basin. This allocation accounts for three percent of total allocations in the Basin.

7.3.1 Water Allocations

As shown in Figure 7-10, more than 60 percent of the water allocations for commercial purposes are for parks and recreation (78 licences with allocation of 6,032 dam^3). Other important commercial activities include golf courses (52 licences with allocation of 1,310 dam^3) and aggregate washing (21 licences with allocation of 941 dam^3). Allocations for all other commercial activities are relatively minor, accounting for 16 percent of the total.

Figure 7-10 Water Allocation for Commercial Activities in the Red Deer Basin

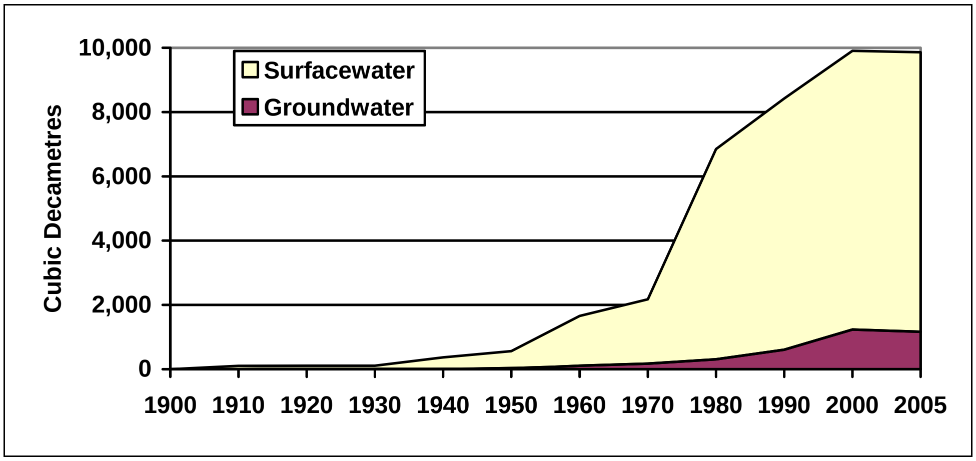


Licences issued for the commercial sector allow maximum withdrawals of about 8,696 dam^3 of surface water; surface water accounts for 86 percent of allocations for commercial purposes. The largest surface water allocation is for parks and recreation which accounts for about 70 percent of the total surface water allocation. Fourteen percent of commercial allocations are for groundwater with licences for 1,251 dam^3. The largest groundwater allocation is for golf courses which account for about 20 percent of total groundwater allocations.

A historical trend of commercial sector allocation in the Red Deer Basin is provided in Figure 7-11. The earliest allocations began in the 1900s for groundwater but the allocations remained relatively unchanged constant until the 1950s. Since that time groundwater allocations increased gradually but have remained relatively constant since 2000s. The first surface water allocations were issued in the 1900s and remained relatively unchanged until the 1920s. Since

that time there have been sharp increases in allocations related to parks and recreation and gardening activities, although there have been no additional allocations since 2000. Overall, groundwater allocations make up a small proportion of total water allocations for commercial purposes.

Figure 7-11 Historical Trend in Commercial Sector Water Allocation in the Red Deer Basin



7.3.2 Licensed Water Use

Table 7-17 provides a summary of licensed water allocations, use and return for various activities within the commercial sector in the Red Deer Basin. The table shows that return flow allowances in licences totalled 3,256 dam^3 (33 percent of allocation) are to be returned. Return flow allowances in licences amount to 37 percent of surface water allocations but only two percent of groundwater allocations. Return flow requirements ranged from 13 percent for aggregate washing to 36 percent for bottling to 52 percent for parks and recreation to 82 percent for construction.

7.3.3 Actual Water Use

At the present time Alberta Environment's Water Use Reporting System (WURS) contains very little information on actual water use in 2005 by the any of the licensees in commercial sector in the Red Deer Basin. The data base contains only one report for parks and recreation and the reported use of 0.2 dam^3 represents less than 0.01 percent of total allocation for that activity. Given the lack of information on actual water use for commercial purposed it is assumed that all licensees are withdrawing and using the full amounts of water to which they are entitled. While this assumption may overstate actual water use in the basin, the commercial sector accounts for three percent of total allocations so it will not appreciably affect overall water use estimate for the Red Deer Basin.

Table 7-17 Licensed Commercial Allocations and Reported Actual Water Use, Red Deer Basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Licensees Reporting	Reported Use	Percent of Allocation
Aggregate washing	Surface	10	760.2	657.8	102.4			
	Groundwater	11	180.6	158.8	21.8	0	N/A	N/A
	Subtotal	**21**	**940.8**	**816.6**	**124.2**	**0**	**N/A**	**N/A**
Bottling	Surface	3	33.9	33.9	0.0	0	N/A	N/A
	Groundwater	3	19.1	12.2	6.9	0	N/A	N/A
	Subtotal	**6**	**53.0**	**46.1**	**6.9**	**0**	**N/A**	**N/A**
Construction	Surface	1	74.0	13.6	60.4	0	N/A	N/A
	Groundwater	3	8.7	8.7	0.0	0	N/A	N/A
	Subtotal	**4**	**82.7**	**22.3**	**60.4**	**0**	**N/A**	**N/A**
Golf courses	Surface	30	1,062.7	1,062.7	0.0	0	N/A	N/A
	Groundwater	22	247.7	247.7	0.0	0	N/A	N/A
	Subtotal	**52**	**1,310.4**	**1,310.4**	**0.0**	0	N/A	N/A
Gardening	Surface	26	575.6	575.6	0.0	0	N/A	N/A
	Groundwater	21	113.2	113.2	0.0	0	N/A	N/A
	Subtotal	**47**	**688.8**	**688.8**	**0.0**	**0**	**N/A**	**N/A**
Water hauling	Groundwater	3	143.4	143.4	**0.0**	0	N/A	N/A
	Subtotal	**3**	**143.4**	**143.4**	**0.0**	**0**	**N/A**	**N/A**
Parks and recreation	Surface	34	5,856.7	2,792.8	**3,064.0**	2	0.195	<0.01
	Groundwater	44	175.5	174.5	**1.0**	0	N/A	N/A
	Subtotal	**78**	**6,032.2**	**2,967.3**	**3,064.9**	**2**	**0.195**	**<0.01**
Rail/transport	Groundwater	3	35.4	35.4	**0.0**	0	N/A	N/A
	Subtotal	**3**	**35.4**	**35.4**	**0.0**	**0**	**N/A**	**N/A**
Food processing	Surface	2	269.6	269.6	**0.0**	1	0.32	<0.001
	Groundwater	6	247.3	247.3	**0.0**			N/A
	Subtotal	**8**	**516.9**	**516.9**	**0.0**	**0.32**	**1**	<0.001
Other	Surface	6	63.5	63.5	**0.0**	0	N/A	N/A
	Groundwater	20	80.6	80.6	**0.0**	0	N/A	N/A
	Subtotal	**26**	**144.1**	**144.1**	**0.0**	**0**	**N/A**	**N/A**
Total	Surface	112	8,696.1	5,469.4	3,226.8	0	N/A	N/A
	Groundwater	136	1,251.4	1,221.7	29.7	0	N/A	N/A
	Total	**248**	**9,947.6**	**6,691.3**	**3,256.4**	**0**	**N/A**	**N/A**

7.3.4 Forecasts of Future Water Use

Since most of the allocation (84 percent) is for three activities –parks and recreation, golf course and aggregate washing- forecasts of future demand focuses on those activities.

7.3.4.1 Parks and Recreation

Water use projections are tied to population growth and scenarios range from 0.5 percent annual growth (Low) to 2.1 percent (High), with 1.3 percent used as the Medium Growth scenario. The resulting forecasts of water use are shown in Table 7-18. Under the Low Growth scenario, water use for parks and recreation is projected to increase to 3,279 dam^3 by 2025, a 10 percent increase from current levels. Under High Growth, water use is expected to increase to 4,497 dam^3 which is a 52 percent increase over current use.

Table 7-18 Forecast of Parks and Recreation Water Use in Red Deer
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	2,793	2,863	2,936	3,010	3,086
	Groundwater	175	179	183	188	193
	Total	**2,967**	**3,042**	**3,119**	**3,198**	**3,279**
Medium Growth	Surface	2,793	2,979	3,178	3,390	3,616
	Groundwater	175	186	199	212	226
	Total	**2,967**	**3,165**	**3,376**	**3,602**	**3,842**
High Growth	Surface	2,793	3,099	3,438	3,814	4,232
	Groundwater	175	194	215	238	264
	Total	**2,967**	**3,292**	**3,653**	**4,053**	**4,497**

7.3.4.2 Golf Courses

The water demand forecast has been developed using the approach outlined in Watrecon (2005) for the Battle Basin which tied water use to the number of golf courses in the Basin and changes in the number of golf courses was related to population growth. This forecast assumes that the proportion of surface and groundwater use does not change over the forecast period relative to 2005 and that actual water use equals allocations. The resulting projections are shown in Table 7-19.

Under the Low Growth scenario, water use is expected to increase to 1,517 dam^3 by 2025; this indicates a 15 percent increase from current use. Using High Growth, water demand is projected to increase to 3,517 dam^3 by 2025 which is 2.7 times the current water use.

Table 7-19 Projected Water Use for Golf Course, Red Deer Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,063	1119	1160	1197	1224
	Groundwater	248	261	271	279	285
	Total	**1,311**	**1,380**	**1,431**	**1,476**	**1,509**
Medium Growth	Surface	1,063	1232	1402	1566	1714
	Groundwater	248	287	327	365	399
	Total	**1,311**	**1,519**	**1,729**	**1,931**	**2,113**
High Growth	Surface	1,063	1479	1933	2393	2837
	Groundwater	248	345	451	558	661
	Total	**1,311**	**1,824**	**2,384**	**2,951**	**3,498**

7.3.4.3 Aggregate Washing

Estimates of future demand for aggregate washing are based on licensed water use as described in Table 7-17. As the demand for aggregate material (and water use) is related to the level of economic activity, particularly construction, the projections of future water use are related to change in economic activity (GDP growth rate). Although Alberta is currently experiencing higher-than-average rate of GDP growth relative to historic levels, the Medium Growth forecasts uses a long term annual growth rates of 2.2 percent, although this could ranges from 1.2 percent per year (Low Growth) to 3.2 percent per year (High Growth).

Projections using these assumptions are shown in Table 7-20. Water use is forecast to increase to 1,037 dam^3 by 2025 under Low Growth, a 27 percent increase from use in 2005. Using High Growth, water use would increase to 1,533 dam^3 by 2025 and this is almost double the current water use.

Table 7-20 Projected Water Use for Aggregate Washing, Red Deer Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	658	698	741	787	835
	Groundwater	159	169	179	190	202
	Total	**817**	**867**	**920**	**977**	**1,037**
Medium Growth	Surface	658	733	818	912	1,017
	Groundwater	159	177	197	220	245
	Total	**817**	**911**	**1,015**	**1,132**	**1,262**
High Growth	Surface	658	770	901	1,055	1,235
	Groundwater	159	186	218	255	298
	Total	**817**	**956**	**1,119**	**1,310**	**1,533**

7.3.4.4 Summary

A summary of projected water demand for the commercial sector in the Red Deer Basin is provided in Table 7-21. These projections include the individual forecasts for the three activities - parks and recreation, golf course, and aggregate washing - which account for 84 percent of

commercial allocation in the Basin, and use by the other activities is expected to remain at current levels.

Table 7-21 Projected Water Use for Commercial Sector in the Red Deer Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	5,469	5,635	5,793	5,950	6,100
	Groundwater	1,222	1,249	1,273	1,297	1,320
	Total	**6,691**	**6,885**	**7,066**	**7,247**	**7,421**
Medium Growth	Surface	5,469	5,899	6,353	6,823	7,302
	Groundwater	1,222	1,290	1,363	1,437	1,510
	Total	**6,691**	**7,191**	**7,716**	**8,261**	**8,813**
High Growth	Surface	5,469	6,304	7,228	8,218	9,260
	Groundwater	1,222	1,365	1,524	1,691	1,863
	Total	**6,691**	**7,668**	**8,752**	**9,910**	**11,124**

Under the Low Growth scenario, water use in 2025 is projected to rise to 7,421 dam^3, an 11 percent increase from current levels. Under the High Growth scenario, water use could increase by 66 percent in 2025.

7.4 PETROLEUM SECTOR

In Red Deer Basin, there are 126 active licences which allocate 49,021 dam^3 of water to the petroleum sector. Petroleum water licences account for 13 percent of total water allocations in the basin. The majority (94 percent) of the allocations are for surface water (46,240 dam^3). As shown in Figure 7-11, the petroleum sector includes water allocations for oilfield injection, gas and petrochemical plants, drilling and various other activities.

Figure 7-12 Petroleum Water Allocation by Use in the Red Deer Basin

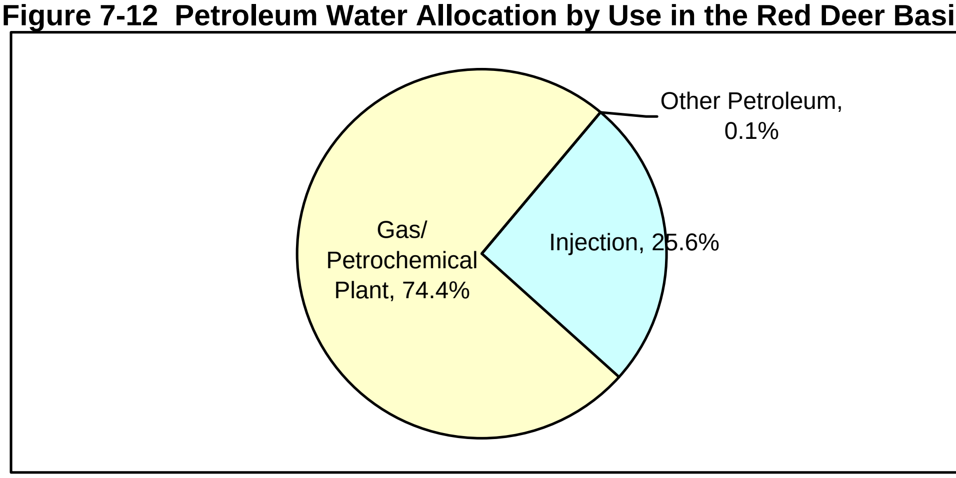


Table 7-22 summarizes the water allocation, use, and return associated with the licences for each activity in the Red Deer Basin.

Table 7-22 Summary of Water Licences Issued to the Petroleum Sector in the Red Deer Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Injection	Surface	36	10,988.1	10,988.1	0.0	182.2	1.7%	1.7%
	Groundwater	19	1,538.0	1,538.0	0.0	215.6	14.0%	14.0%
	Subtotal	**55**	**12,526.1**	**12,526.1**	**0.0**	**397.8 ***	**3.2%**	**3.2%**
Gas/Petrochemical Plant	Surface	22	35,235.7	30,872.3	4,363.3	17,960.2	58.2%	51.0%
	Groundwater	41	1,223.7	1,223.7	0.0	2,923.8	238.9%	238.9%
	Subtotal	**63**	**36,459.3**	**32,096.0**	**4,363.3**	**20,884.1 ****	**65.1%**	**57.3%**
Drilling (developing oil/gas well)	Surface	1	1.2	1.2	0.0	1.2	1.2	100.0%
	Groundwater	1	8.6	8.6	0.0	8.6	8.6	100.0%
	Subtotal	**2**	**9.9**	**9.9**	**0.0**	**9.9 *****	**9.9**	**100.0%**
Other petroleum	Surface	1	14.8	14.8	4,363.3	14.8	14.8	100.0%
	Groundwater	4	10.6	10.6	0.0	10.6	10.6	100.0%
	Subtotal	**5**	**25.4**	**25.4**	4,363.3	**25.4 *****	**25.4**	**100.0%**
Total	Surface	60	46,239.8	41,876.4	4,363.3	18,158.5	43.4%	39.3%
	Groundwater	65	2,780.9	2,780.9	0.0	3,158.7	113.6%	113.6%
	Total	**125**	**49,020.7**	**44,657.4**	**4,363.3**	**21,317.1**	**47.7%**	**43.5%**

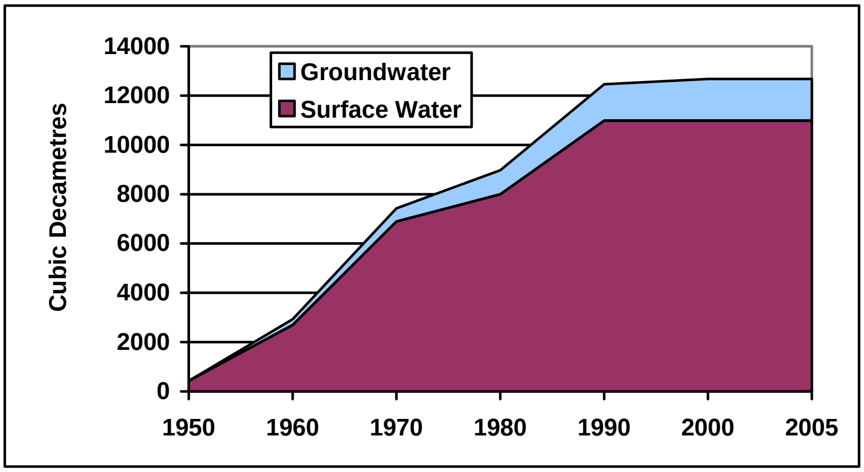
* EUB water use data provided by Geowa.
** Estimated water use based on provincial rates for WURS data
** Estimated water use is assumed to be 100% of licensed use.

7.4.1 Injection

7.4.1.1 Water Allocations

Almost 26 percent of the allocations are for injection purposes for enhanced oil and gas recovery (12,526 dam^3). Table 7-20 shows that 55 licences have been issued for injection purposes, with surface water accounting for almost 88 percent of allocations. Water use for injection commenced in the 1950s and grew steadily until about 1990. Figure 7-13 shows that allocations have remained constant during that since the 1990s.

Figure 7-13 Historical Trends in Water Allocations for Injection



7.4.1.2 Licensed Water Use

As shown in Table 7-20, the licences issued for injection purposes assume 100 percent of allocations will be used.

7.4.1.3 Actual Water Use

Detailed summary of reported water used for injection have been prepared by Geowa based on EUB data. In 2005, 398 dam^3 of fresh water was diverted for injection purposes. This volume includes 182 dam^3 of surface water and 216 dam^3 of groundwater. Based on the reported water use in Table 7-20, injection activities in the Basin are currently diverting and using approximately three percent of their licensed allocations and use.

7.4.1.4 Forecasts of Future Water Use

The general trend in Alberta is for conventional crude oil production to decline as existing fields mature and there are fewer new finds. The most recent forecast from the EUB and CAPP have oil production decreasing by between 30 and 38 percent between 2005 and 2015, and a further decline of about 23 percent by 2020. Oil production in the Red Deer Basin is expected to follow the overall Alberta production trend since most of the basin's production is from existing wells. The forecast of future water use for injection in the Red Deer Basin in Table 7-23 assumes declining rates of water use required that match the rates at which oil production in Alberta is

expected to decline. For the purposes of this analysis it is assumed that production forecasts for 2010 and 2020 is the same as the previous five years. Forecasts also assume that the current ratio of surface to ground water consumption will remain the same.

Table 7-23 Forecast of Injection Water Use in the Red Deer Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
High Decline	Surface	182	182	107	107	64
	Groundwater	216	216	126	126	75
	Total	**398**	**398**	**233**	**233**	**139**
Medium Decline	Surface	182	182	112	112	67
	Groundwater	216	216	133	133	79
	Total	**398**	**398**	**245**	**245**	**146**
Low Decline	Surface	182	182	128	128	76
	Groundwater	216	216	151	151	90
	Total	**398**	**398**	**279**	**279**	**166**

Under the low decline scenario, water use for injection in 2025 will decline by 35 percent from current levels. Under the high decline scenario, the decline will be 42 percent.

7.4.2 Gas/Petrochemical Plants

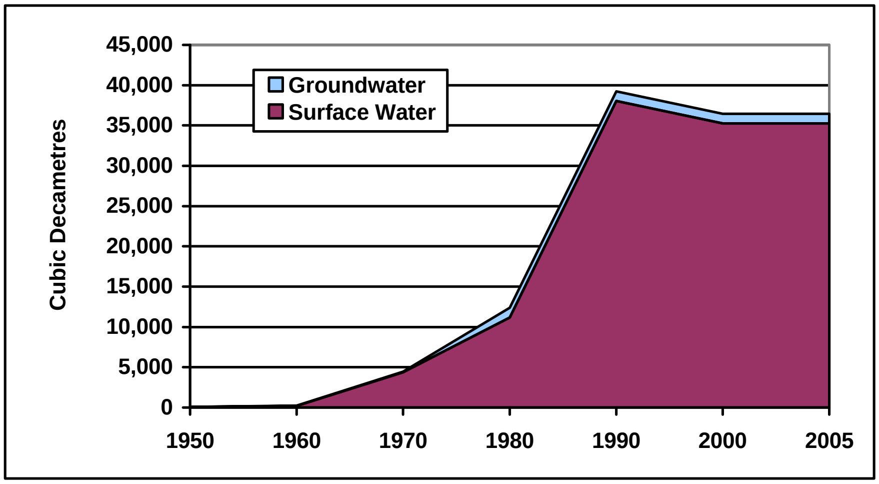
7.4.2.1 Water Allocations

The majority of the allocations for the petroleum sector in the Red Deer River Basin (74 percent) are for gas/petrochemical plants (36,460 dam^3). This includes a relatively large number of groundwater licences (41) with a small total allocation (1,224 dam^3) and 22 surface water allocations with an allocation of 30,872 dam^3. As shown in Figure 7-14, the first allocations of surface water for gas/petrochemical plants were issued in the 1950s for a very small amount of water (62 dam^3). Allocations increased sharply in the 1980s, peaked in the 1990s and have declined since then.

7.4.2.2 Licensed Water Use

As shown in Table 7-20, groundwater licences issued to gas/petrochemical plants have return flow (100 percent consumption) while surface water licences assume that 78 percent of diversions of surface water will be consumed (22 percent return flow).

Figure 7-14 Historical Trends in Water Allocations for Gas and Petrochemical Plants



7.4.2.3 <u>Actual Water Use</u>

The WURS database has water use information for 24 of the 64 water licences issued for gas/petrochemical plants in the Red Deer basin. These licences account for only 31 percent of allocations for surface water and they reported using 59 percent of their allocations. This information was judged to be insufficient to provide a reliable assessment of actual surface water use by all gas/petrochemical plants in the Red Deer River Basin so estimates of actual water use were based on provincial trends. Analysis of the WURS database for the entire province indicates that plants with surface water allocations were using an average of 48 percent of their allocations and 58 percent of the water that they are expected to consume. As this matches the water use reported in the Red Deer River Basin, surface water use in 2005 was estimated based on 58 percent of licensed water use, or about 17,920 dam^3.

The WURS database contains actual groundwater use information for licensees that account for 85 percent of total groundwater allocations. The water use reports indicate that these licensees are actually using 263 percent of the water that they are licensed to use. Estimates of actual groundwater use in 2005 are based on actual use for the licensees who reported and 99 percent utilization for the other licensees (this matches the provincial rate). Thus, use of groundwater for gas/petrochemical plants in the Red Deer River Basin is estimated to be 2,924 dam^3 in 2005.

7.4.2.4 <u>Forecasts of Future Water Use</u>

In the absence of information about this component of the petroleum sector, it is assumed that water used by gas and petrochemical plants in the Red Deer will remain constant for the forecast period. This assumption infers that overuse of groundwater allocations will continue, but the expectation is that the plants will apply for and receive the licences that they need to continue operating at their current capacities.

7.4.3 Drilling

Two licences have been issued for drilling. They allow withdrawals of up to 1.2 dam^3 of surface water and 8.6 dam^3 of groundwater. Water licences issued for drilling began in the 1990s and have increased slightly over time. Licensees are expected to consume all of the water they withdraw. There is no information on actual water diversions and consumption for these other petroleum uses and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the petroleum sector, it is assumed that water used by other petroleum activities in the Red Deer will remain constant for the forecast period.

7.4.4 Other Petroleum Use

Five licences have been issued for other petroleum use. They allow withdrawals of up to 15 dam^3 of surface water and 11 dam^3 of groundwater. The first licensees for other petroleum uses were issued in the 1990s and have increased slightly over time. Holders of the licensees are expected to consume all of the water they withdraw. There is no information on actual water diversions and consumption for these other petroleum uses and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the petroleum sector, it is assumed that water used by other petroleum activities in the Red Deer will remain constant for the forecast period.

7.4.5 Summary

The petroleum sector in the Red Deer Basin is dominated by water allocated for gas/petrochemical plants. These plants account for 74 percent of allocations and, because of over-utilization of groundwater allocations, they accounted for 98 percent of actual water use in the petroleum sector in 2005. Water use data shows that although water licences issued to be petroleum sector assume that 44,657 dam^3 of water will be consumed, licensees are only using 48 percent of this amount. However, this utilization ranges from three percent for injection licensees to 65 percent for gas/petrochemical plants.

In the future, there is expected to be a continued decline in the amount of water required for injection as oil production from existing oilfields declines. The overall water use projections for the petroleum sector are provided in Table 7-24. These forecasts assume that there is no change in current water use for gas and petrochemical plants, drilling or other petroleum activities. Table7-24 shows that, for all three scenarios, the overall demand for water in the Red Deer Basin is expected to decline in water required for injection decreases. In all cases, a reduction of at most 1.2 percent over 20 years is predicted.

Table 7-24 Forecast of Petroleum Water Use in the Red Deer Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	18,158	18,158	18,083	18,083	18,040
	Groundwater	3,159	3,159	3,069	3,069	3,018
	Total	**21,317**	**21,317**	**21,152**	**21,152**	**21,058**
Medium Growth	Surface	18,158	18,158	18,088	18,088	18,043
	Groundwater	3,159	3,159	3,076	3,076	3,022
	Total	**21,317**	**21,317**	**21,164**	**21,164**	**21,065**
High Growth	Surface	18,158	18,158	18,104	18,104	18,052
	Groundwater	3,159	3,159	3,094	3,094	3,033
	Total	**21,317**	**21,317**	**21,198**	**21,198**	**21,085**

7.5 INDUSTRIAL SECTOR

In the Red Deer River Basin there are 20 active licences which allocate 22,315 dam^3 of water to the industrial sector. Industrial water licences account for six percent of the total allocations in the basin. The majority (99.5 percent) of all water allocations to the industrial sector is for surface water (22,210 dam^3). As shown in Figure 7-15, the industrial sector includes water allocations for cooling, forestry, fertilizer plants, manufacturing, coal mining, and other industrial activities.

Figure 7-15 Water Allocations for the Industrial Sector, Red Deer River Basin

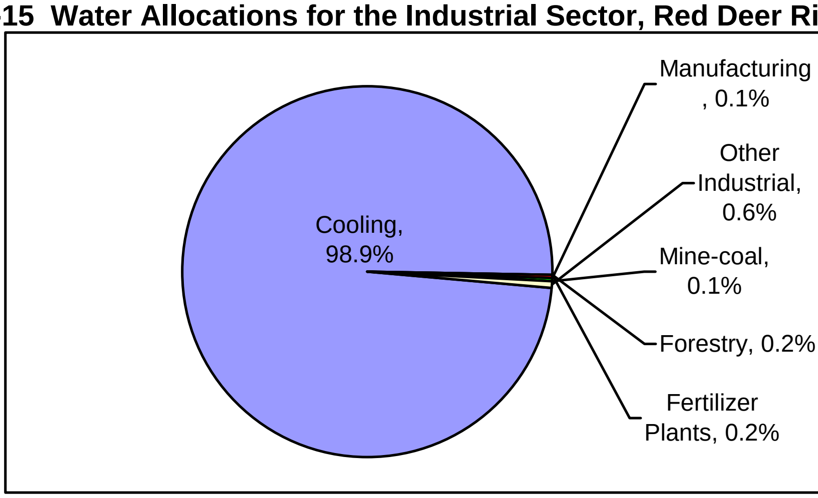


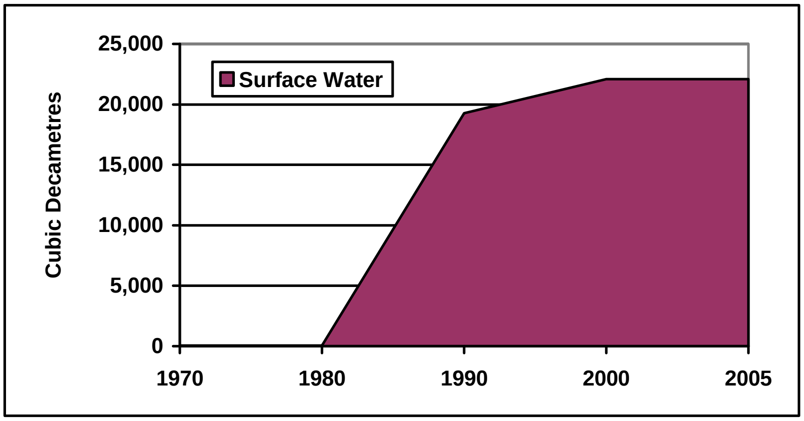
Table 7-25 summarizes the water allocation, use, and return associated with the licences for each activity in the Red Deer Basin.

7.5.1 Cooling

Just over 98 percent of the industrial allocations are for cooling purposes for thermal power generation or cooling such as air conditioning (22,076 dam^3). Table 7-25 shows that four surface water licences have been issued for cooling purposes. Water use for cooling

commenced in the 1970s, increased in the 1980s and 1990s, but has remained constant since 2000 (see Figure 7-16).

Figure 7-16 Historical Trends in Water Allocations for Cooling



The licences issued for cooling purposes assume 62 percent of surface water allocations will be used. Return flow allowances in licences amounted to 8,388 dam^3. There is no information on actual water diversions and consumption for the cooling sector and, for purposes of this analysis; it is assumed that licences are using the full amount of water they are expected to use. In the absence of information about this component of the industrial sector, it is assumed that water used by forestry activities in the Red Deer Basin will remain constant for the forecast period.

7.5.2 Forestry

One licence has been issued for forestry in the Red Deer River Basin allowing withdrawals of up to 36 dam^3 of groundwater. Forestry water allocation commenced in the 1990s and has remained the same since. The licensee is expected to consume 100 percent of the ground water that is allocated. There is no information on actual water diversions and consumption for forestry and, for purposes of this analysis; it is assumed that licensee is using its full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by forestry in the Red Deer Basin will remain constant for the forecast period.

7.5.3 Fertilizer Plants

Two licences have been issued for fertilizer plants in the Red Deer Basin allowing withdrawals of up to 44 dam^3 of groundwater. The allocations for fertilizer plants were issued in the 1980s and have remained the same since. Licences assume that fertilizer plants will use 22 percent of the water they are allocated. Return flow allowances in licences amounted to 35 dam^3. There is no information on actual water diversions and consumption for fertilizer plants and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by fertilizer plants in the Red Deer Basin will remain constant for the forecast period.

7.5.4 Manufacturing

Four licences have been issued for manufacturing activities in the Red Deer River Basin allowing withdrawals of up to 14 dam^3 of groundwater. Manufacturing water allocation commenced in the 1970s, and did not grow until the early 2000s. Licensees are assumed to consume 100 percent of the water they are allocated. There is no information on actual water diversions and consumption for manufacturing and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by manufacturing in the Red Deer Basin will remain constant for the forecast period.

7.5.5 Mining Other Than Coal

Three licences have been issued for mining other than coal in the Red Deer Basin allowing withdrawals of up to 3 dam^3 of groundwater. Mining other than coal water allocation commenced in the 1980s and grew slightly in the early 2000s. Licensees are assumed to consume 100 percent of the water they are allocated. There is no information on actual water diversions and consumption for mining other than coal and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by mining other than coal in the Red Deer Basin will remain constant for the forecast period.

7.5.6 Coal Mining

One licence has been issued for coal mining in the Red Deer Basin allowing withdrawals of up to 12 dam^3 of groundwater. Coal mining water allocation commenced in the 1980s and has remained the same since. The licensee is assumed to consume 100 percent of the groundwater that is allocated. There is no information on actual water diversions and consumption for coal mining and, for purposes of this analysis; it is assumed that licensee is using its full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by coal mining in the Red Deer Basin will remain constant for the forecast period.

7.5.7 Other Industrial

Five licences have been issued for other industrial purposes. They allow withdrawals of up to 122 dam^3 of surface water and 7 dam^3 groundwater. Other industrial water allocations commenced in the 1950s for surface water and the 1920s for groundwater. Both sources have remained the same over time. Licensees are assumed to consume 100 percent of the water they are allocated. There is no information on actual water diversions and consumption for the other industrial activities and, for purposes of this analysis; it is assumed that licensees are

Table 7-25 Licensed Allocations and Use and Estimated Actual Use, Industrial Sector, Red Deer River Basin

RED DEER RIVER			**DAM3 based on licence**			**DAM3 based on WURS**		
Water Use	**Source**	**Number of Licences**	**Allocation**	**Water Use**	**Return**	**Reported Water Use**	**Number of Licensees who reported**	
Cooling	Surface	4	22,195.0	13,807.3	8,387.7			
	Groundwater	0	0.0	0.0	0.0			
	Subtotal	**4**	**22,195.0**	13,807.3	**8,387.7**			
Forestry	Surface	0	0.0	0.0	0.0			
	Groundwater	1	35.8	35.8	0.0			
	Subtotal	**1**	**35.8**	35.8	**0.0**			
Chemical Plants	Surface	0	0.0	0.0	0.0			
	Groundwater	0	0.0	0.0	0.0			
	Subtotal	**0**	**0.0**	0.0	**0.0**			
Fertilizer Plants	Surface	0	0.0	0.0	0.0			
	Groundwater	2	44.4	9.9	34.5	16.3	1.0	
	Subtotal	**2**	**44.4**	9.9	**34.5**			
Manufacturing	Surface	0	0.0	0.0	0.0			
	Groundwater	4	13.9	13.9	0.0			
	Subtotal	**4**	**13.9**	13.9	**0.0**			
Mine-other	Surface	0	0.0	0.0	0.0			
	Groundwater	3	3.4	3.4	0.0			
	Subtotal	**3**	**3.4**	3.4	**0.0**			
Mine-coal	Surface	1	12.3	12.3	0.0			
	Groundwater	0	0.0	0.0	0.0			
	Subtotal	**1**	**12.3**	12.3	**0.0**			
Other Industrial	Surface	3	122.2	122.2	0.0			

	Groundwater	2	7.4	7.4	0.0			
	Subtotal	**5**	**129.6**	129.6	**0.0**			
Total	Surface	8	22,329.5	13,941.8	8,387.7			
	Groundwater	12	104.9	70.4	34.5	16.3	1	
	Subtotal	20	22,434.4	14,012.2	8,422.2	16.3	1	

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Cooling	Surface	4	22,075.6	13,688.0	8,387.7	13,688.0	100%	62%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**4**	**22,075.6**	**13,688.0**	**8,387.7**	**13,688.0 ***	**100%**	**62%**
Forestry	Surface	0	0.0	0.0	0.0	0.0		
	Groundwater	1	35.8	35.8	0.0	35.8	100%	100%
	Subtotal	**1**	**35.8**	**35.8**	**0.0**	**35.8 ***	**100%**	**100%**
Fertilizer Plants	Surface	0	0.0	0.0	0.0	0.0		
	Groundwater	2	44.4	9.9	34.5	9.9	100%	22%
	Subtotal	**2**	**44.4**	**9.9**	**34.5**	**9.9 ***	**100%**	**22%**
Manufacturing	Surface	0	0.0	0.0	0.0	0.0		
	Groundwater	4	13.9	13.9	0.0	13.9	100%	100%
	Subtotal	**4**	**13.9**	**13.9**	**0.0**	**13.9 ***	**100%**	**100%**
Mine-other	Surface	0	0.0	0.0	0.0	0.0		
	Groundwater	3	3.4	3.4	0.0	3.4	100%	100%
	Subtotal	**3**	**3.4**	**3.4**	**0.0**	**3.4 ***	**100%**	**100%**
Mine-coal	Surface	1	12.3	12.3	0.0	12.3	100%	100%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**1**	**12.3**	**12.3**	**0.0**	**12.3 ***	**100%**	**100%**
Other Industrial	Surface	3	122.2	122.2	0.0	122.2	100%	100%
	Groundwater	2	7.4	7.4	0.0	7.4	100%	100%
	Subtotal	**5**	**129.6**	**129.6**	**0.0**	**129.6 ***	**100%**	**100%**
Total	Surface	8	22,210.1	13,822.5	8,387.7	13,822.5	100.0%	62.2%

	Groundwater	12	104.9	70.4	34.5	70.4	100.0%	67.1%
	Total	**20**	**22,315.0**	**13,892.9**	**8,422.2**	**13,892.9**	**100.0%**	**62.3%**
* Estimated water use assumes 100 percent consumption.								

using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by other industrial activities in the Red Deer Basin will remain constant for the forecast period.

7.5.8 Summary

The industrial sector in the Red Deer Basin is dominated by water allocated for cooling activities. Cooling plants account for 98 percent of allocations and licensed water use. Actual industrial water use in the Red Deer River Basin in 2005 is estimated to be 13,893 dam^3. This estimate assumes that licence holders are using 100 percent of the licensed consumption. In the absence of information about the industrial sector in the Red Deer Basin, it is assumed that water used by other industrial activities in the Red Deer Basin will remain constant for the forecast period.

7.6 OTHER SECTOR

In the Red Deer River Basin a total of 263 active licences have been issued for other purposes and these licences allow diversions of up to 114,640 dam^3 of water. These allocations consist almost entirely of surface water (111,635.5 dam^3 or 97 percent). As shown in Figure 7-17, water allocations to the other sector uses are primarily for water management (flood control and lake stabilization), fish, wildlife and habitat enhancement, and uses specified by a director with AENV.

Figure 7-17 Other Sector Water Allocations by Use in the Red Deer Basin

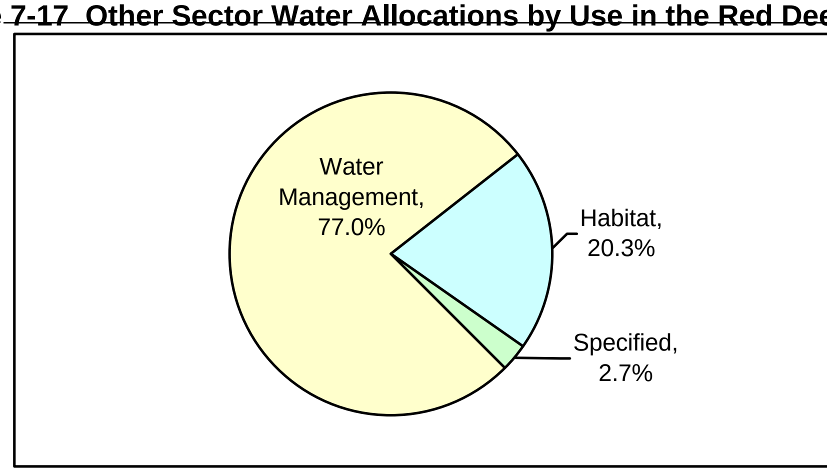


Table 7-26 summarizes the water allocation, use, and return associated with the licences for each activity in the Red Deer Basin.

Table 7-26 Licensed Allocations and Use and Estimated Actual Use, Other Sector, Red Deer River Basin

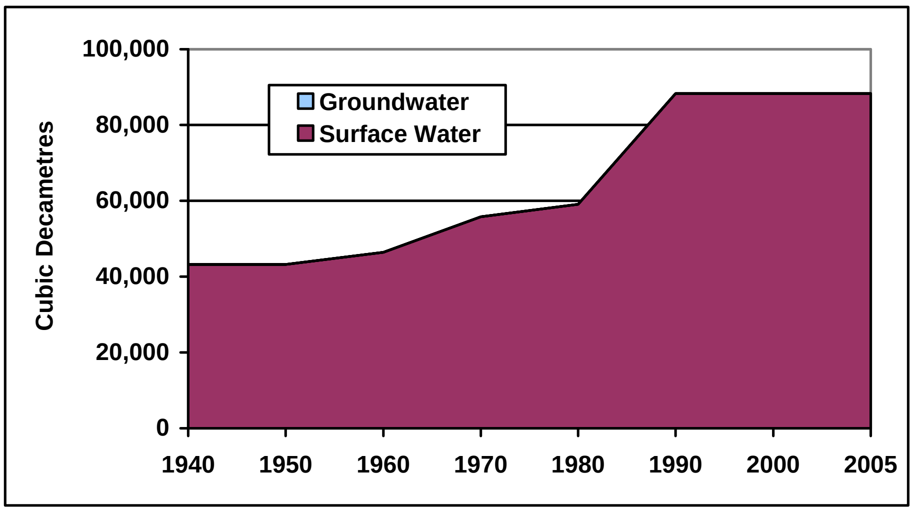
Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Water Management	Surface	40	88,262.9	40,706.3	47,556.7	40,706.3	100%	46.1%
	Groundwater	1	0.5	0.5	0.0	0.5	100%	100.0%
	Subtotal	**41**	**88,263.4**	**40,706.8**	**47,556.7**	**40,706.8**	**100%**	**46.1%**
Habitat	Surface	198	23,142.9	20,751.2	2,391.7	20,751.2	100%	89.7%
	Groundwater	20	144.1	90.3	53.8	90.3	100%	62.6%
	Subtotal	**218**	**23,287.0**	**20,841.4**	**2,445.6**	**20,841.4**	**100%**	**89.5%**
Specified	Surface	2	229.7	229.7	0.0	229.7	100%	100.0%
	Groundwater	2	2,859.7	1,582.5	1,277.2	1,582.5	100%	55.3%
	Subtotal	**4**	**3,089.4**	**1,812.2**	**1,277.2**	**1,812.2**	**100%**	**58.7%**
Total	Surface	240	111,635.5	61,687.1	49,948.4	61,687.1	100%	55.3%
	Groundwater	23	3,004.3	1,673.3	1,331.0	1,673.3	100%	55.7%
	Total	**263**	**114,639.8**	**63,360.4**	**51,279.4**	**63,360.4**	**100%**	**55.3%**

7.6.1 Water Management

Almost 77 percent of the allocations are for water management purposes such flood control and lake stabilization (88,263 dam^3). Table 7-26 shows that 41 licences have been issued for water management purposes and all but one are for surface water. One groundwater licence with an allocation of 0.5 dam^3 has been issued for water management in the Red Deer Basin.

As shown in Figure 7-18, surface water use for water management commenced in the 1940s, stayed relatively constant until the 1960s, grew rapidly during the 1980s and has remained constant since 1990.

Figure 7-18 Historical Trends in Water Allocations for Water Management



As shown in Table 7-26, licences issued for water management purposes assume about 46 percent of their surface water allocations and 100 percent of groundwater allocations to be used. Return flow allowances in licences total 47,557 dam^3 for surface water. There is no information on actual water diversions and consumption for water management activities and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the other sector, it is assumed that water used for water management in Red Deer will remain constant for the forecast period.

7.6.2 Habitat Enhancement

About 20 percent of the allocations are for fish, wildlife and habitat enhancement (23,287 dam^3). Table 7-26 shows that 218 licences have been issued for habitat projects, with nearly 91 percent of these for surface water. Twenty licences have been issued for groundwater, with allocations of 144 dam^3. Surface water use for habitat commenced in the 1940s but grew rapidly between the 1950s and the early 2000s (Figure 7-19). The first licences for water for habitat enhancement were issued in 1920s and allocations increased slightly between the 1990s and the 2000s.

Figure 7-19 Historical Trends in Water Allocations for Habitat Enhancement

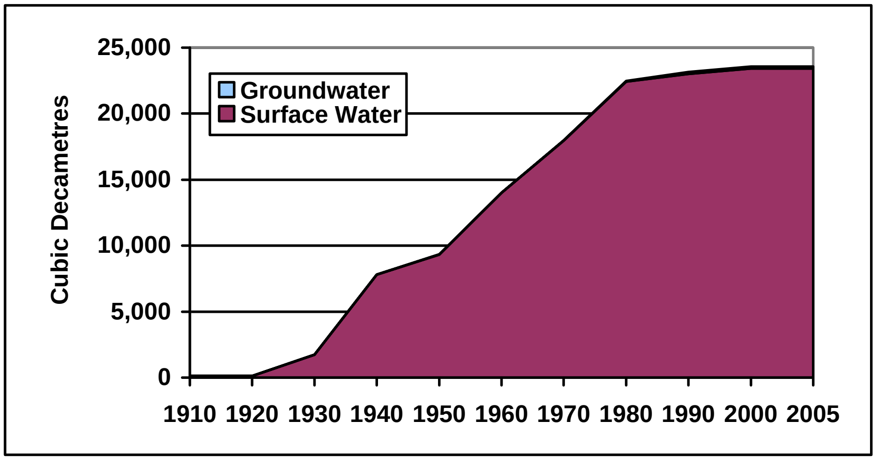


Table 7-26 shows that licences issued for habitat enhancement purposes assume that about 90 percent of surface water allocations and 63 percent of groundwater allocations will be used. Return flow allowances in licences amounted to 2,392 dam^3 for surface water and 54 dam^3 for groundwater. There is no information on actual water diversions and consumption for habitat enhancement activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement.

7.6.3 Forecasts of Future Water Use

Forecasts of future water use by the other sector are based on consultation with large licence holders. Neither Ducks Unlimited nor Alberta Environment has formal forecasts of their future water needs. The number of projects that Ducks Unlimited implements depend on a number of factors such as their budget, the state of the economy, and environment objectives. It is anticipated that there will be an increased emphasis on restoring drained wetlands to pre-drainage or natural conditions. These types of projects will not require new water licences. In terms of new water licences, Ducks Unlimited foresees a yearly increase of about one new water licence for water management of about 300 dam^3 per year each and one new water licence for 600 dam^3 by 2015. The water used by Alberta Environment is not expected to change in the period forecasted. Forecasts assume that new projects are for surface water use, this is appropriate given the current distribution of surface to ground water licences.

The water use forecasts in Table 7-27 provide a Medium Growth scenario that assumes a five percent increase in water demand every five years. The Low Growth scenario is based on a two percent increase in water demand every five years. The High Growth scenario assumed construction of all of the potential Ducks Unlimited Projects.

Table 7-27 Forecast of Water Use by Habitat Enhancement Projects in Red Deer
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	20,751	21,168	21,593	22,027	22,469
	Groundwater	90	90	90	90	90
	Total	**20,841**	**21,258**	**21,683**	**22,117**	**22,559**
Medium Growth	Surface	20,751	21,793	22,887	24,036	25,243
	Groundwater	90	90	90	90	90
	Total	**20,841**	**21,884**	**22,978**	**24,127**	**25,333**
High Growth	Surface	20,751	29,751	39,351	48,351	57,351
	Groundwater	90	90	90	90	90
	Total	**20,841**	**29,841**	**39,441**	**48,441**	**57,441**

Under the Low Growth scenario, water use for water management projects in 2025 will increase by just over eight percent from current levels. Under the High Growth scenario, water use could increase by 175 percent.

7.6.4 Director-Specified Activities

Less than three percent of the allocations for other purposes are for uses specified by a director with AENV. These allocations total 3,089 dam^3. Table 7-26 shows that two such licences have been issued for groundwater (2,860 dam^3) and account for 93 percent of allocations for this activity. The initial licences were issued for surface water use in the 1910s and that allocations have only increased slightly since then. Figure 7-20 shows that allocations of groundwater for specified activities commenced in the 1950s and have remained relatively constant since then.

Figure 7-20 Historical Trends in Water Allocations for Specified Activities

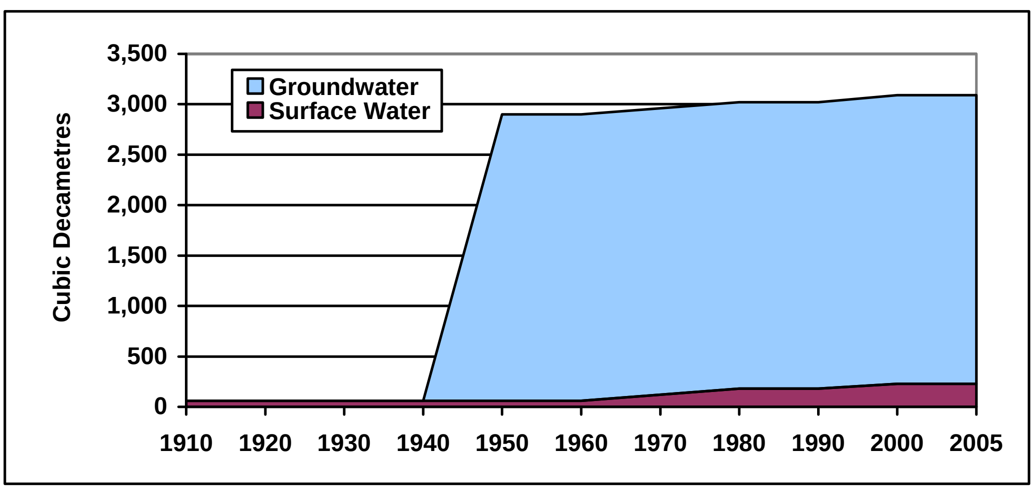


Table 7-26 shows that the licences issued for director-specified purposes allow use up to 100 percent of surface water allocations and 55 percent of groundwater. Return flow requirements in licences amounted to 1,277 dam^3 for groundwater. There is no information on actual water diversions and consumption for specified activities and, for purposes of this

analysis, it is assumed that licensees are using their full entitlement. In the absence of information about this component of the other sector, it is assumed that water used by activities specified by the director in the Red Deer Basin will remain constant for the forecast period.

7.6.5 Summary

The other sector in the Red Deer Basin is dominated by water allocated for water management. These projects account for 77 percent of the water allocation and 64 percent of the licensed water use. In the future, there is expected to be an increase in the amount of water used for other sector activities. The overall water use projections for the other sector are provided in Table 7-28. These forecasts assume that there is a slight increase in the amount of habitat enhancement projects (as per Table 7-27) but that the allocations for water management, water conservation and activities specified by the director will remain the same for the forecasted period.

Table 7-28 Forecast of Other Use in the Red Deer Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	61,687	62,104	62,529	62,963	63,405
	Groundwater	1,673	1,673	1,673	1,673	1,673
	Total	**63,360**	**63,777**	**64,202**	**64,636**	**65,078**
Medium Growth	Surface	61,687	62,729	63,823	64,972	66,179
	Groundwater	1,673	1,673	1,673	1,673	1,673
	Total	**63,360**	**64,402**	**65,497**	**66,646**	**67,852**
High Growth	Surface	61,687	70,687	80,287	89,287	98,287
	Groundwater	1,673	1,673	1,673	1,673	1,673
	Total	**63,360**	**72,360**	**81,960**	**90,960**	**99,960**

Table 7-28 shows that, for all three scenarios, the overall demand for water in the Red Deer Basin is expected to increase over the forecast period.

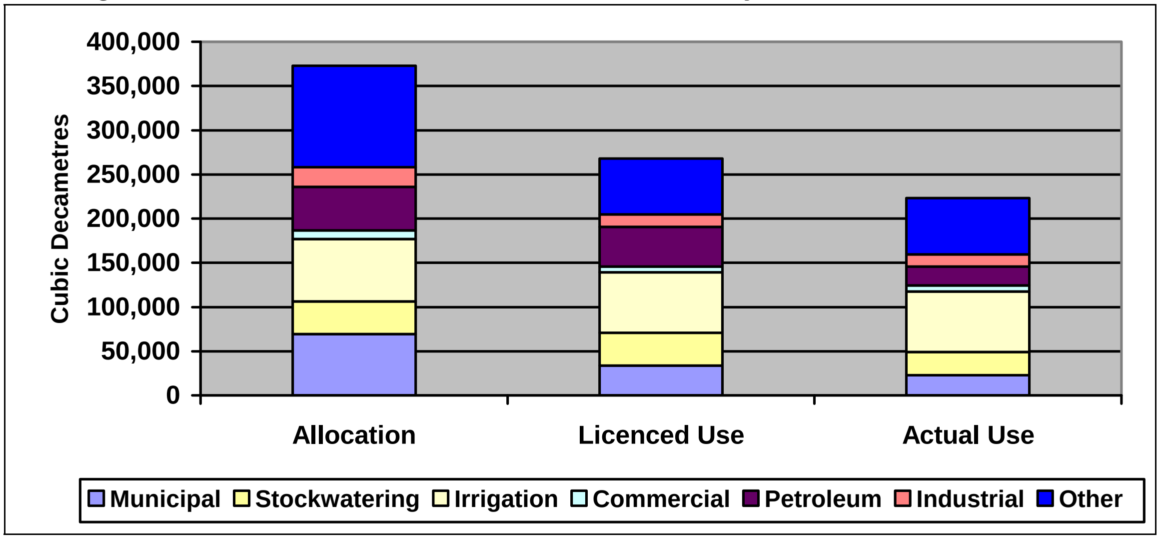
7.7 SUMMARY

Table 7-29 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the Red Deer River Basin. In total, existing licences and registrations allow a maximum of 356,475 dam^3 of water to be withdrawn for use. These licences include 251,593 dam^3 of water for use and a return flow allowance of 104,882 dam^3. As noted previously, the largest amounts of water have been allocated to the other uses sector, particularly water management projects.

With respect to actual use, the exact volumes withdrawn and used in 2005 are not known because very few water use reports have been filed with Alberta Environment. However, based on the assumptions used in the previous sections, it is estimated that 223,060 dam^3 were actually used in 2005. This represents 83 percent of water use allowed in existing licences and registrations. Based on estimated use, the agricultural sector accounted for 43 percent of total

water use in the Red Deer River Basin in 2005. Figure 7-21 shows how actual use compares to licensed allocations and use for each of the water use sectors.

Figure 7-21 Water Allocations and Actual Use, by Sector, Red Deer Basin



Forecasts of future water use in the Red Deer River Basin are provided in Tables 7-30 to 7-32 for the low, medium and high growth scenarios. Predicted water use under the Medium growth scenario is shown in Figure 7-23. This figure shows that most of the growth in water use will occur in the agricultural sector, with water used for stockwatering and irrigation accounting for 45 percent of total water use by 2025. Under the medium scenario, water demand in 2025 will be about 11.6 percent higher than at present. For the other scenarios, the increase in water demand over 20 years will range from 5.3 percent for low growth and 33.1 percent for high growth. For all scenarios, actual water use will be less than the amount that can be consumed under the terms of existing licences.

Figure 7-22 Forecast Water Use in the Red Deer Basin: Medium Scenario

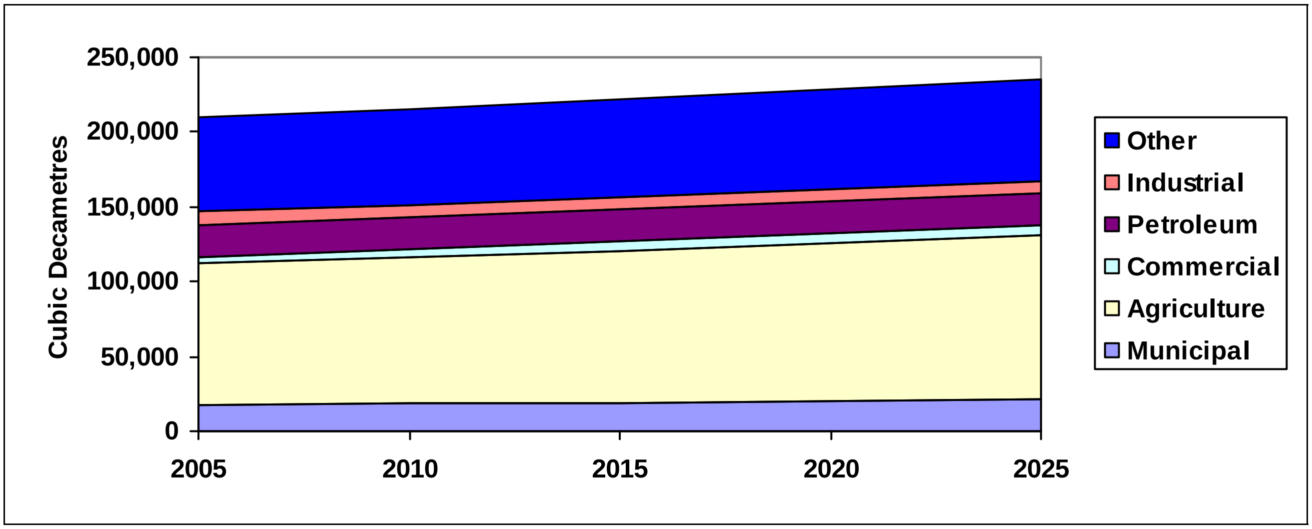

250,000
200,000
150,000
100,000
50,000
0
Cubic Decametres
2005
2010
2015
2020
2025
Other
Industrial
Petroleum
Commercial
Agriculture
Municipal

Table 7-29 Summary of Allocations and Estimated Water Use, Red Deer Basin

Sector		Licensed Allocation and Use (dam^3)				Estimated Water Use (dam^3)		
		Allocation	Water Use	Return	Percent of Total Use	Use	Percent of Licensed use	Percent of Total Use
Municipal		69,339	33,733	35,606	7%	22,752	67%	10%
Agricultural	Stockwatering	37,131	37,127	4	15%	26,562	72%	12%
	Irrigation	70,317	68,366	1,951	27%	68,366	100%	31%
Commercial		9,948	6,691	3,256.40	3%	6,691	100%	3%
Petroleum		49,021	44,657	4,363	18%	21,317	48%	10%
Industrial		22,434	14,012	8,422	6%	14,012	100%	6%
Other		114,640	63,360	51,279	25%	63,360	100%	29%
Total		**372,830**	**267,946**	**104,881**	**100%**	**223,060**	**83%**	**100%**

Table 7-30 Forecast Water Use, By Sector, Red Deer Basin: Low Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	15,664	16,364	16,891	17,348	17,680
	Agricultural	83,371	84,297	85,280	86,323	87,431
	Commercial	4,520	4,687	4,845	5,001	5,152
	Petroleum	18,158	18,158	18,083	18,083	18,040
	Industrial	8,388	8,388	8,388	8,388	8,388
	Other	61,687	62,104	62,529	62,963	63,405
	Total	191,788	193,998	196,016	198,106	200,096
Groundwater	Municipal	1,307	1,365	1,409	1,448	1,475
	Agricultural	11,528	12,235	12,985	13,781	14,626
	Commercial	581	608	633	657	680
	Petroleum	3,159	3,159	3,069	3,069	3,018
	Industrial	35	35	35	35	35
	Other	1,673	1,673	1,673	1,673	1,673
	Total	18,283	19,075	19,804	20,663	21,507
Total	Municipal	16,971	17,729	18,300	18,796	19,155
	Agricultural	94,899	96,532	98,265	100,104	102,056
	Commercial	5,101	5,295	5,478	5,658	5,832
	Petroleum	21,317	21,317	21,152	21,152	21,058
	Industrial	8,423	8,423	8,423	8,423	8,423
	Other	63,360	63,777	64,202	64,636	65,078
	Total	210,071	213,073	215,820	218,769	221,602

Table 7-31 Forecast Water Use, By Sector, Red Deer Basin: Medium Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	15,664	16,715	17,772	18,792	19,713
	Agricultural	83,371	85,103	87,034	89,187	91,587
	Commercial	4,520	4,952	5,406	5,877	6,357
	Petroleum	18,158	18,158	18,088	18,088	18,043
	Industrial	8,388	8,388	8,388	8,388	8,388
	Other	61,687	62,729	63,823	64,972	66,179
	Total	191,788	196,045	200,511	205,304	210,267
Groundwater	Municipal	1,307	1,395	1,483	1,568	1,645
	Agricultural	11,528	12,850	14,323	15,966	17,797
	Commercial	581	650	723	797	871
	Petroleum	3,159	3,159	3,076	3,076	3,022
	Industrial	35	35	35	35	35
	Other	1,673	1,673	1,673	1,673	1,673
	Total	18,283	19,762	21,313	23,115	25,043
Total	Municipal	16,971	18,110	19,255	20,360	21,358
	Agricultural	94,899	97,953	101,357	105,152	109,384
	Commercial	5,101	5,602	6,129	6,674	7,228
	Petroleum	21,317	21,317	21,164	21,164	21,065
	Industrial	8,423	8,423	8,423	8,423	8,423
	Other	63,360	64,402	65,496	66,645	67,852
	Total	210,071	215,807	221,824	228,418	235,310

Table 7-32 Forecast Water Use, By Sector, Red Deer Basin: High Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	15,664	17,375	19,241	21,126	22,951
	Agricultural	83,371	85,941	88,949	92,471	96,593
	Commercial	5,469	6,304	7,228	8,218	9,260
	Petroleum	18,158	18,158	18,104	18,104	18,052
	Industrial	13,942	13,942	13,942	13,942	13,942
	Other	61,687	70,687	80,287	89,287	98,287
	Total	198,291	212,407	227,751	243,148	259,085
Groundwater	Municipal	1,307	1,450	1,605	1,763	1,915
	Agricultural	11,528	13,489	15,784	18,471	21,617
	Commercial	1,222	1,365	1,524	1,691	1,863
	Petroleum	3,159	3,159	3,094	3,094	3,033
	Industrial	70	70	70	70	70
	Other	1,673	1,673	1,673	1,673	1,673
	Total	18,959	21,206	23,750	26,762	30,171
Total	Municipal	16,971	18,825	20,846	22,889	24,866
	Agricultural	94,899	99,430	104,733	110,942	118,210
	Commercial	6,691	7,669	8,752	9,909	11,123
	Petroleum	21,317	21,317	21,198	21,198	21,085
	Industrial	14,012	14,012	14,012	14,012	14,012
	Other	63,360	72,360	81,960	90,960	99,960
	Total	217,250	233,613	251,501	269,910	289,256

Battle River Basin

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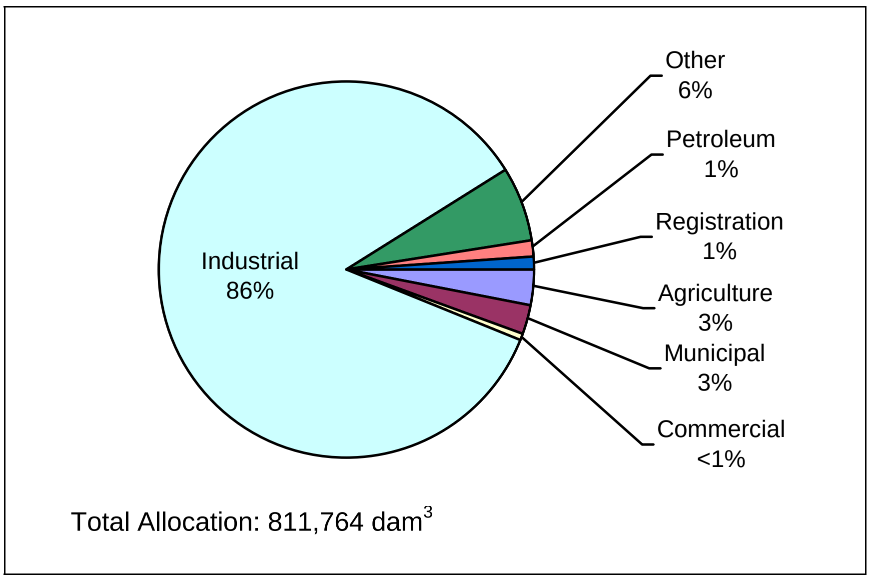
8.0 BATTLE RIVER BASIN

The Battle River Basin is about 36,000 km^2 in area and occupies approximately six percent of Alberta. The mean annual natural river discharge of the Battle River is 278,000 dam^3. It is part of the Nelson River system, which drains eventually into Hudson Bay. In 2001, the Basin had a population of 122,476 people, which is four percent of the provincial population, and an average population density of over three people per square kilometer. The Battle Basin consists of all or parts of 55 urban municipalities, 14 rural or regional municipalities and four Aboriginal settlements.

An overview of existing surface and groundwater allocations is provided in Figure 8-1. It shows that the industrial sector accounts for 86 percent of total allocations or 691,866 dam^3 in 2005. Of lesser importance is the other sector (51,373 dam^3 or six percent of total allocations) the agricultural sector (24,182 dam^3 or three percent) and the municipal sector (21,950 dam^3 or three percent). Total allocations in the Basin in 2005 were 811,803 dam^3.

Figure 8-1 Distribution of Active Water Allocations in the Battle Basin



Figures 8-2 and 8-3 show the location, allocation and sector of all active surface and groundwater water licences in the Battle Basin. Figure 8-4 shows the location of all registrations that have been issued for the Battle River Basin.

8.1 MUNICIPAL AND RESIDENTIAL SECTOR

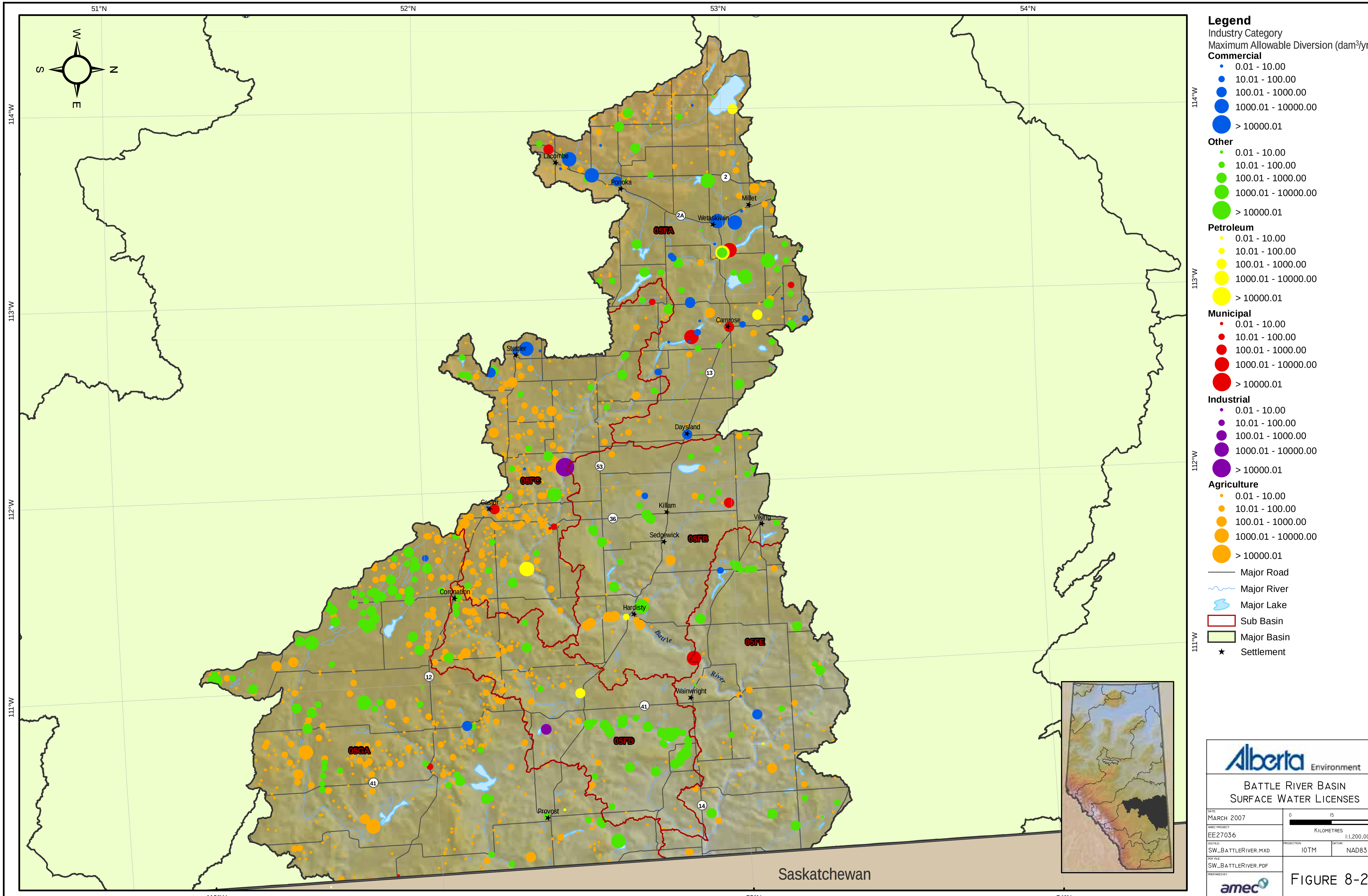
8.1.1 Population

The population of the Battle River Basin is 58 percent urban, 35 percent rural and has seven percent of its population living in Aboriginal settlements. Between 1996 and 2001, the population grew by only 2.8 percent. However, as shown in Table 8-1, the rural municipalities actually shrank by 0.5 percent while the urban population increased by 3.4 percent. The highest population growth rate occurred among the Aboriginal population which increased by 16.2 percent.

Table 8-1 Population Distribution and Growth in Battle River Basin, 2001

	2001		1996	1996 to 2001 Population Change
	Population	Percent	Population	Percent
Urban Municipality	70,917	57.9%	68,586	3.4%
Rural or Regional Municipality	42,349	34.6%	42,573	-0.5%
First Nations and Métis Settlements	9,211	7.5%	7,927	16.2%
Total	**122,477**	**100%**	**119,086**	**2.8%**

Table 8-2 lists all of the urban municipalities that located in the Battle River Basin, their estimated 2001 populations within the basin, and a summary of water licence information for those communities that have a licence for 100 dam^3. The major population centres include the City of Camrose (14,854 residents), the City of Wetaskiwin (11,154) and the Town of Lacombe (9,384). Table 8-3 identifies all the rural and regional municipalities and First Nations in the basin, along with their 2001 populations and water licence information. The most populous rural and regional municipalities in the Basin are the County of Wetaskiwin No. 10 (7,330), Camrose County (6,287), Ponoka County (4,482) and the Municipal District of Wainwright (4,231). The Samson Cree Nation (4,955) has the largest population among Aboriginal communities.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Industry Category
Maximum Allowable Diversion (dam³/yr)
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Other
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Petroleum
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Major River
Major Lake
Sub Basin
Major Basin
Settlement
Lacombe
Ponoka
Millet
Wetaskiwin
Camrose
Stettler
Daysland
Castor
Killam
Viking
Sedgewick
Coronation
Hardisty
Battle River
Wainwright
Provost
05FA
05FC
05FB
05FE
05FD
05GA
Saskatchewan
Alberta Environment
Battle River Basin
Surface Water Licenses
March 2007
EE27036
SW_BattleRiver.mxd
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Kilometres
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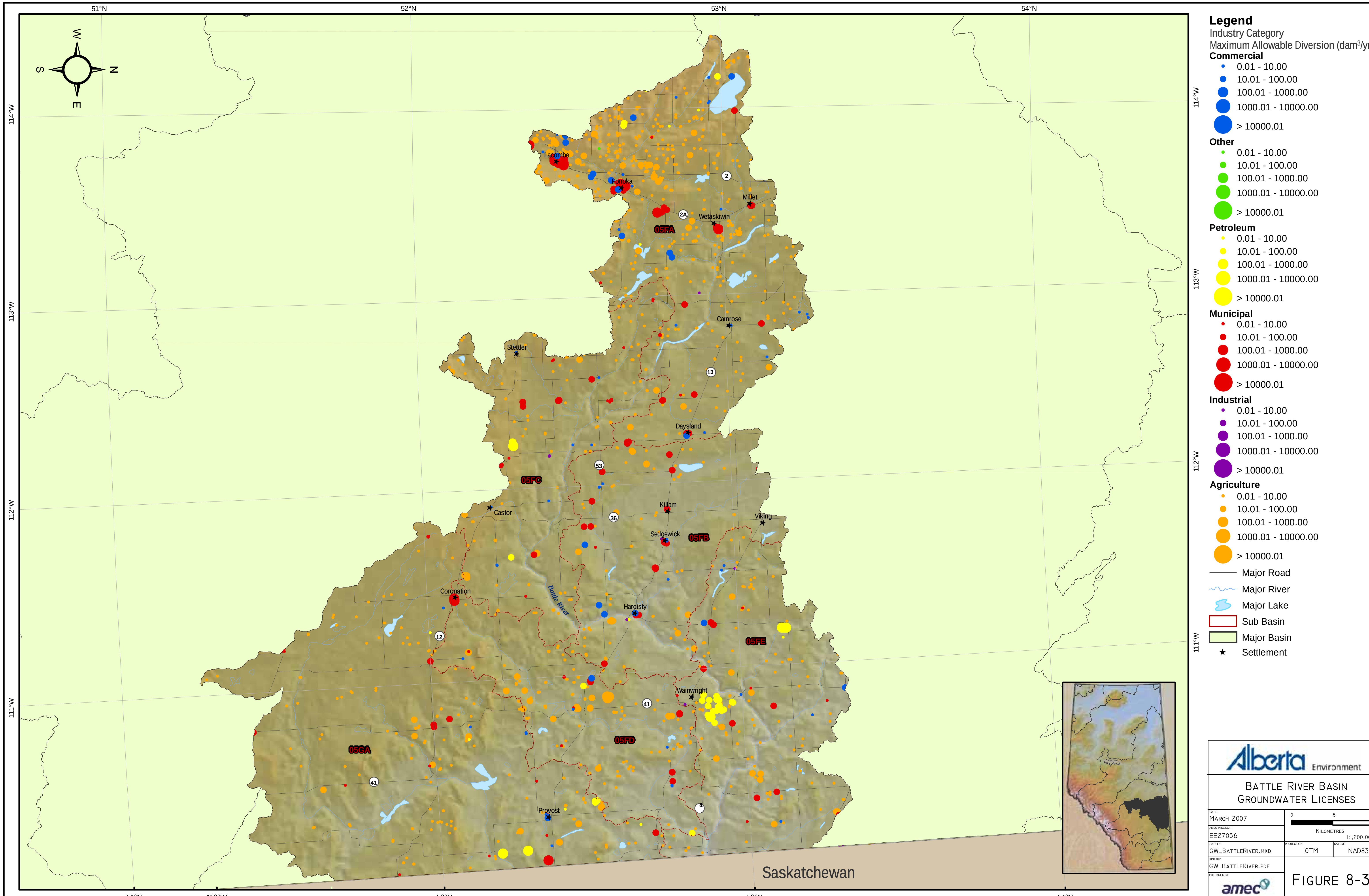
Figure 8-2



Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
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Other
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Major River
Major Lake
Sub Basin
Major Basin
Settlement
Lacombe
Ponoka
Millet
Wetaskiwin
Camrose
Stettler
Daysland
Castor
Killam
Viking
Sedgewick
Coronation
Hardisty
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Saskatchewan
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March 2007
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NAD83
Kilometres
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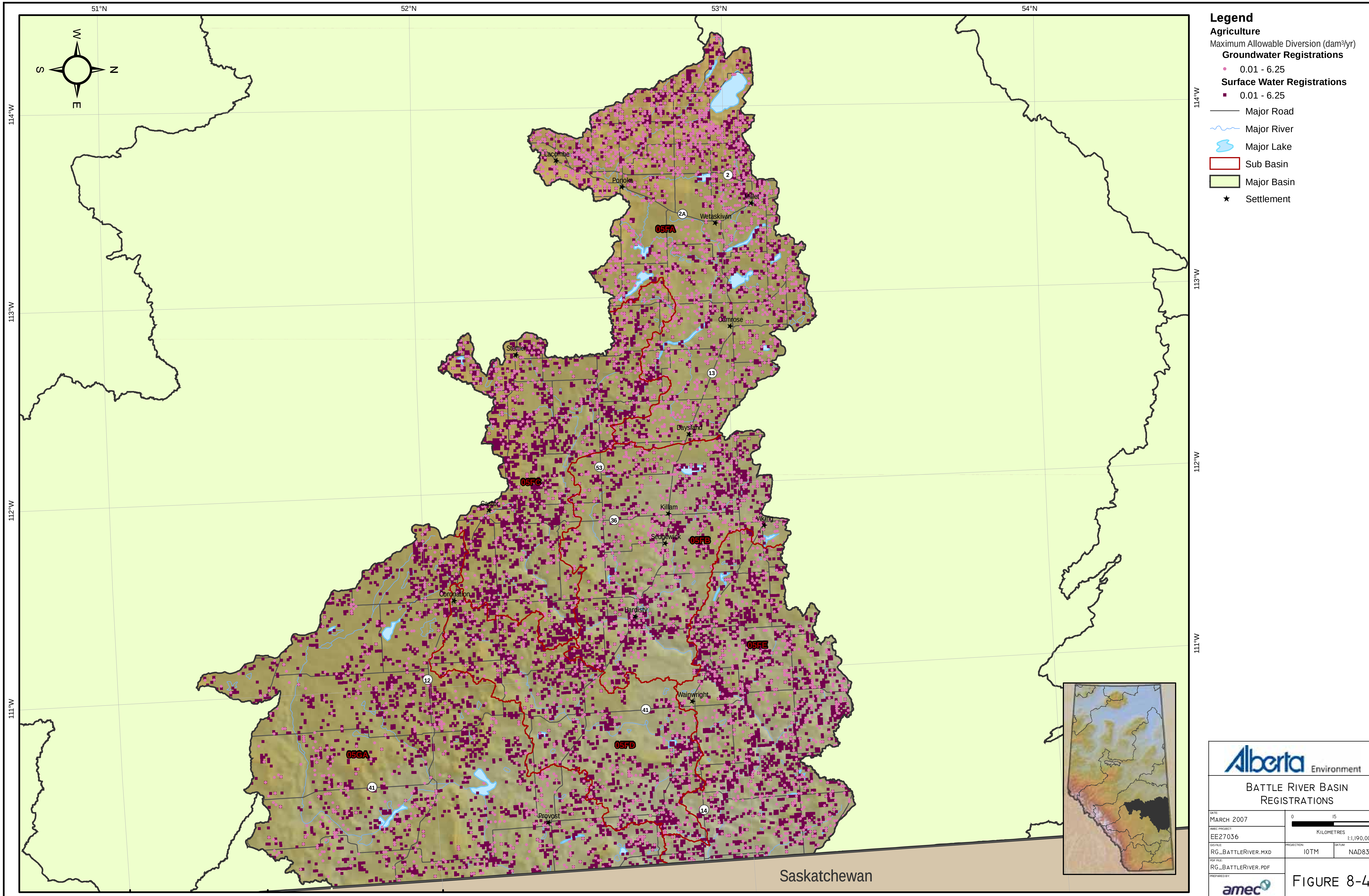
Figure 8-3



Battle River Basin Registrations

Figure 8-4

Table 8-2 2001 Urban Populations and Water Allocations within Battle River Basin

Urban Municipality Name		2001 Population	Source	2005 Allocation (dam^3)
Cities	CAMROSE	14,854	Surface	3,269
	WETASKIWIN	11,154	Surface Groundwater	2467 163
Towns	LACOMBE	9,384	Groundwater	2,271
	PONOKA	6,330	Groundwater	883
	STETTLER	5,215		
	WAINWRIGHT	5,117	Surface	1,727
	MILLET	2,037	Groundwater	153
	PROVOST	1,980	Groundwater	424
	VIKING	1,052	Surface	548
	KILLAM	1,004	Groundwater	214
	CASTOR	935	Surface	247
	CORONATION	902	Groundwater	342
	SEDGEWICK	865	Groundwater	227
	DAYSLAND	779	Groundwater	167
	HARDISTY	743	Groundwater	136
	BLACKFALDS	684		
Summer Villages	GOLDEN DAYS	125		
	GRANDVIEW	85		
	POPLAR BAY	84		
	MA-ME-O BEACH	81		
	CRYSTAL SPRINGS	72		
	SILVER BEACH	39		
	SUNDANCE BEACH	37		
	NORRIS BEACH	29		
	ARGENTIA BEACH	24		
	ITASKA BEACH	10		
Villages	CONSORT	634	Groundwater	160
	IRMA	435	Groundwater	148
	FORESTBURG	870	Groundwater	178
	EDGERTON	403		
	CHAUVIN	366	Groundwater	113
	BAWLF	362		
	HAY LAKES	346		
	NEW NORWAY	292		
	VETERAN	292		
	STROME	273		
	HUGHENDEN	235		
	DONALDA	230		
	LOUGHEED	228		
	BITTERN LAKE	221		
	CZAR	205		
	ROSALIND	190		
	BOTHA	186		
	HEISLER	183		
	YOUNGSTOWN	182		
	AMISK	181		
	ALLIANCE	171	Groundwater	105
	GALAHAD	161		
	PARADISE VALLEY	152		
	EDBERG	150		
	FERINTOSH	150		
	HALKIRK	117		
	GADSBY	40		
	CEREAL	12		
	VERMILION	29		
Total		70,917		13,942

Table 8-3 2001 Rural Populations and Water Allocations within Battle River Basin

Rural Municipality Name		2001 Population	Source	2005 Allocation (dam^3)
Rural	COUNTY OF WETASKIWIN NO. 10	7,330		
	CAMROSE COUNTY	6,287		
	PONOKA COUNTY	4,482		
	M.D. OF WAINWRIGHT NO. 61	4,231	Groundwater	173
	FLAGSTAFF COUNTY	3,672		
	COUNTY OF VERMILION RIVER	2,825		
	M.D.OF PROVOST NO. 52	2,635		
	COUNTY OF STETTLER NO. 6	2,251		
	SPECIAL AREAS (2, 3 AND 4)	2,015		
	COUNTY OF PAINTEARTH NO. 18	1,898		
	BEAVER COUNTY	1,676		
	LACOMBE COUNTY	1,479	Surface	740
	LEDUC COUNTY	1,246		
	COUNTY OF MINBURN NO. 27	321		
Total		**42,348**		**913**
Aboriginal	SAMSON CREE NATION	4,955	Groundwater	423
	ERMINESKIN BAND	2,393		
	LOUIS BULL BAND	1,271		
	MONTANA BAND	592		
Total		**9,211**		**423**

8.1.2 Allocations

As of 2005, 246 municipal water licences had been issued to 78 licensees in the Battle River Basin. These licences allow maximum withdrawals of up to 21,950 dam^3. Municipal licensees account for three percent of licensed water allocations in Battle Basin. Allocations to urban municipalities account for 69 percent of total allocations. Rural users account for 29 percent of total municipal allocations.

Municipalities are licensed to withdraw up to 14,261 dam^3 of surface water; surface water accounts for 65 percent of total municipal water allocations. Twelve licences for surface water have been issued to urban users with total allocations of 8,264 dam^3. Rural users have six licences allowing withdrawals of up to 5,966 dam^3. The Battle River Basin is unusual within Alberta because 42 percent of the surface water allocation is for rural use, including water cooperatives, single- and multi-homes, farmsteads, and Hutterite colonies.

Municipalities are licensed to withdraw up to 7,689 dam^3 from groundwater licences; this represents 35 percent of total municipal water allocations. Urban municipalities have been issued 144 licences that allow withdrawals of 6,930 dam^3. Another 404 dam^3 of groundwater has been allocated to rural municipal users (65 licences) and 356 dam^3 has been issued to other municipal users (18 licences). The Battle River Basin is unusual because of the relatively large proportion of allocations of groundwater for municipal water use allocation (46 percent).

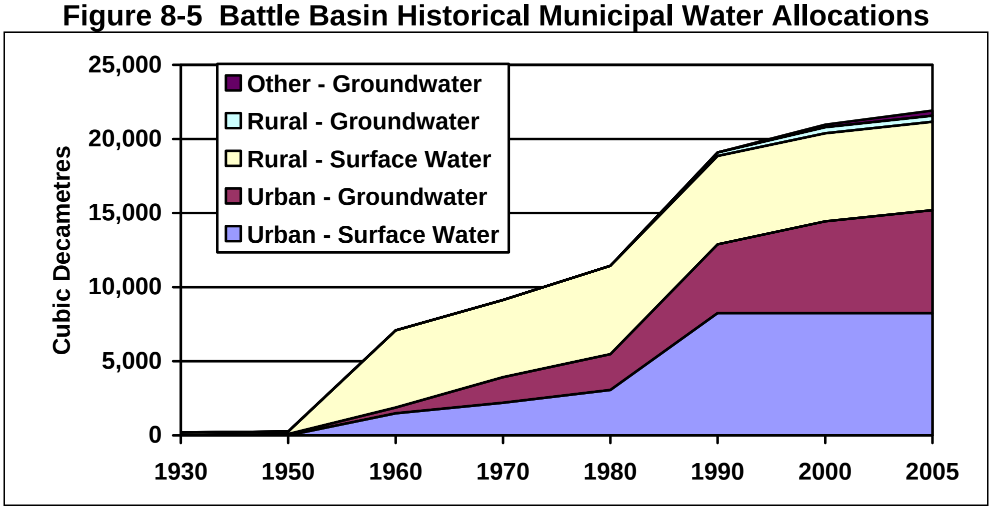
Table 8-4 lists the other large municipal water licensees in the Battle River Basin that have allocations of 100 dam^3 or more. It should be noted that the Town of Millet is located in Battle Basin but draws part of its water from the North Saskatchewan Basin. The Town of Stettler is also located in the Battle Basin but draws its water from the Red Deer Basin. The Department of Defense has the largest municipal allocation among non-municipality licensees, for the Canadian Forces Base at Wainwright.

Table 8-4 Other Large Municipal Water Licensees in the Battle River Basin

Approval Holder	Water Source	Allocation (dam^3)
DEPARTMENT OF NATIONAL DEFENCE	Surface	5,019
ALBERTA MENTAL HEALTH BOARD	Groundwater	163
LONE PINE HUTTERIAN BRETHREN	Groundwater	101

Figure 8-5 shows historical cumulative municipal water allocations in the Battle Basin up to 2005. Municipal uses accounting for less than 0.2 percent of MAD are not shown. All types of surface and groundwater allocations have ground steadily from 1950 to 1990, with the exception of rural and other groundwater allocations which have grown since 1980. Urban and rural surface water allocations have not significantly increased since 1990, whereas urban groundwater allocations have continued to grow to the present.

Figure 8-5 Battle Basin Historical Municipal Water Allocations



8.1.3 Licensed Water Use

Table 8-5 summarizes licensed water use for the municipal sector in Battle Basin. These licences assume that a maximum of 8,198 dam^3 will be used and include a return flow allowance of 13,752 dam^3 which represents 63 percent of the allocations returned. Return flow allowances range from 78 percent for urban surface water licences to 67 percent for rural surface water users. There are no return flow allowances in municipal licences issued for surface water allocations. For groundwater users, 46 percent of urban withdrawals are expected

to be returned to surface water sources. The return flows from municipal groundwater users actually exceed surface water consumption by municipalities. Only nine percent of the groundwater allocated to other municipal uses must be returned, and there are nor return flow requirements for rural groundwater users.

8.1.4 Actual Water Use

In 2005, six licensees reported their water diversions to the provincial government through the Water Use Reporting System. These licensees had a total allocation of 1,712 dam^3, which represents only eight percent of total municipal allocation in the basin, and they reported diverting 1,545 dam^3 in 2005, which amounts to 90 percent their maximum allocations. This indicates that the sample of licensees is withdrawing almost all of the water allowed in their licences. Only the Town of Castor reported return flow in 2005; a total of 132 dam^3 was returned. Environment Canada's Municipal Water Use database includes information for eight municipalities that accounted for 31 percent of the basin's 2001 population. Four of these reported return flow. The two data sets were combined and used to calculate ratios of allocation to actual diversion and diversion to use that allowed estimation of actual withdrawals and water use for all the communities in the basin.[1]

Based on extrapolation of the WURS and MUD information, it is estimated that municipalities are actually using is 151 percent of their licensed surface water use and 85 percent of licensed groundwater use. Overall, municipal water use in the Battle River Basin is estimated to be 15 percent higher than the total amount allowed on the licences. The estimate of surface water use may overestimate actual use because of the limited amount of information in the provincial and federal water use databases.

Another source of information on actual municipal water use is a study entitled "*Battle River Basin: Water Use Assessment and Projections"* (Watrecon 2005). That study estimated water use in 2004 based on a review of monthly water use and wastewater reports for the majority of the urban communities (91 percent of the urban population).

[1] Due to an anomalous return value likely resulting from a data entry error, the MUD record for the Town of Provost was not used in the estimation of water use. The Town of Provost indicated a 2005 groundwater withdrawal of 385 dam^3 and a return of 9,667 dam^3. A return of 24 times the diverted water amount seems untenable, unless the Town of Provost is collecting the wastewater flow of a large industrial or petroleum water user, which was unknown at the time of writing

Table 8-5 Licensed and WURS Reported Diversions, Water Use and Returns by Type of Municipal Use for Battle Basin

Water Use	Source	Number of Licensees	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Diversion	Water Use	Return
Urban*	Surface	12	8,264	1,777	6,487	174	42	132
	Groundwater	144	6,930	3,713	3,217	1,262	1,262	0
	Subtotal	**156**	**15,194**	**5,490**	**9,704**	**1,436**	**1,304**	**132**
Rural**	Surface	6	5,966	1,951	4,015	N/A	N/A	N/A
	Groundwater	65	404	404	0	N/A	N/A	N/A
	Subtotal	**71**	**6,370**	**2,355**	**4,015**	**N/A**	**N/A**	**N/A**
Other***	Surface	1	30	30	0	N/A	N/A	N/A
	Groundwater	18	356	323	33	108	108	0
	Subtotal	**19**	**386**	**353**	**33**	**108**	**108**	**0**
Total	Surface	19	14,261	3,759	10,502	174	42	132
	Groundwater	227	7,689	4,439	3,250	1,371	1,371	0
	Total	**246**	**21,950**	**8,198**	**13,752**	**1,545**	**1,412**	**132**

* Urban includes villages, summer villages, towns, cities, hamlets;
** Rural includes condominiums / townhouses / mobile homes / complexes, hotels / motels, cooperatives, farmsteads, single-multi homes, colonies and subdivisions
*** Other includes camps, institutions, senior/correctional centres, nursing/children's homes, hospitals

The Watrecon study concluded that communities were withdrawing 41 percent of their surface water entitlements and 56 percent of their groundwater allocations. It also determined that communities were consuming 23 percent of surface water withdrawals and 25 percent of groundwater withdrawals. These rates, when combined with the water licence information in Table 8-5, suggest that actual withdrawals amounted to 10,153 dam^3, or 46 percent of the maximum allocation. Actual water use is estimated to be 2,731 dam^3 or 27 percent of actual withdrawals. These water use estimates are slightly different from the Watrecon report and reflect some minor differences in the licensed allocations. The water use estimates based on the Watrecon information are substantially less (6,700 dam^3) than the estimates calculated using information from WURS and MUD. However, the Watrecon numbers are used in this analysis because the analysis was based on a much larger sample of water use data from communities in the Battle River Basin.

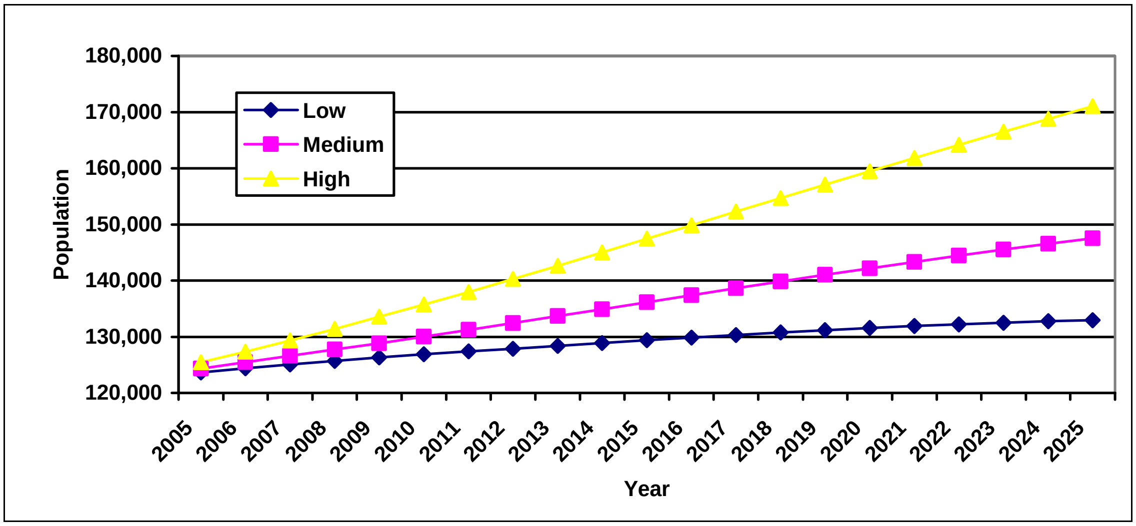
Table 8-6 Estimated Municipal Water Use in the Battle River Basin

Municipal Use	Source	Withdrawals (dam^3)	Use (dam^3)	Return Flow (dam^3)
Urban	Surface	3,388	779	2,609
	Groundwater	3,881	970	2,911
	Subtotal	**7,269**	**1,749**	**5,520**
Rural	Surface	2,446	563	1,883
	Groundwater	226	226	0
	Subtotal	**7,772**	**2,873**	**4,899**
Other	Surface	12	12	0
	Groundwater	199	181	18
	Subtotal	**212**	**193**	**19**
Total Use	Surface	5,847	1,354	9,052
	Groundwater	4,306	1,377	2,669
	Total	**10,153**	**2,731**	**11,721**
Licensed Use	Surface	14,261	3,759	10,502
	Groundwater	7,689	4,439	3,250
	Total	**21,950**	**8,198**	**13,752**
Percent of Licensed Use	Surface	41.0%	36.0%	86.2%
	Groundwater	56.0%	31.0%	82.1%
	Total	**46.3%**	**33.3%**	**85.2%**

8.1.5 Future Water Use Forecasts

Figure 8-5 shows low, medium and high population projection scenarios for Battle Basin based on Alberta Finance Census Division projections. These population forecasts have been used to predict future municipal surface and groundwater use. The resulting forecasts of water use are provided in Table 7.7, and are based on the estimated per capita water use in 2005.

Figure 8-6 Battle Basin Population Growth Forecast



Under the Low Population Growth scenario, municipal water use in 2025 is expected to be eight percent greater than at present. Under the High Population Growth scenario, water use will increase by 36 percent over current levels. For all scenarios water diversions in the Basin will not exceed current licensed diversions. However, as noted in the Watrecon report, some individuals, such as Wetaskiwin, Bawlf, New Norway and Ferintosh, may need additional allocations to accommodate their growing populations.

Table 8-7 Projected Water Use for the Municipal Sector in the Battle Basin
(dam^3)

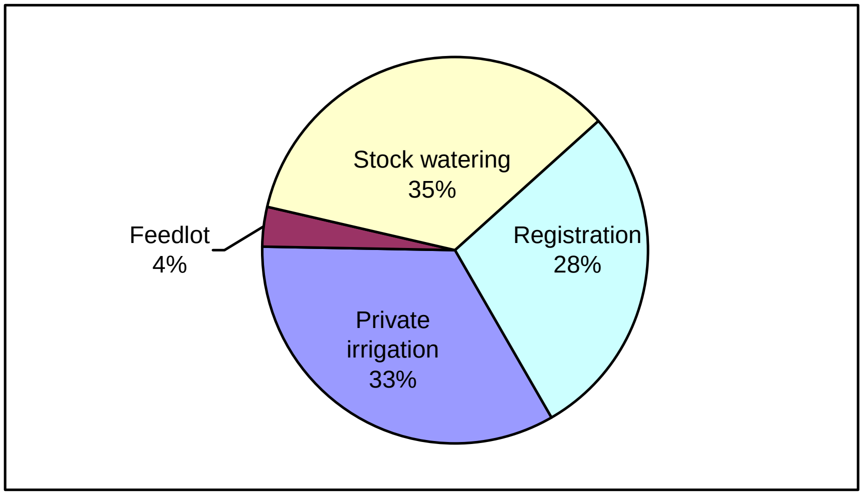
Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,354	1,390	1,417	1,441	1,455
	Groundwater	1,377	1,413	1,441	1,465	1,480
	Total	**2,731**	**2,803**	**2,858**	**2,906**	**2,936**
Medium Growth	Surface	1,354	1,416	1,482	1,548	1,606
	Groundwater	1,377	1,440	1,508	1,575	1,634
	Total	**2,731**	**2,856**	**2,990**	**3,123**	**3,240**
High Growth	Surface	1,354	1,465	1,591	1,721	1,846
	Groundwater	1,377	1,490	1,619	1,751	1,878
	Total	**2,731**	**2,955**	**3,210**	**3,472**	**3,724**

8.2 AGRICULTURAL SECTOR

As of December 2005 a total of 33,720 dam^3 had been allocated to the agricultural sector in the Battle River Basin. This includes 16,738 registrations representing 9,537 dam^3 and 2,427 licences representing 24,182 dam^3 of water. Water allocated to agriculture accounts for four percent of all allocations in the Battle River Basin.

Figure 8-7 shows how this water is distributed among the different agricultural uses in the Basin. The largest allocation is for stockwatering (35 percent). Private irrigation accounts for 33 percent, registration accounts for 28 percent, and feedlot accounts for four percent of the total allocation.

Figure 8-7 Water Allocation by Volume for Agricultural Activities in Battle Basin



A total of 10,541 registrations and 945 licences allow withdrawals of up to 20,830 dam^3 of surface water; this accounts for 62 percent of all water that is allocated to the agricultural sector. There are 1,432 licences and 6,195 registrations that have been issued to withdraw up to 12,925 dam^3 of groundwater (38 percent of total allocation).

8.2.1 Overview of Agriculture in the Battle River Basin

Based on information from the 2001 Census of Agriculture, there were about 6,080 farms (12 percent of Alberta total) with an average size of 944 acres in the Battle River Basin. In Alberta, there are about 53,000 farms with an average size of 970 acres. Farms in the Battle Basin cover an area of nearly 5.74 million acres; this is equivalent to about 23,000 km^2 or about 65 per cent of the basin. Table 8-8 shows that about 46 percent of the land in the Basin is used to raise crops. About 42 per cent of agricultural land is pasture. The rest of the lands are in summerfallow or other uses.

Table 8-8 Agricultural Land Use in the Battle River Basin, 2001

Land Use	Acres	Percent
Crop Land	2,648,724	46.2%
Summerfallow	336,419	5.9%
Tame/Seeded Pasture	607,412	10.6%
Natural Pasture	1,818,486	31.7%
Other	325,073	5.7%
Total	**5,736,114**	**100.0%**

The types of farming activity vary within the Battle River Basin. Table 8-9 shows the classification of farms based on the commodity groups that accounted for 51 per cent or more of total gross farm receipts. The table shows that 46 percent of the farms in the Basin raise beef cattle and about 25 percent of the farms are grain and oilseed farms. Specialty farms make up about nine percent of the farms. The mix of farm types in the Battle River Basin is very similar to that of Alberta, with cattle (beef) farm being the predominant farm types. However, the Battle River Basin has a much higher percentage of dairy, grains and oilseed, and fruit farms that are found in Alberta, and a lower percentage of farms growing field crops or vegetables.

Table 8-9 Classifications of Farms in the Battle Basin and Alberta, 2001

Farm Type (Farms with Gross Receipts >$2,500)	Battle River Basin	Alberta	Percent of Alberta
Dairy Farms	2.2%	16.5%	1.5%
Cattle (beef) Farms	46.0%	11.7%	45.4%
Hog Farms	1.9%	12.8%	1.7%
Poultry & Egg Farms	1.1%	14.0%	0.9%
Wheat Farms	5.9%	9.3%	7.4%
Grain & Oilseed Farms	24.7%	15.5%	18.4%
Field Crop Farms	5.3%	6.6%	9.3%
Fruit Farms	0.2%	14.4%	0.1%
Misc.Speciality Farms	8.5%	9.1%	10.9%
Sum of Livestock Comb. Farms	2.8%	13.9%	2.3%
Sum of Vegetable Farms	0.1%	7.4%	0.1%
Sum of Other Comb Farms	1.3%	7.9%	2.0%
Total	**100.0%**	**11.6%**	**100.0%**

8.2.2 Livestock

As noted in Table 8-9 about 50 percent of the farms in the Battle Basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species in 2001 are provided in Table 8-10. The table shows that there about one million cattle and calves, which together, accounted for about 90 percent of livestock population in the Battle Basin. This is about 8.2 times the human population of the BRB. Other livestock in the Battle Basin included pigs, sheep and lamb, horses and ponies, bison, deer and elk.

Table 8-10 Estimated Livestock Populations in the Battle Basin and Alberta, 2001

Livestock Species	Basin Total	Alberta	% Alberta
Hens and Chicken	1,418,808	12,175,246	11.7%
Turkey	117,479	864,438	13.6%
Cattle	748,631	6,615,201	11.3%
Calves	261,624	2,169,607	12.1%
Pigs	247,258	2,027,533	12.2%
Sheep and Lamb	34,439	307,302	11.2%
Horse and Ponies	19,462	159,962	12.2%
Bison	9,892	79,731	12.4%
Deer	2,358	8,331	28.3%
Elk	2,358	31,304	7.5%

8.2.2.1 Water Allocation

Overall, 18,972 licensees and registrations have been issued for livestock watering, with the total allocation amounting to 22,414 dam^3. In addition to these allocations, farmers are able to obtain up to 1,250 m^3 of water for household purposes. The numbers of such households in the Basin is not known. Furthermore, the numbers of "exempted agricultural" users are also not known in the Battle Basin.

A historical perspective on water used for livestock is provided in Figure 8-8. The figure shows that some registrations were issued with priority dates in the 1890s while licences for stockwatering began to be issued from the early 1900s. Allocations for stockwatering have risen steadily since the 1920s with surface and groundwater licences and groundwater registrations accounting for much of that increase. Since 1990 water allocation has remained relatively stable at around 22,000 dam^3. Over the last few decades livestock operations have gone through intensification, characterized by feedlots. In the Battle Basin however, feedlots allocations began in 1980s and account for 5.4 percent of total livestock water allocation.

Figure 8-8 Historical Trends in Water Allocation for Livestock in the Battle Basin

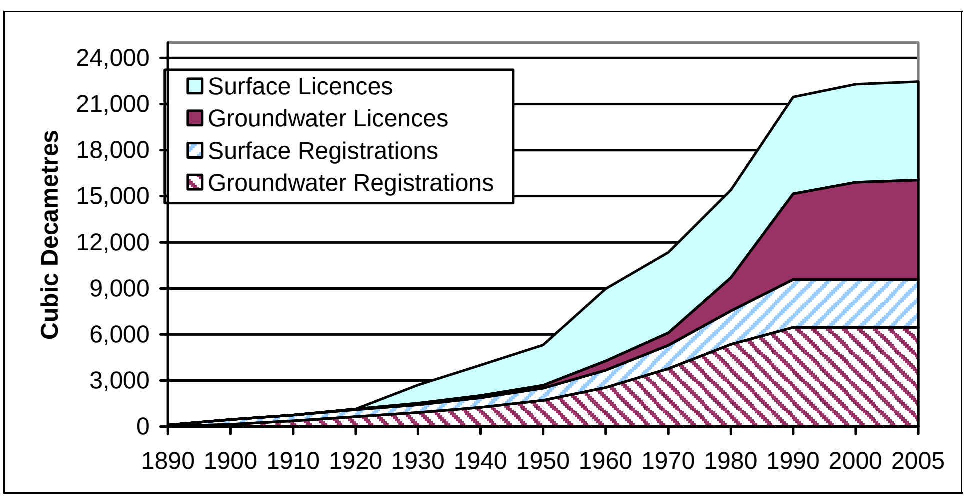


Table 8-11 Summary of Water Licences and Registrations Issued for Livestock Watering in the Battle Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensee Reporting	Reported Use
Feedlot	Surface	5	206.0	206.0	0.0	0	N/A
	Groundwater	85	999.8	999.8	0.0	0	N/A
	Subtotal	**90**	**1,205.8**	**1,205.8**	**0.0**	**0**	**N/A**
Stock watering	Surface	799	6,188.8	6,188.8	0.0	0	N/A
	Groundwater	1,347	5,482.1	5,482.1	0.0	0	N/A
	Subtotal	**2,146**	**11,671.0**	**11,671.0**	**0.0**	**0**	**N/A**
Registration	Surface	10,541	3,129.9	3,129.9	0.0	0	N/A
	Groundwater	6,197	6,407.5	6,407.5	0.0	0	N/A
	Subtotal	**16,738**	**9,537.4**	**9,537.4**	**0.0**	**0**	**N/A**
Total	Surface	11,345	9,524.7	9,524.7	0.0	0	N/A
	Groundwater	7,627	12,889.4	12,889.4	0.0	0	N/A
	Total	**18,972**	**22,414.1**	**22,414.1**	**0.0**	**0**	**N/A**

Table 8-11 summarizes current water licences and registrations issued for livestock according to the water source. It shows that surface water accounts for about 42 percent of allowable diversions for livestock and that registrations account for 28 percent of the allocations.

8.2.2.2 Licensed Water Use

Table 8-11 shows that licences and registration for stockwatering do not include any allowance for return flow. It is expected that all withdrawals will be used.

8.2.2.3 Actual Water Use

There is no information in Alberta Environment's WURS that indicates the extent to which water allocations are actually used in the Battle Basin. However, a reasonable estimate of water use can be derived using the actual animal population in the Basin as shown in Table 8-12. Based on livestock populations for the Basin in 2001, the total water required for livestock was estimated to be 9,594 dam^3, or about 42 percent of the licensed allocation. The calculations for this estimate are provided also in Table 8-12 which shows livestock populations in the Basin and the daily water requirements for various livestock species as provided by Alberta Environment in its "Guide to Calculate Quantities for Water for Raising Animals".

Table 8-12 Estimated Livestock Water Requirements for 2001

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chickens	1,418,808	0.045	105.9
Turkey	117,479	0.15	29.2
Bulls	15,633	9.0	233.3
Milk Cows	12,918	30.0	642.7
Beef Cows	284,969	9.0	4,253.2
Heifers	106,902	6.0	1,063.7
Steers	64,304	6.0	639.8
Calves	261,624	3.0	1,301.6
Boars	949	6.5	10.2
Sows and Gilts - Breeding	24,776	6.5	267.1
Nursing and Weaner Pigs	221,535	0.5	183.7
Grower and Finishing Pigs	136,914	1.5	340.6
Sheep and Lambs	34,439	2.0	114.2
Horse and Ponies	19,462	10.0	322.7
Bison	9,892	2.0	32.8
Deer	2,358	10.0	39.1
Elk	2,358	3.5	13.7
Total			**9,593.5**

In terms of water requirements by species, cattle account for about 85 percent of the total, about eight percent is required by pigs, one percent is required by poultry and all other species accounted for the remaining six percent.

While the estimated actual consumption based on livestock populations (9,594 dam^3**)** appears to be significantly less than the amount of water allocated (22,450 dam^3), the data in Table 8-12 do not include an allowance for the evaporative and seepage losses associated with storing water for livestock use. Typically, licensed consumption accounts for only 35 percent of surface water allocated for livestock use while losses account for 65 percent (Watrecon 2005). Since 58 percent of livestock water consumption comes from groundwater (no losses) and the balance comes from surface water with 65 percent losses, a total allocation of 11,763 dam^3 would be required to support the animal populations in Table 8-10. This water requirement is about 52 percent of the water allocation through licences and registrations. Consequently, it is assumed that actual water use is less than the water allocated for livestock. It is also assumed that surface water withdrawals occurred during April when dugouts and storage dams were filled and flows were at their peak.

8.2.2.4 <u>Forecasts of Future Stockwatering Water Use</u>

The key factor affecting future livestock water demand is changes in cattle populations in the basin. Cattle accounts for about 85 percent of livestock water demand in the Battle Basin, so changes in the populations of other livestock species will have a minimal overall impact on future water demand. The historical trend analysis in Figure 8-8 shows that the amount of water allocated for livestock has been increasing over time, including the last decade, suggesting an increasing livestock population, which is confirmed by Census data which shows a seven percent increased in cattle populations in the Basin between 1996 and 2001.

Some indication of the potential for expansion of cattle populations in the Battle River Basin can be determined by examining applications for new and expanded confined feeding operations, which must be approved by the NRCB in accordance with *AOPA*. Information from the NRCB indicates that, as of December 31, 2005, there had been 39 applications from farmers throughout the Basin for cattle and dairy operations, most of which were approved (Table 8-13).

Table 8-13 Status of Applications Under *AOPA* in the Battle Basin

Type of Application	Number	Withdrawn	Approved	Denied
Approval	7	1	6	0
Registrations	14	0	11	3
Authorizations	18	0	17	1
Total	**39**	**1**	**34**	**4**

A study undertaken by Alberta Agriculture in the late 1990s also provides some insights regarding the potential for expansion of the beef industry in the province. That study identified several criteria – manure, odor and population densities, local silage supplies, water supply, landscape characteristics and land for manure spreading – to be considered in evaluating the

capability of supporting a 5,000-head back grounding operation and a 20,000-head operation. Townships suitable for livestock expansions are shown in Figures 2-2 and 2-3 in Section 2.3. These figures show that more townships meet all of the criteria for back grounding operations than finishing operations. For most townships that meet some of the criteria limiting factors include groundwater, landscape and silage for back grounding operations. For finishing operations relatively few townships meet any of the criteria, however, some townships meet some criteria but are limited by groundwater and landscape.

Based on Alberta Agriculture's assessment, it would appear that livestock expansion in the Battle River Basin could occur and would most likely consist of 5,000-head operations. Watrecon (2005) derived the same conclusion with respect to livestock expansion and used 1.2 percent annual growth rate of water use. However, given the numbers of applications to the NRCB, Alberta Agriculture's assessment and proximity of the Basin to livestock processing facilities in southern Alberta, a Base Growth scenario based on a 2.2 percent annual increase has been assumed; this reflects the long term growth rate of cattle population of Alberta (1958-2005). The Low and High growth scenarios assume annual growth rates of 1.2 and 3.2 percent, respectively. The forecast also assumes that the current mix of livestock water use (85 percent cattle) and balance of surface and groundwater use will remain unchanged over the forecast period. The resulting projections, based on actual use are shown in Table 8-14.

Table 8-14 Forecast of Water Use for Livestock in the Battle River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	6,199	6,580	6,984	7,413	7,869
	Groundwater	5,564	5,906	6,269	6,654	7,063
	Total	**11,763**	**12,485**	**13,253**	**14,067**	**14,932**
Medium Growth	Surface	6,199	6,911	7,706	8,591	9,579
	Groundwater	5,564	6,204	6,917	7,712	8,598
	Total	**11,763**	**13,117**	**14,622**	**16,303**	**18,177**
High Growth	Surface	6,199	7,256	8,494	9,942	11,638
	Groundwater	5,564	6,513	7,624	8,924	10,447
	Total	**11,763**	**13,769**	**16,118**	**18,867**	**22,085**

Under the Low Growth scenario, water demand is projected to increase to 14,932 dam^3 by 2025; this represents a 27 percent increase over current use but is within current allocations. Under the High Growth scenario, livestock water use would increase to 22,085 dam^3 by 2025. This increase is 1.9 times higher than current livestock use and equivalent to current allocations.

8.2.3 Irrigation

The other major use of water for agricultural purposes is irrigation or crop watering. Unlike some river basins in southern Alberta, there are no licences for district irrigation in the Battle

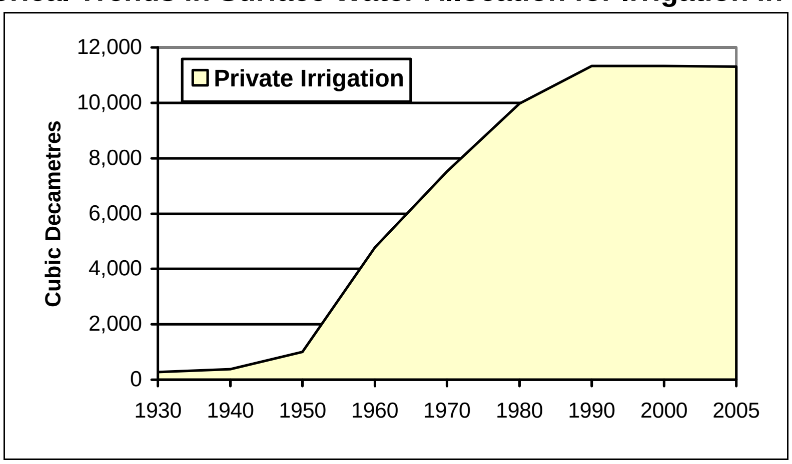
River Basin. The farmers in this Basin are private irrigators who have their own water licences and divert water using their own pumps and water distribution equipment.

When aggregate information from the 2001 Census of Agriculture for individual counties and municipal districts is modified to reflect river Basin boundaries, the resulting estimates suggest that about 3,128 acres of land in the Battle River Basin were irrigated in 2001. This number could be incorrect however, because irrigation acres are not evenly distributed throughout each of the counties that make up the Basin and because of likelihood of inaccuracy in the Census data. An estimate of the irrigated acres can be made based on water allocations and irrigation requirement of about 450 mm (18 inches). Based on this requirement it is estimated that water allocations are sufficient to support irrigation on about 9,297 acres. There is no information on the mix of crops grown by private irrigators; AAFRD[2] has indicated that most private irrigation in Alberta is used to raise supplemental forages to feed livestock.

8.2.3.1 Water Allocation

There are 191 private licences that allocate approximately 11,000 dam^3 for irrigation, all from surface water sources. This Basin accounts for about two percent of total private allocation and about seven percent of the private licences issued in the province. A historical perspective on water used for irrigation is provided in Figure 8-9. The allocations for irrigation date from the 1930s, and have increased substantially since that time, particularly from the 1950s to 1990s. As of 2005, about 11,300 dam^3 had been allocated and this is virtually unchanged from 2000.

Figure 8-9 Historical Trends in Surface Water Allocation for Irrigation in the Battle Basin



[2] Cited in Watrecon (2005) as Personal communication, Wally Chinn, Head - Irrigation Development Section, Irrigation Branch, AAFRD, January 7, 2005.

Table 8-15 Irrigation Allocations and Use and Reported Actual Water Use, Battle River Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
Private irrigation	Surface	191	11,305.5	10,286.7	1,018.8	0	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Subtotal	**191**	**11,305.5**	**10,286.7**	**1,018.8**	**0**	**N/A**
Total	Surface	191	11,305.5	10,286.7	1,018.8	0	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Total	**191**	**11,305.5**	**10,286.7**	**1,018.8**	**0**	**N/A**

8.2.3.2 Licensed Water Use

Table 8-15 summarizes the water licences issued for irrigation according to water source. The table shows that up to 91 percent of the total allocation of surface water is expected to be used and that nine percent (1,019 dam^3) will to be returned to surface sources.

8.2.3.3 Actual Water Use

Neither AAFRD nor AENV has any information on actual water use by private irrigators. For the purposes of this study it is assumed that actual use is equal to licensed water use, excluding the three licences who account for all of the return flow. However, water use in any given year will depend on how much of the crop water demand can be satisfied by natural precipitation. It is noteworthy that actual stockwatering use in the Basin (11,763 dam^3) is similar to the amount of water used for crop watering.

8.2.3.4 Forecasts of Future Irrigation Water Use

With expansion of livestock, additional demand for livestock forage is expected. The historical trend provided in Figure 8-9 shows that water allocation for irrigation has increased over time, suggesting that past increases in livestock have led to increased water demand for irrigation. The ability to expand forage production will depend on a number of factors including the availability of land. Currently 65 percent of the Basin is agricultural land with majority used for crop production. Irrigated acres account for small portion of the crop lands so some expansion is possible. However, irrigation is a capital intensive operation but the net returns from forage production are not great (Watrecon, 2005). It is assumed that current forage production is sufficient to support some expansion with some growth occurring over the forecast period. Annual growth rates of 0.5, 1.0 and 2.0 percents in water use are assumed for Low, Base and High Growth Cases respectively and shown in Table 8-16. All water use is assumed to come from surface water sources.

Table 8-16 Projected Water Use for Irrigation in the Battle River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	10,287	10,546	10,813	11,086	11,366
	Groundwater	0	0	0	0	0
	Total	**10,287**	**10,546**	**10,813**	**11,086**	**11,366**
Medium Growth	Surface	10,287	10,811	11,363	11,943	12,552
	Groundwater	0	0	0	0	0
	Total	**10,287**	**10,811**	**11,363**	**11,943**	**12,552**
High Growth	Surface	10,287	11,357	12,539	13,845	15,285
	Groundwater	0	0	0	0	0
	Total	**10,287**	**11,357**	**12,539**	**13,845**	**15,285**

Under the Low Growth, water demand is projected to increase to 11,366 dam^3 by 2025; this represents a 10 percent increase over current use. Under the High Growth, water use would increase to 15,285 dam^3 by 2025. This increase is 1.5 times higher than current irrigation water use.

8.2.4 Summary

In summary, current agricultural water use in the Battle Basin is estimated to be about 22,050 dam^3, of which 53 percent is for stockwatering and 47 percent is for irrigation. In the future, agricultural water demand in the Basin is expected to increase as a result of expansion of livestock populations and increased forage production. A summary of future agricultural water demand is provided in Table 8-17. Agricultural water use in 2025 would be 26,297 dam^3 (an increase of 20 percent from 2005) under the Low Growth. Under High Growth water use would be 37,370 dam^3 which is an increase of 70 percent from 2005.

Table 8-17 Projected Water Use for Agriculture in the Battle River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	16,485	17,126	17,797	18,499	19,234
	Groundwater	5,564	5,906	6,269	6,654	7,063
	Total	**22,049**	**23,032**	**24,065**	**25,153**	**26,297**
Medium Growth	Surface	16,485	17,722	19,068	20,534	22,130
	Groundwater	5,564	6,204	6,917	7,712	8,598
	Total	**22,049**	**23,926**	**25,985**	**28,245**	**30,729**
High Growth	Surface	16,485	18,613	21,033	23,787	26,924
	Groundwater	5,564	6,513	7,624	8,924	10,447
	Total	**22,049**	**25,126**	**28,657**	**32,711**	**37,370**

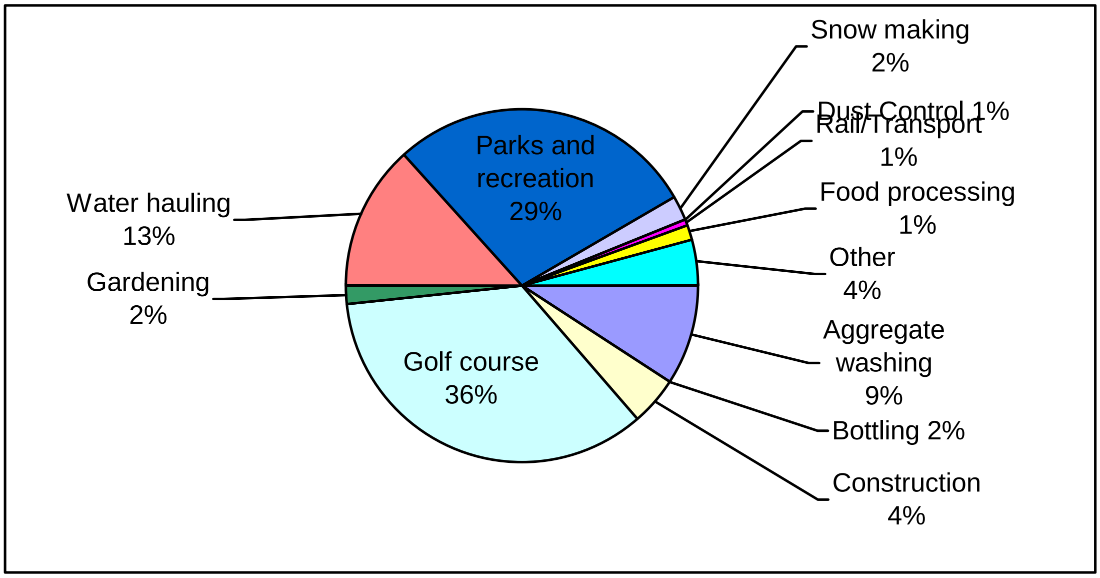
8.3 COMMERCIAL SECTOR

There are 129 licences that allow maximum withdrawals of up to 2,729 dam^3 of water for the commercial sector in the Battle River Basin. This allocation accounts for 0.3 percent of total allocations in the Basin

8.3.1 Water Allocations

As shown in Figure 8-10, the three largest activities in the commercial sector include golf courses (36 percent of sector allocations), parks and recreation (29 percent), and water hauling (13 percent). All other activities only account for 22 percent of the total allocation.

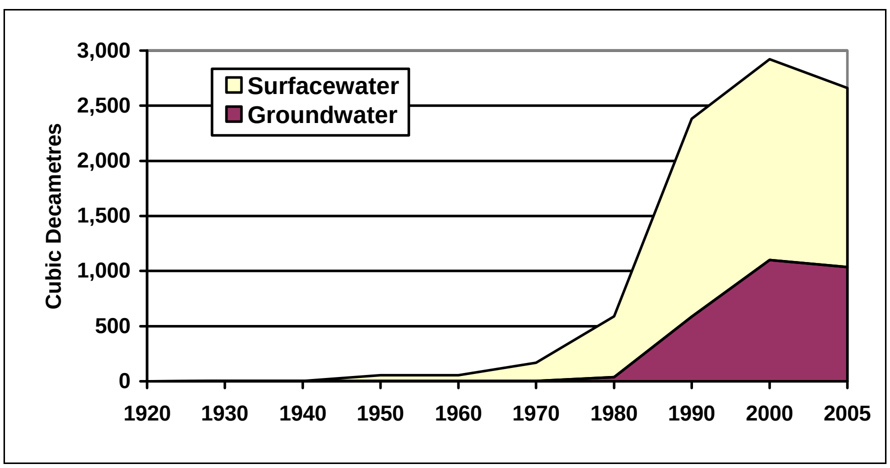
Figure 8-10 Water Allocation for Commercial Activities in the Battle Basin



Licences issued for the commercial sector allow maximum withdrawals of about 1,625 dam^3 of surface water (60 percent of total allocations). The largest allocation is for parks and recreation which accounts for about 40 percent of the total surface water allocation. Licences issued for the commercial sector allow maximum withdrawals of 1,104 dam^3 of groundwater (40 percent of total allocations). The largest allocation is for groundwater hauling which accounts for about 30 percent of the total groundwater allocation.

A historical trend of commercial sector allocation in the Battle Basin is provided in Figure 8-11.

Figure 8-11 Historical Trend in Commercial Sector Water Allocation in the Battle



The earliest allocation began in the 1920s but remained relatively small at less than 10 dam^3. Allocations began to increase in the 1940s with surface water allocations increasing more rapidly than groundwater allocations. Since 2000 there has been a slight decrease in allocations for both ground and surface water.

8.3.2 Licensed Water Use

Table 8-18 provides a summary of licensed water allocations, use and return for various activities within the commercial sector in the Battle Basin. The table shows that licences issued for commercial purposes assume that 105 dam^3 (four percent of allocation) will be returned, mostly surface water sources.

8.3.3 Actual Water Use

At the present time Alberta Environment's Water Use Reporting System (WURS) contains no information on actual water use in 2005 by the any of the licensees in commercial sector in the Battle Basin (Table 8-18). Therefore, it is assumed that all licensees are withdrawing and using the full amounts of water to which they are entitled. While this assumption may overstate actual water use in the basin, the commercial sector accounts for 0.3 percent of total allocations so it will not appreciably affect overall water use estimate for the Battle River Basin.

8.3.4 Forecasts of Future Water Use

Since most (78 percent) of water allocations for the commercial sector are for three activities (golf course, parks and recreation, and water hauling), forecasts of future demand will focus on those activities.

8.3.4.1 Golf Courses

The demand forecast for golf courses adopts the approach outlined in Watrecon (2005) for the Battle Basin. This approach tied water demand to the demand for additional golfing facilities which is based on future population growth. In the case of the Battle River Basin it was assumed that, for the different population growth scenarios, nine, 18 and 27 new holes would be added every five years for Low Growth, Medium Growth and High Growth scenarios. It is assumed that the mix of surface and groundwater use does not change over the forecast period relative to 2005 and that all withdrawals are lost or consumed. The resulting projections are shown in Table 8-19.

Table 8-18 Licensed Commercial Allocations and Reported Actual Water Use, Battle Basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Licensees Reporting	Reported Use	Percent of Allocation
Aggregate washing	Surface	3	62.2	62.2	0.0	0	N/A	N/A
	Groundwater	6	188.2	182.3	5.9	0	N/A	N/A
	Subtotal	**9**	**250.4**	244.6	**5.9**	**0**	**N/A**	**N/A**
Bottling	Surface	0	0.0	0.0	0.0	0	N/A	N/A
	Groundwater	2	1.7	1.7	0.0	0	N/A	N/A
	Subtotal	**2**	**1.7**	1.7	**0.0**	**0**	**N/A**	**N/A**
Construction	Surface	5	93.5	44.1	49.3	0	N/A	N/A
	Groundwater	3	22.3	22.3	0.0	0	N/A	N/A
	Subtotal	**8**	**115.8**	66.5	**49.3**	**0**	**N/A**	**N/A**
Golf course	Surface	10	595.2	595.2	0.0	0	N/A	N/A
	Groundwater	17	358.1	358.1	0.0	0	N/A	N/A
	Subtotal	**27**	**953.4**	904.0	**49.3**	**0**	**N/A**	**N/A**
Gardening	Surface	5	18.7	18.7	0.0	0	N/A	N/A
	Groundwater	9	27.2	27.2	0.0	0	N/A	N/A
	Subtotal	**14**	**45.9**	45.9	**0.0**	**0**	**N/A**	**N/A**
Water hauling	Surface	0	0.0	0.0	**0.0**	0	N/A	N/A
	Groundwater	14	359.9	359.9	**0.0**	0	N/A	N/A
	Subtotal	**14**	**359.9**	359.9	**0.0**	**0**	**N/A**	**N/A**
Parks and Recreation	Surface	12	666.0	666.0	**0.0**	0	N/A	N/A
	Groundwater	22	105.8	105.8	**0.0**	0	N/A	N/A
	Subtotal	**34**	**771.8**	771.8	**0.0**	**0**	**N/A**	**N/A**

Table 8-18 Licensed Commercial Allocations and Reported Actual Water Use, Battle Basin (continued)

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Licensees Reporting	Reported Use	Percent of Allocation
Snow making	Surface	1	51.0	51.0	**0.0**	0	N/A	N/A
	Groundwater	1	9.9	9.9	**0.0**	0	N/A	N/A
	Subtotal	**2**	**60.9**	**60.9**	**0.0**	**0**	**N/A**	**N/A**
Dust control	Surface	0	0.0	0.0	**0.0**	0	N/A	N/A
	Groundwater	1	1.2	1.2	**0.0**	0	N/A	N/A
	Subtotal	**1**	**1.2**	**1.2**	**0.0**	**0**	**N/A**	**N/A**
Rail/Transport	Surface	0	0.0	0.0	**0.0**	0	N/A	N/A
	Groundwater	4	13.1	13.1	**0.0**	0	N/A	N/A
	Subtotal	**4**	**13.1**	**13.1**	**0.0**	**0**	**N/A**	**N/A**
Food processing	Surface	1	34.5	34.5	**0.0**	0	N/A	N/A
	Groundwater	4	4.2	4.2	**0.0**	0	N/A	N/A
	Subtotal	**5**	**38.7**	**38.7**	**0.0**	**0**	**N/A**	**N/A**
Other	Surface	3	103.6	103.6	**0.0**	0	N/A	N/A
	Groundwater	5	12.4	12.4	**0.0**	0	N/A	N/A
	Subtotal	**8**	**116.0**	**116.0**	**0.0**	**0**	**N/A**	**N/A**
Total	Surface	40	1,624.8	1,575.5	49.3	0	N/A	N/A
	Groundwater	88	1,104.1	1,098.2	5.9	0	N/A	N/A
	Total	**128**	**2,728.9**	**2,673.7**	**55.2**	**0**	**N/A**	**N/A**

Table 8-19 Projected Water Use for Golf Course, Battle Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	595	614	629	641	649
	Groundwater	358	370	378	386	390
	Total	**953**	**984**	**1,007**	**1,028**	**1,039**
Medium Growth	Surface	595	661	732	802	864
	Groundwater	358	398	440	483	520
	Total	**953**	**1,060**	**1,172**	**1,284**	**1,384**
High Growth	Surface	595	774	978	1,187	1,388
	Groundwater	358	466	588	714	835
	Total	**953**	**1,240**	**1,566**	**1,901**	**2,223**

Under the High Growth scenario, water use is 2,223 dam^3 by 2025, which is 2.3 times the current use. Under the Low Growth water use is 1,069 dam^3 by 2025, or 1.1 times current use.

8.3.4.2 Parks and Recreation

Future demands for water use for parks and recreation are also tied to expected population growth. Projections are based on annual growth of 0.2 percent for the Low Growth scenario, 0.8 percent for the Medium Growth scenario and 1.7 percent for the High Growth scenario. The projections assume that, consistent with the water licence requirements, all withdrawals for parks and recreation are consumed. The resulting forecasts are shown in Table 8-20.

Table 8-20 Projected Water Use for Parks and Recreation, Battle Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	666	673	679	686	693
	Groundwater	106	107	108	109	110
	Total	**772**	**780**	**787**	**795**	**803**
Medium Growth	Surface	666	693	721	751	781
	Groundwater	106	110	115	119	124
	Total	**772**	**803**	**839**	**870**	**905**
High Growth	Surface	666	725	788	858	933
	Groundwater	106	115	125	136	148
	Total	**772**	**840**	**914**	**994**	**1,081**

Under the Low Growth scenario, water use is projected to increase to 803 dam^3 by 2025, a four percent increase from current levels. Water use is expected to increase to 1,081 dam^3 under the High Growth scenario and this is a 40 percent increase from current use.

8.3.4.3 Water Hauling

A review of licence information showed that most allocations for water hauling have been issued to local municipal governments. Therefore, it is assumed that water hauling allocations are for municipal purposes, and that future demand will be tied to local population growth rates. Consequently, projections assume annual growths of 0.2 percent for the Low Growth scenario, 0.8 percent for the Medium Growth scenario and 1.7 percent for the High Growth scenario. The forecast also assumes that all withdrawals are consumed. Table 8-21 shows that, under these assumptions, water use under the Low Growth scenario is projected to increase to 375 dam^3 by 2025 (a four percent increase). Under High Growth, water use is expected to increase to 422 dam^3 which is a 17 percent increase from current use.

Table 8-21 Projected Water Use for Water Hauling, Battle Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	0	0	0	0	0
	Groundwater	360	364	367	371	375
	Total	**360**	**364**	**367**	**371**	**375**
Medium Growth	Surface	0	0	0	0	0
	Groundwater	360	375	390	406	422
	Total	**360**	**375**	**390**	**406**	**422**
High Growth	Surface	0	0	0	0	0
	Groundwater	360	392	426	463	504
	Total	**360**	**392**	**426**	**463**	**504**

8.3.4.4 Summary

A summary of projected water demand for the commercial sector in the Battle Basin is provided in Table 8-22. Note that this summary and projections include the forecasts for the three activities described above and assume that water use for all other commercial sector activities remain constant.

Table 8-22 Projected Water Use for the Commercial Sector in the Battle River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,575	1,601	1,622	1,642	1,656
	Groundwater	1,098	1,114	1,127	1,140	1,149
	Total	**2,674**	**2,715**	**2,750**	**2,782**	**2,806**
Medium Growth	Surface	1,575	1,669	1,767	1,867	1,959
	Groundwater	1,098	1,157	1,219	1,282	1,340
	Total	**2,674**	**2,826**	**2,986**	**3,148**	**3,300**
High Growth	Surface	1,575	1,813	2,081	2,359	2,635
	Groundwater	1,098	1,247	1,414	1,588	1,762
	Total	**2,674**	**3,060**	**3,494**	**3,947**	**4,397**

Under the low growth scenario, water demand is projected to rise to 2,217 dam^3, a 17 percent increase from current levels by 2025. Under the high growth scenario, water demand is projected to rise to 3,808 dam^3, a 1.8 times increase from current levels by 2025.

8.4 PETROLEUM SECTOR

In the Battle Basin there are 71 active licences which allocate 10,089 dam^3 of water to the petroleum sector. Petroleum water licences account for one percent of the total allocations in the basin. Most of the water allocations for the petroleum sector are for surface water (72 percent or 7,378 dam^3. As shown in Figure 8-12, the petroleum sector includes water allocations for oilfield injection, gas and petrochemical plants, and various other petroleum related activities.

Figure 8-12 Petroleum Water Allocation by Use in the Battle Basin

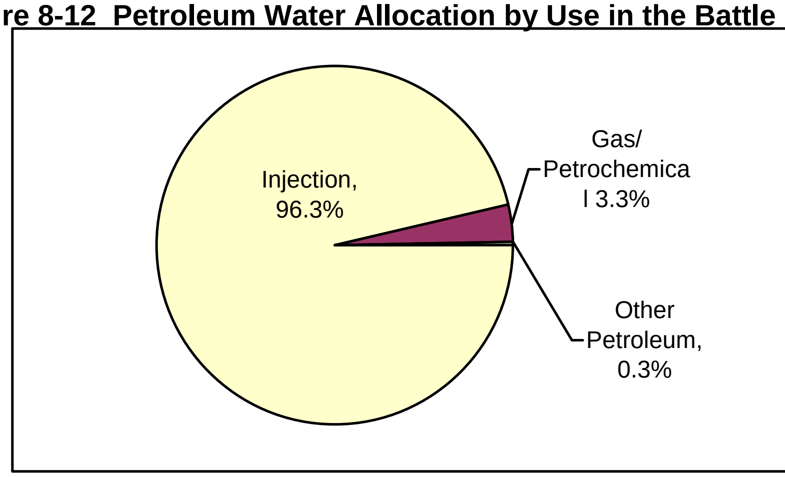


Table 8-23 summarizes the water allocation, use, and return associated with the licences for each activity in the Battle Basin.

8.4.1 Injection

8.4.1.1 Water Allocations

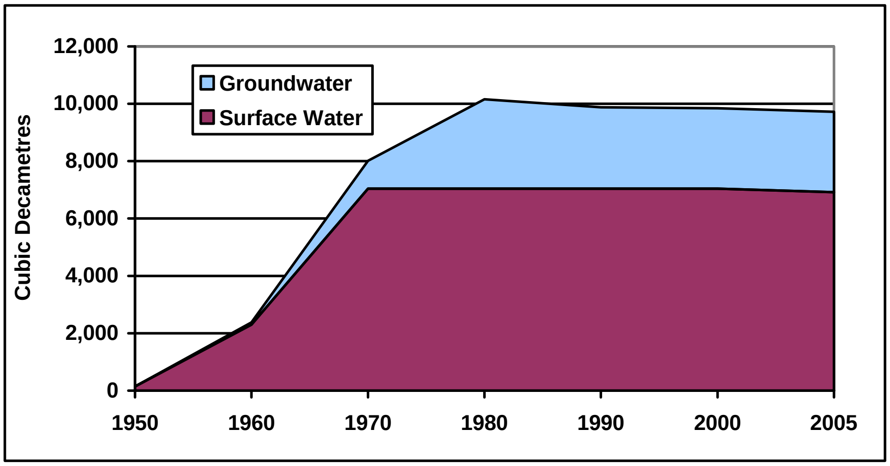
Just over 96 percent of the allocations are for injection purposes for enhanced oil and gas recovery (9,717 dam^3). Table 8-23 shows that 61 licences have been issued for injection purposes, mostly for groundwater (53 licences). However, most of water allocations (73 percent) are for surface water. Water allocations for injection commenced in the 1950s and grew until the 1980s. Figure 8-13 shows that there has actually been a slight decline in licensed allocations for groundwater since the 1980s, but allocations of surface water have remained constant during that period.

Table 8-23 Licensed Allocations and Reported Actual Water Use, for the Petroleum Sector, Battle River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Injection*	Surface	8	7,043.2	6,902.6	140.6	220.4	3.2%	3.1%
	Groundwater	53	2,673.7	2,673.7	0.0	302.8	11.3%	11.3%
	Subtotal	**61**	**9,716.9**	**9,576.3**	**140.6**	**523.2**	**5.5%**	**5.4%**
Gas/Petrochemical Plant **	Surface	1	333.0	333.0	0.0	253.1	76.0%	76.0%
	Groundwater	5	4.2	4.2	0.0	4.3	102.3%	102.3%
	Subtotal	**6**	**337.2**	**337.2**	**0.0**	**257.4**	**76.3%**	**76.3%**
Other petroleum ***	Surface	1	1.2	1.2	0.0	1.2	100.0%	100.0%
	Groundwater	2	33.3	33.3	0.0	33.3	100.0%	100.0%
	Subtotal	**3**	**34.5**	**34.5**	**0.0**	**34.5**	**100.0%**	**100.0%**
Total	Surface	10	7,377.5	7,236.8	140.6	474.7	6.6%	6.4%
	Groundwater	60	2,711.2	2,711.2	0.0	340.4	12.6%	12.6%
	Total	**70**	**10,088.6**	**9,948.0**	**140.6**	**815.1**	**8.2%**	**8.1%**

* EUB water use data provided by Geowa.
** Estimates based on WURS data.
*** Estimated water use assumes 100 percent of licensed consumption.

Figure 8-13 Historical Trends in Water Allocations for Injection



8.4.1.2 Licensed Water Use

As shown in Table 8-23, the licences issued for injection purposes assume that 98 percent of surface water allocations and 100 percent of groundwater allocations will be consumed. Return flow allowances in licences for injection only amounted to 141 dam^3.

8.4.1.3 Actual Water Use

Detailed summary of reported water used for injection have been prepared by Geowa based on EUB data. In 2005, 523 dam^3 of fresh water was diverted for injection purposes. This volume includes 220 dam^3 of surface water and 303 dam^3 of groundwater. Based on the reported water use in Table 9-7, injection activities in the Basin are currently diverting and using approximately 5.5 percent of their licensed allocations and use.

This conclusion in consistent with the 2004 assessment of water use in the Battle River Basin (Watrecon 2005) which found that actual water use for injection consisted of 153 dam^3 of surface water and 191 dam^3 of groundwater and that licensee only used 4.2 percent of their licence entitlements.

8.4.1.4 Forecasts of Future Water Use

The general trend in Alberta is for conventional crude oil production to decline as existing fields mature and there are fewer new finds. The most recent forecast from the EUB and CAPP have oil production decreasing by between 30 and 38 percent between 2005 and 2015, and a further decline of about 23 percent by 2020. Oil production in the Battle Basin is expected to follow the overall Alberta production trend since most of the basin's production is from existing wells. The forecast of future water use for injection in the Battle Basin in Table 8-24 assumes declining rates of water use required that match the rates at which oil production in Alberta is expected to decline. For the purposes of this analysis it is assumed that production forecasts for 2010 and

2020 is the same as the previous five years. Forecasts also assume that the current ratio of surface to groundwater consumption will remain the same.

Table 8-24 Forecast of Injection Water Use in the Battle Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
High Decline	Surface	220	220	129	129	77
	Groundwater	303	303	178	178	106
	Total	**523**	**523**	**307**	**307**	**183**
Medium Decline	Surface	220	220	136	136	81
	Groundwater	303	303	187	187	112
	Total	**523**	**523**	**323**	**323**	**193**
Low Decline	Surface	220	220	154	154	92
	Groundwater	303	303	212	212	127
	Total	**523**	**523**	**366**	**366**	**219**

Under the Low Decline scenario, water use for injection in 2025 will decline by 35 percent from current levels. Under the High Decline scenario, the decline will be 42 percent.

8.4.2 Gas/Petrochemical Plants

Six licences have been issued for other petroleum use. They allow withdrawals of up to 333 dam^3 of surface water and 4.2 dam^3 of groundwater. The first surface water allocations were issued in the 1950s and have remained the same since then. The volume of groundwater allocated to gas/petrochemical plants has increased slightly since the 1950s. Licensees are allowed to consume all of the surface and groundwater they withdraw.

The WURS database has water use information for all of the surface water licences issued for gas/petrochemical plants in the Battle basin. Analysis of the WURS database indicates that plants with surface water allocations used an average of 76 percent of their allocations and their licensed use. Plants with groundwater allocations are assumed to have used 100 percent of their licensed use in 2005. The water use estimates in Table 8-23 were calculated assuming that these percentages apply to all gas/petrochemical plants in the Battle River Basin. Based on this assumption, estimated total water use by gas/petrochemical plants is 895 dam^3, consisting of 555 dam^3 of surface water and 340 dam^3 of groundwater. In the absence of information about this component of the petroleum sector, it is assumed that water used by gas and petrochemical plants in the Battle will remain constant for the forecast period.

8.4.3 Other Petroleum Use

Three licences have been issued for other petroleum use. They allow withdrawals of up to 1.2 dam^3 of surface water and 33.3 dam^3 of groundwater. Licensees are expected to consume all of the water they withdraw. There is no information on actual water diversions and consumption for these other petroleum uses and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the petroleum sector, it is assumed that water used by other petroleum activities in the Battle will remain constant for the forecast period.

8.4.4 Summary

Water use in the petroleum sector in the Battle River Basin is dominated by water allocated for injection purposes. Water used for injection accounts for 96 percent of allocations and 64 percent of actual water use in 2005. Water use data shows that although water licences allow up to 9,948 dam^3 of water to be consumed for petroleum purposes, licensees are only using 8.2 percent of this amount. Forecasts of future water demand for the petroleum sector combines the forecast for injection (Table 8-24) with the assumptions that water demands for gas/petrochemical plants and the other petroleum will remain constant to 2025. The net result is that future water use by petroleum sector is expected to decline slightly over the next 20 years (Table 8-25), with the rate of decline depending on the oil production rates.

Table 8-25 Forecast of Petrochemical Water Use in the Battle Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	475	475	384	384	332
	Groundwater	340	340	215	215	143
	Total	**815**	**815**	**599**	**599**	**475**
Medium Growth	Surface	475	475	391	391	336
	Groundwater	340	340	224	224	149
	Total	**815**	**815**	**615**	**615**	**485**
High Growth	Surface	475	475	409	409	347
	Groundwater	340	340	249	249	164
	Total	**815**	**815**	**658**	**658**	**511**

8.5 INDUSTRIAL SECTOR

In the Battle Basin there are 15 active licences which allocate 691,886 dam^3 of water to the industrial sector. Industrial allocations account for 86 percent of total allocations in the basin. Almost all of the water allocated is for surface water (691,860 dam^3). Allocations from groundwater only amount to 26 dam^3. While the industrial sector includes small amounts of water used for fertilizer plants, manufacturing, mining other than coal, and other industrial activities (270 dam^3), the vast majority of industrial water use for cooling. Table 8-26

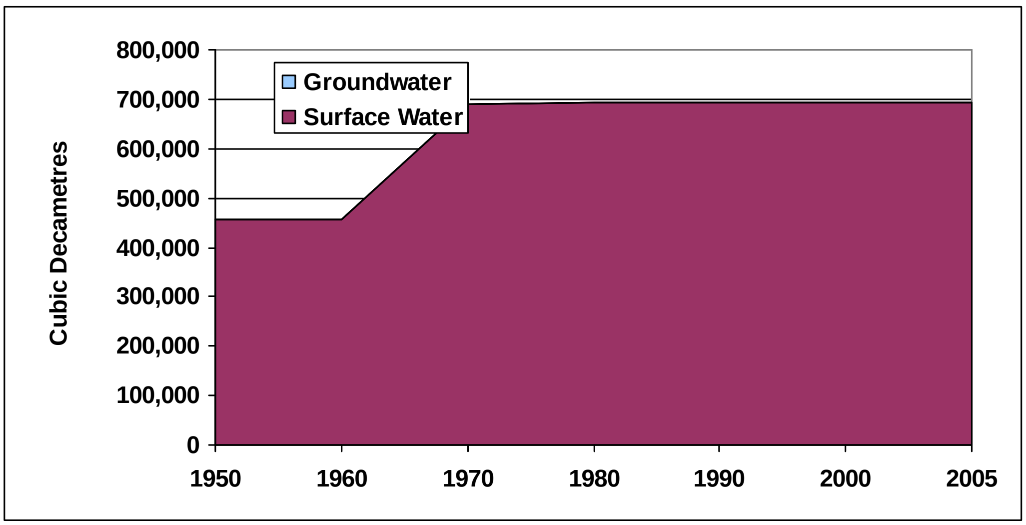
summarizes the water allocation, use, and return associated with the licences for each activity in the Battle Basin.

8.5.1 Cooling

8.5.1.1 Water Allocations

Almost 100 percent of the industrial allocations are for cooling purposes for thermal power generation or cooling (691,742 dam^3). Table 8-26 shows that four licences have been issued for cooling purposes, with nearly all of these for surface water. Only one very small licence has been issued for groundwater (4.9 dam^3). A figure 8-14 show that surface water use for cooling commenced in the 1950s grew rapidly in the 1970s and has remained the same since. The single groundwater licences was issued in the 1970s.

Figure 8-14 Historical Trends in Water Allocations for Cooling



8.5.1.2 Licensed Water Use

As shown in Table 8-26, the licences issued for cooling purposes assume that about two percent of surface water allocations and 100 percent of groundwater allocations will be used. Return flow allowances in licences amounted to 677,996 dam^3 for surface water.

Table 8-26 Licensed Allocations and Reported Actual Water Use for the Industrial Sector, Battle River Basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Cooling	Surface	3	691,736.7	13,741.0	677,995.7	7,683.9	55.9%	1.1%
	Groundwater	1	4.9	4.9	0.0	4.9	100.0%	100.0%
	Subtotal	**4**	**691,741.6**	**13,745.9**	**677,995.7**	**7,688.8 ***	**55.9%**	**1.1%**
Fertilizer Plants	Surface	0	0.0	0.0	0.0	0.0		
	Groundwater	1	6.2	6.2	0.0	6.2	100.0%	100.0%
	Subtotal	**1**	**6.2**	**6.2**	**0.0**	**6.2 ****	**100.0%**	**100.0%**
Manufacturing	Surface	0	0.0	0.0	0.0	0.0		
	Groundwater	3	8.6	8.6	0.0	8.6	100.0%	100.0%
	Subtotal	**3**	**8.6**	**8.6**	**0.0**	**8.6 ****	**100.0%**	**100.0%**
Mine-other	Surface	1	123.4	123.4	0.0	22.2	18.0%	18.0%
	Groundwater	1	2.5	2.5	0.0	2.5	100.0%	100.0%
	Subtotal	**2**	**125.8**	**125.8**	**0.0**	**24.7 ****	**19.6%**	**19.6%**
Other Industrial	Surface	0	0.0	0.0	0.0	0.0		
	Groundwater	5	3.7	3.7	0.0	3.7	100.0%	100.0%
	Subtotal	**5**	**3.7**	**3.7**	**0.0**	**3.7 ****	**100.0%**	**100.0%**
Total	Surface	4	691,860.0	13,864.3	677,995.7	7,706.1	55.6%	1.1%
	Groundwater	11	25.9	25.9	0.0	25.9	100.0%	100.0%
	Total	**15**	**691,886.0**	**13,890.2**	**677,995.7**	**7,732.0**	**55.7%**	**1.1%**

* Estimates of water use are based information provided to AMEC by licence holders.
** Actual water use is assumed to be 100 percent of licensed consumption.

8.5.1.3 Actual Water Use

The actual water use data for 2005 was provided to AMEC by licence holders. There is water use information for all but one of the surface water licences. Analysis of the data indicates that plants with surface water allocations were using an average of one percent of their allocations and 56 percent of the water that they are entitled to consume. Plants with groundwater allocations are assumed to consume 100 percent of the amounts specified in their licences. The water use estimates in Table 8-26 were calculated assuming that these percentages apply to all plants in the Battle basin. Based on this assumption, the total water use by cooling plants in 2005 is estimated to be 7,689 dam^3, consisting of 7,684 dam^3 of surface water and five dam^3 of groundwater.

8.5.1.4 Forecasts of Future Water Use

In the future, it is anticipated that the water demand for cooling purposes will remain largely the same. Battle River Units 3 and 4 are scheduled to retire by 2015; Battle River 5 is to be retired by 2025. At the same time, there have been discussions of possible expansions at the Battle Generation Station; however, at the present time, these plans are still undetermined. Therefore, in the absence of information about this component of the industrial sector, it is assumed that water used for cooling in the Battle Basin will remain constant for the forecast period.

8.5.2 Fertilizer Plants

Only one licence has been issued for fertilizer plants, it allows withdrawals of up to six dam^3 of groundwater. Fertilizer plant water allocations commenced in the 1970s and have remained the same over the years. Licensee is expected to consume 100 percent of its groundwater allocation. There is no information on actual water diversions and consumption for fertilizer plants and, for purposes of this analysis; it is assumed that the licensee is using its full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by fertilizer plants in the Battle Basin will remain constant for the forecast period.

8.5.3 Mining Other Than Coal

Two licences have been issued for mining other than coal. They allow withdrawals of up to 123 dam^3 of surface water and three dam^3 of groundwater. Mining other than coal water allocations commenced in the 1960s for surface water and the 1980s for groundwater. Both sources have remained at the amount since. Licensees are expected to consume 100 percent of the groundwater they are allocated.

There is no information on actual water diversions and consumption for mining other than coal and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that

water used by mining other than coal in the Battle Basin will remain constant for the forecast period.

8.5.4 Other Industrial

Five groundwater licences have been issued for other industrial purposes allowing withdrawals of up to 3.7 dam^3 of groundwater. Other industrial groundwater allocations commenced in the early 2000s and have increased slightly overtime. Groundwater allocations commenced in the 1990s and have remained the same since. Licensees are expected to consume 100 percent of the surface water they are allocated. There is no information on actual water diversions and consumption for the other industrial activities and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by other industrial activities in the Battle Basin will remain constant for the forecast period.

8.5.5 Summary

The industrial sector in the Battle Basin is dominated by water allocated for cooling plants. These plants account for almost all of the allocations and actual water use in 2005. Water use data shows that although water licences allow up to 13,890 dam^3 of water to be consumed for industrial purposes, licensees are only using 56 percent of this amount.

For the forecast scenarios, the Low Growth scenario assumes current water use. The Medium Growth scenario assumes the industrial sector increases its water use to the full capacity of the water licences by 2020. The High Growth assumes the sector uses full capacity of the water licences by 2015.

Table 8-27 Forecast of Industrial Water Use in the Battle Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	7,706	7,706	7,706	7,706	7,706
	Groundwater	26	26	26	26	26
	Total	**7,732**	**7,732**	**7,732**	**7,732**	**7,732**
Medium Growth	Surface	7,706	7,706	7,706	13,864	13,864
	Groundwater	26	26	26	26	26
	Total	**7,732**	**7,732**	**7,732**	**13,890**	**13,890**
High Growth	Surface	7,706	7,706	13,864	13,864	13,864
	Groundwater	26	26	26	26	26
	Total	**7,732**	**7,732**	**13,890**	**13,890**	**13,890**

Table 8-27 shows that, for two of the scenarios, the overall demand for water in the Battle River Basin is expected to increase over the forecast period due to the increase in water required for generating power

8.6 OTHER SECTOR

In the Battle River Basin there are 244 active licences which allocate 51,373 dam^3 of water to the other sector. Other sector activities account for about six percent of licensed water allocations in the Battle basin. Almost all of the water allocated is for surface water (51,351 dam^3), accounting for 99 percent of the other sector licences. As illustrated in Figure 8-15, the other sector uses include water management for flood control and lake stabilization, and fish, wildlife and habitat enhancement.

Figure 8-15 Other Sector Water Allocation by Use in the Battle Basin

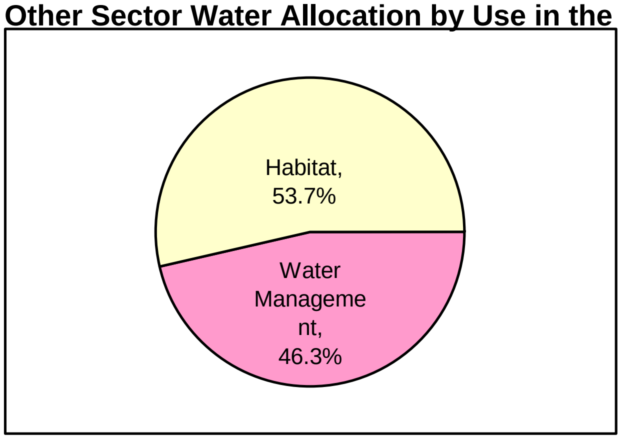


Table 8-28 summarizes the water allocation, use, and return flow associated with the licences for each activity in the Battle River Basin.

8.6.1 Water Management

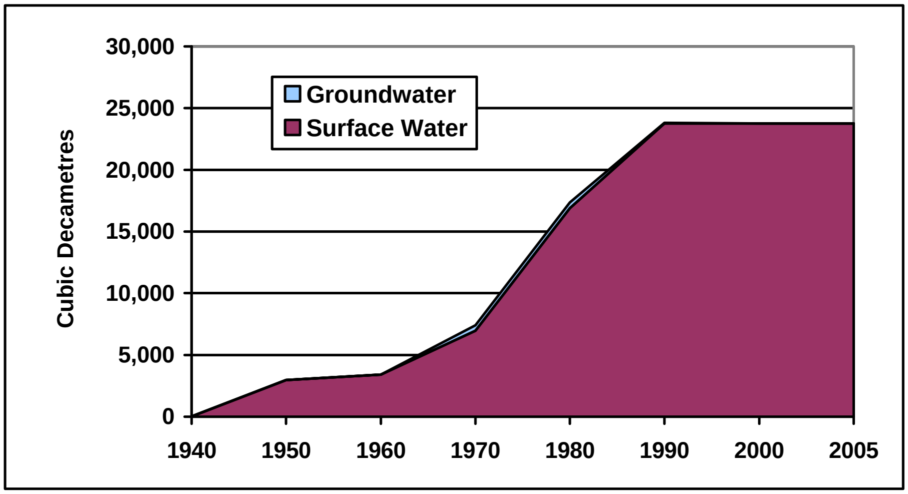
8.6.1.1 Water Allocations

About 46 percent of allocations for the other sector are for water management purposes, including flood control and lake stabilization (23,795 dam^3). Table 8-28 shows that 244 licences have been issued for water management purposes, with nearly 97 percent of these for surface water. Two licences have been issued for groundwater with allocations totaling 22 dam^3. Water use for water management commenced in the 1940s but grew rapidly from the 1970s to the 1990s (Figure 8-16). A relatively small amount of groundwater has been allocated to water management beginning in the 1950s, increasing substantially in the 1970s and 1980s. However, since the 1980s the amount of groundwater allocated to water management has decreased significantly.

Table 8-28 Licensed Allocations and Reported Actual Water Use for the Other Sector, Battle River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Water Management	Surface	57	23,773.2	17,935.8	5,837.3	17,935.8	100%	75.4%
	Groundwater	2	22.2	1.1	21.1	1.1	100%	5.0%
	Subtotal	**59**	**23,795.4**	**17,937.0**	**5,858.4**	**17,937.0**	**100%**	**75.4%**
Habitat	Surface	185	27,577.7	26,056.8	1,520.9	26,056.8	100%	94.5%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**185**	**27,577.7**	**26,056.8**	**1,520.9**	**26,056.8**	**100%**	**94.5%**
Total	Surface	242	51,350.8	43,992.7	7,358.2	43,992.7	100%	85.7%
	Groundwater	2	22.2	1.1	21.1	1.1	100%	5.0%
	Total	**244**	**51,373.0**	**43,993.8**	**7,379.3**	**43,993.8**	**100%**	**85.6%**

Figure 8-16 Historical Trends in Water Allocations for Water Management



8.6.1.2 Licensed Water Use

Table 8-28 shows that the licences issued for water management purposes assume that about 75 percent of surface water allocations and five percent of groundwater allocations will be consumed or lost. Return flow allowances in licences amounted to 17,936 dam^3 for surface water and 21 dam^3 for groundwater.

8.6.1.3 Actual Water Use

There is no information on actual water diversions and consumption for water management activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement.

8.6.1.4 Forecasts of Future Water Use

Forecasts of future water use by the other sector are based on consultations with the largest licence holders: Ducks Unlimited and Alberta Environment. Neither of these licence holders have formal forecasts of their future water needs. Ducks Unlimited indicated that the number of projects that it implements depends on a number of factors such as its budget, the state of the economy, and environment objectives. It is anticipated that there will be an increased emphasis on restoring drained wetlands to pre-drainage or natural conditions. These types of projects will not require new water licences.

In terms of new water licences, Ducks Unlimited foresees a yearly increase of about four new water licences of about 300 dam^3 per year each, with two of these licences being issued for water management and two for habitat enhancement. Forecasts assume that new projects are for surface water use. Water use by Alberta Environment is not expected to change over the forecast period forecasted.

Table 8-29 includes a Low Growth scenario that would result in a two percent increase in water demand every five years and does not include any major Ducks Unlimited projects. The Medium Growth scenario assumes a five percent increase in water demand every five years and does also not include any Ducks Unlimited projects. The High Growth scenario assumes that two major Ducks Unlimited projects will be constructed each year until 2010 and that water use increases at two percent of each of the following five year intervals.

Table 8-29 Forecast of Water Use by Water Management Projects in the Battle Basin (dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	17,936	18,295	18,661	19,034	19,415
	Groundwater	1	1	1	1	1
	Total	**17,937**	**18,296**	**18,662**	**19,035**	**19,416**
Medium Growth	Surface	17,936	18,833	19,774	20,763	21,801
	Groundwater	1	1	1	1	1
	Total	**17,937**	**18,834**	**19,775**	**20,764**	**21,802**
High Growth	Surface	17,936	20,936	21,355	21,782	22,217
	Groundwater	1	1	1	1	1
	Total	**17,937**	**20,937**	**21,356**	**21,783**	**22,218**

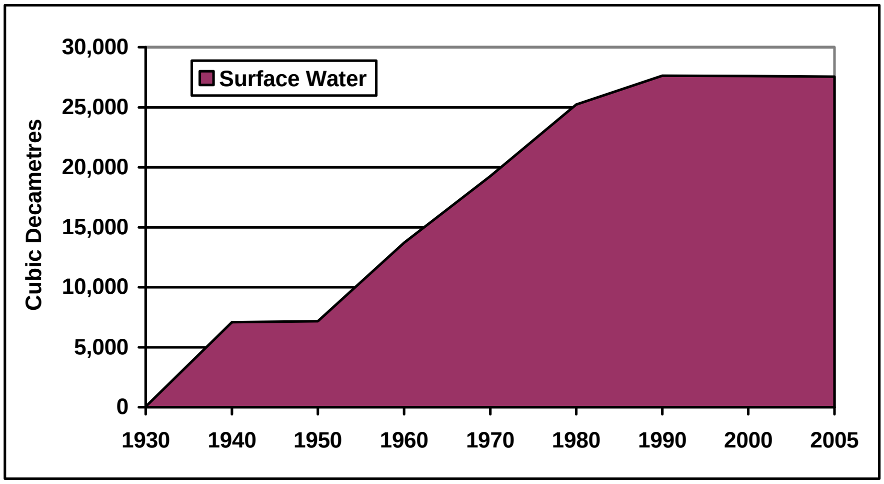
Under the Low Growth scenario, water use for water management projects in 2025 will increase by just over eight percent from current levels. Under the High Growth scenario, water use could increase by 24 percent.

8.6.2 Habitat

8.6.2.1 Water Allocations

About 54 percent of the allocations are for fish, wildlife and habitat enhancement (27,578 dam^3). Details of the licences issued to the other sector in the Battle Basin are provided in Table 8-28. The table shows that 185 licences have been issued for habitat projects; all of these are for surface water. Surface water use for habitat commenced in the 1930s but grew rapidly from the 1940s to the 1990s. Figure 8-17 shows that there has actually been a slight decline in licensed allocations for surface water in 2005.

Figure 8-17 Historical Trends in Water Allocations for Habitat Enhancement



8.6.2.2 Licensed Water Use

Table 8-28 shows that the licences issued for habitat enhancement purposes assume that about 95 percent of surface water allocations will be used. Return flow allowances in licences amounted to 1,521 dam^3 for surface water.

8.6.2.3 Actual Water Use

There is no information on actual water diversions and consumption for habitat enhancement activities and, for purposes of this analysis; it is assumed that licensees are using their full entitlement.

8.6.2.4 Forecasts of Future Water Use

Ducks Unlimited holds most of the licences for habitat enhancement. As noted in Section 8.5.2.4, Ducks Unlimited is contemplating two new licences for habitat enhancement of about 300 dam^3 per year each for surface water. As licences for habitat enhancement and water management appear to be very similar, the same forecast assumptions have been employed. Thus, the forecast in Table 8-30 includes a Low Growth scenario based on a two percent increase in water demand every five years with no major Ducks Unlimited projects and a Medium Growth scenario that assumes water use will increase by five percent every five years with no Ducks Unlimited projects. The High Growth scenario assumes that two major Ducks Unlimited projects will be constructed each year until 2010 and that water use increases at two percent of each of the following five year intervals

Table 8-30 Forecast of Water Use by Habitat Enhancement Projects in the Battle Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	26,057	26,578	27,110	27,652	28,205
	Groundwater	0	0	0	0	0
	Total	**26,057**	**26,578**	**27,110**	**27,652**	**28,205**
Medium Growth	Surface	26,057	27,360	28,728	30,164	31,672
	Groundwater	0	0	0	0	0
	Total	**26,057**	**27,360**	**28,728**	**30,164**	**31,672**
High Growth	Surface	26,057	29,057	29,638	30,231	30,836
	Groundwater	0	0	0	0	0
	Total	**26,057**	**29,057**	**29,638**	**30,231**	**30,836**

Under the Low Growth scenario, water use for water management projects in 2025 will increase by just over eight percent from current levels. Under the High Growth scenario, water use could increase by 17 percent. However, the assumptions used for the Medium Growth scenario actually result in higher water use in 2025 (a 22 percent increase) than is predicted for the High Growth scenario.

8.6.3 Summary

The other sector in the Battle River Basin essentially consists of water allocated for water management and habitat enhancement, with Ducks Unlimited holding the majority of licences for both purposes. In the future, there is expected to be an increase in the amount of water used for other sector activities, primarily as a result of Ducks Unlimited undertaking additional projects in the basin. The overall water use projections for the other sector are provided in Table 8-31 and have been calculated by combining the forecasts in Tables 8-29 and 8-30.

Table 8-31 Forecast of Other Sector Water Use in the Battle Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	43,993	44,873	45,770	46,686	47,619
	Groundwater	1	1	1	1	1
	Total	**43,994**	**44,874**	**45,771**	**46,687**	**47,620**
Medium Growth	Surface	43,993	46,193	48,502	50,927	53,474
	Groundwater	1	1	1	1	1
	Total	**43,994**	**46,194**	**48,503**	**50,928**	**53,475**
High Growth	Surface	43,993	49,993	50,993	52,013	53,053
	Groundwater	1	1	1	1	1
	Total	**43,994**	**49,994**	**50,994**	**52,014**	**53,054**

Table 8-31 shows that, for all three scenarios, the overall demand for water in the Battle Basin is expected to increase over the forecast period, amounting to about eight percent for the Low Growth scenario and by about 21 percent for both the Medium and high Growth scenarios.

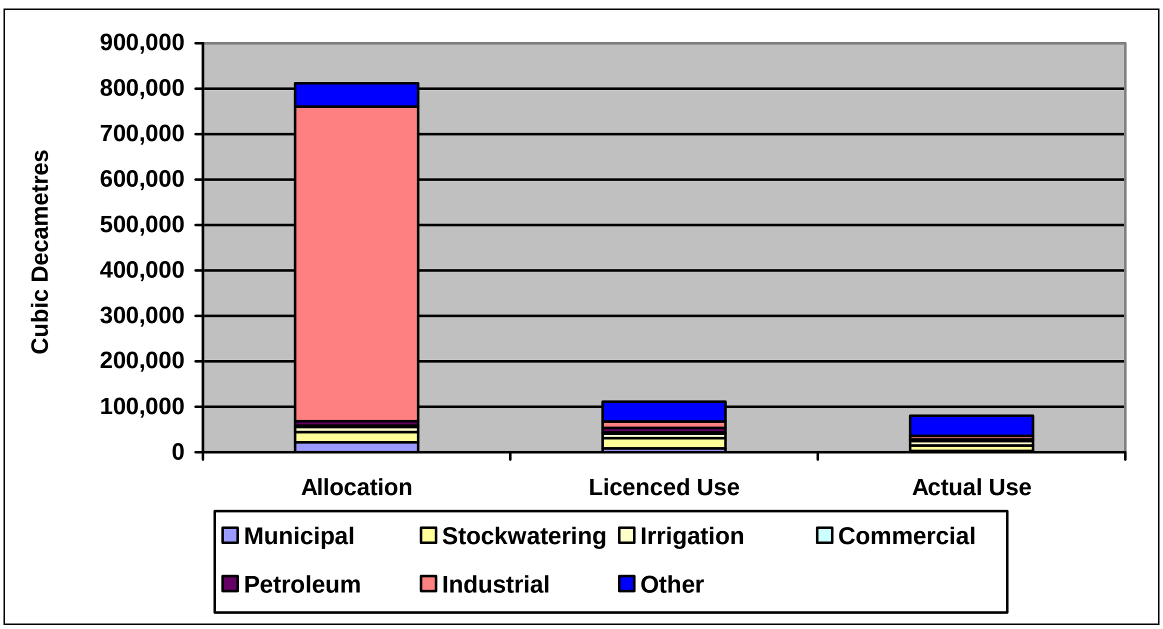
8.7 SUMMARY

Table 8-28 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the Battle River basin. In total, existing licences and registrations allow a maximum of 811,782 dam^3 of water to be withdrawn for use. This includes 111,440 dam^3 that is expected to be used and 700,342 dam^3 that will be returned to surface water. As noted previously, the largest amounts of water have been allocated to the industrial sector, particularly cooling.

With respect to actual use, the exact volumes withdrawn and used in 2005 are not known because very few water use reports have been filed with Alberta Environment, especially for all the numerous small licences. However, based on the assumptions used in the previous sections, it is estimated that 79,996 dam^3 were actually used in 2005. This represents 72 percent of licensed water use in the basin.

Although the industrial sector accounts for 85 percent of allocations in the basin, this sector only is entitled to use 12 percent of all licensed use and, in 2005, actually accounted for 10 percent of estimated actual water consumption. The other sector is actually the largest water user in the Battle River Basin. Existing licences account for 39 percent of all licensed water use in the Basin and, in 2005, it is estimated that this sector accounted for 55 percent of actual water use in the basin. This finding is consistent with the 2005 Battle River Basin study (Watrecon, 2005). Figure 8-18 shows how actual use compares to licensed allocations and use for each of the water use sectors.

Figure 8-18 Water Allocations and Actual Use, by Sector, Battle River Basin



Forecasts of future water use in the Battle River Basin are provided in Tables 8-33 to 8-35 for the low, medium and high growth scenarios. Predicted water use under the Medium growth scenario is shown in Figure 8-19. This figure shows that, for most sectors, water use will increase gradually over time. While there will be a reduction in water use in the petroleum sector, water use in the industrial sector could increase if the thermal power plant is operating at full capacity. However, despite growth in the agriculture sector, water use in the other sector will still account for the majority of actual water use, accounting for 51 percent of total water use by 2025. Under the medium scenario, water demand in 2025 will be about 31 percent higher than at present. For the other scenarios, the increase in water demand over 20 years will range from 10 percent for low growth and 33 percent for high growth. For all scenarios, actual water use will be less than the amount that can be consumed under the terms of existing licences.

Figure 8-19 Forecast Water Use in the Battle Basin: Medium Scenario

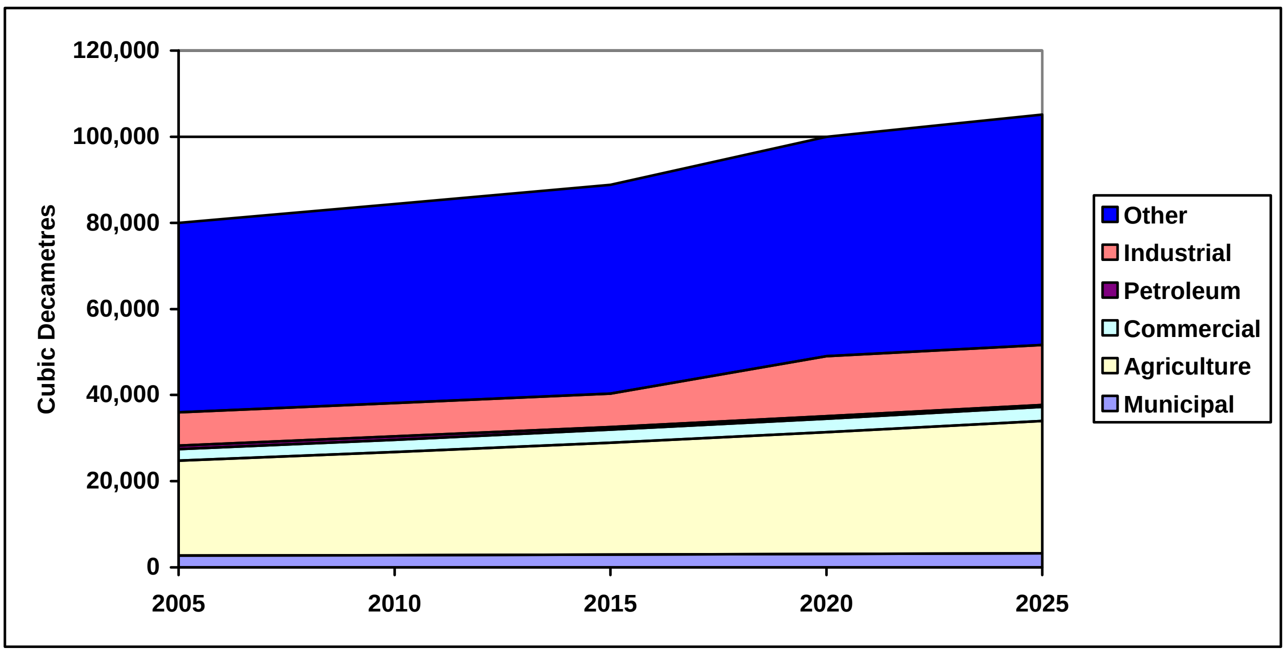


Table 8-32 Summary of Allocations and Estimated Water Use, Battle Basin

Sector		Licensed Allocation and Use (dam^3)				Estimated Water Use (dam^3)		
		Allocation	Water Use	Return	Percent of Total Use	Use	Percent of Licensed use	Percent of Total Use
Municipal		21,950	8,198	13,752	7%	2,731	33%	3%
Agricultural	Stockwatering	22,414	22,414	0	20%	11,763	52%	15%
	Irrigation	11,306	10,287	1,019	9%	10,287	100%	13%
Commercial		2,729	2,674	55	2%	2,674	100%	3%
Petroleum		10,089	9,948	141	9%	815	8%	1%
Industrial		691,886	13,890	677,996	12%	7,732	56%	10%
Other		51,373	43,994	7,379	39%	43,994	100%	55%
Total		**811,747**	**111,405**	**700,342**	**100%**	**79,996**	**72%**	**100%**

Table 8-33 Forecast Water Use, By Sector, Battle: Low Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	1,354	1,390	1,417	1,441	1,455
	Agricultural	16,485	17,126	17,797	18,499	19,234
	Commercial	1,575	1,601	1,622	1,642	1,656
	Petroleum	475	475	384	384	332
	Industrial	7,706	7,706	7,706	7,706	7,706
	Other	43,993	44,873	45,770	46,686	47,619
	Total	71,588	73,171	74,696	76,358	78,002
Groundwater	Municipal	1,377	1,413	1,441	1,465	1,480
	Agricultural	5,564	5,906	6,269	6,654	7,063
	Commercial	1,098	1,114	1,127	1,140	1,149
	Petroleum	340	340	215	215	143
	Industrial	26	26	26	26	26
	Other	1	1	1	1	1
	Total	8,406	8,800	9,079	9,501	9,862
Total	Municipal	2,731	2,803	2,858	2,906	2,935
	Agricultural	22,049	23,032	24,066	25,153	26,297
	Commercial	2,673	2,715	2,749	2,782	2,805
	Petroleum	815	815	599	599	475
	Industrial	7,732	7,732	7,732	7,732	7,732
	Other	43,994	44,874	45,771	46,687	47,620
	Total	79,994	81,971	83,775	85,859	87,864

Table 8-34 Forecast Water Use, By Sector, Battle Basin: Medium Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	1,354	1,416	1,482	1,548	1,606
	Agricultural	16,485	17,722	19,068	20,534	22,130
	Commercial	1,575	1,669	1,767	1,867	1,959
	Petroleum	475	475	391	391	336
	Industrial	7,706	7,706	7,706	13,864	13,864
	Other	43,993	46,193	48,502	50,927	53,474
	Total	71,588	75,181	78,916	89,131	93,369
Groundwater	Municipal	1,377	1,440	1,508	1,575	1,634
	Agricultural	5,564	6,204	6,917	7,712	8,598
	Commercial	1,098	1,157	1,219	1,282	1,340
	Petroleum	340	340	224	224	149
	Industrial	26	26	26	26	26
	Other	1	1	1	1	1
	Total	8,406	9,168	9,895	10,820	11,748
Total	Municipal	2,731	2,856	2,990	3,123	3,240
	Agricultural	22,049	23,926	25,985	28,246	30,728
	Commercial	2,673	2,826	2,986	3,149	3,299
	Petroleum	815	815	615	615	485
	Industrial	7,732	7,732	7,732	13,890	13,890
	Other	43,994	46,194	48,503	50,928	53,475
	Total	79,994	84,349	88,811	99,951	105,117

Table 8-35 Forecast Water Use, By Sector, Battle Basin: High Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	1,354	1,465	1,591	1,721	1,846
	Agricultural	16,485	18,613	21,033	23,787	26,924
	Commercial	1,575	1,813	2,081	2,359	2,635
	Petroleum	475	475	409	409	347
	Industrial	7,706	7,706	7,706	7,706	7,706
	Other	43,993	49,993	50,993	52,013	53,053
	Total	71,588	80,065	83,813	87,995	92,511
Groundwater	Municipal	1,377	1,490	1,619	1,751	1,878
	Agricultural	5,564	6,513	7,624	8,924	10,447
	Commercial	1,098	1,247	1,414	1,588	1,762
	Petroleum	340	340	249	249	164
	Industrial	26	26	26	26	26
	Other	1	1	1	1	1
	Total	8,406	9,617	10,933	12,539	14,278
Total	Municipal	2,731	2,955	3,210	3,472	3,724
	Agricultural	22,049	25,126	28,657	32,711	37,371
	Commercial	2,673	3,060	3,495	3,947	4,397
	Petroleum	815	815	658	658	511
	Industrial	7,732	7,732	7,732	7,732	7,732
	Other	43,994	49,994	50,994	52,014	53,054
	Total	79,994	89,682	94,746	100,534	106,789

North Saskatchewan River Basin

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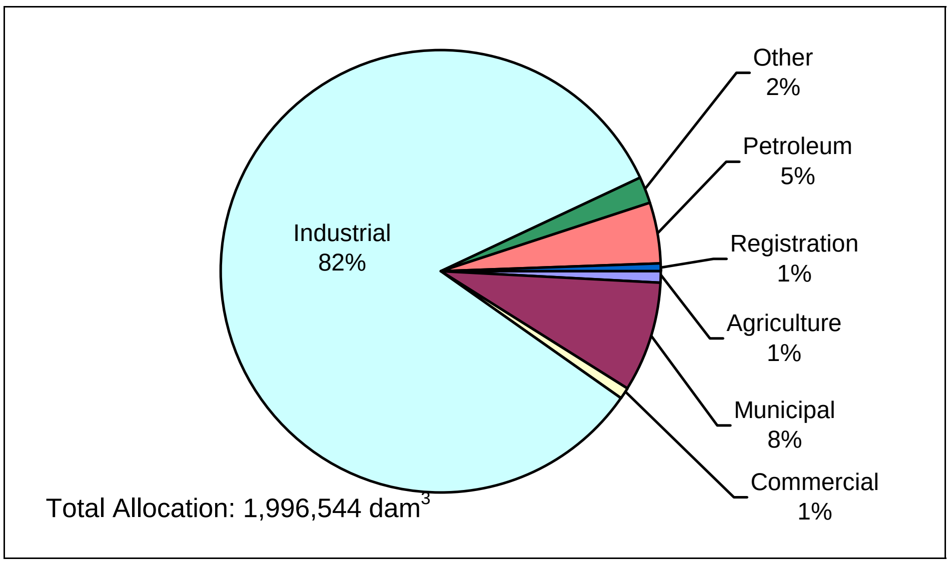
9.0 NORTH SASKATCHEWAN RIVER BASIN

The North Saskatchewan Basin is about 55,000 km^2 in areas and occupies approximately nine percent of Alberta by area. The mean annual natural river discharge of the North Saskatchewan River is 7,277,000 dam^3. The North Saskatchewan River Basin is part of the larger Nelson River system, which eventually drains eventually into Hudson Bay. In 2001, the Basin had a population of 1,047,017 people, which represents 35 percent of the provincial population, with a population density of 41 people per square kilometer. The North Saskatchewan Basin River consists of all or parts of 68 urban municipalities, 25 rural or regional municipalities and twelve Aboriginal settlements.

An overview of surface and groundwater allocations is provided in Figure 9-1. It shows that the industrial sector accounts for 82 percent of total allocations or 1,663,566 dam^3 in 2005. The municipal and petroleum sectors account for most of the remaining allocations, totaling 164,401 dam^3 (eight percent) and 90,353 dam^3 (five percent), respectively. Total allocations in the Basin in 2005 were 1,996,927 dam^3.

Figure 9-1 Distribution of Active Water Allocations in the North Saskatchewan Basin



Figures 9-2 and 9-3 show the location, allocation and sector of all active water licences in North Saskatchewan Basin. The locations of registrations issued in the North Saskatchewan River Basin are provided in Figure 9-4.

9.1 MUNICIPAL AND RESIDENTIAL SECTOR

9.1.1 Population

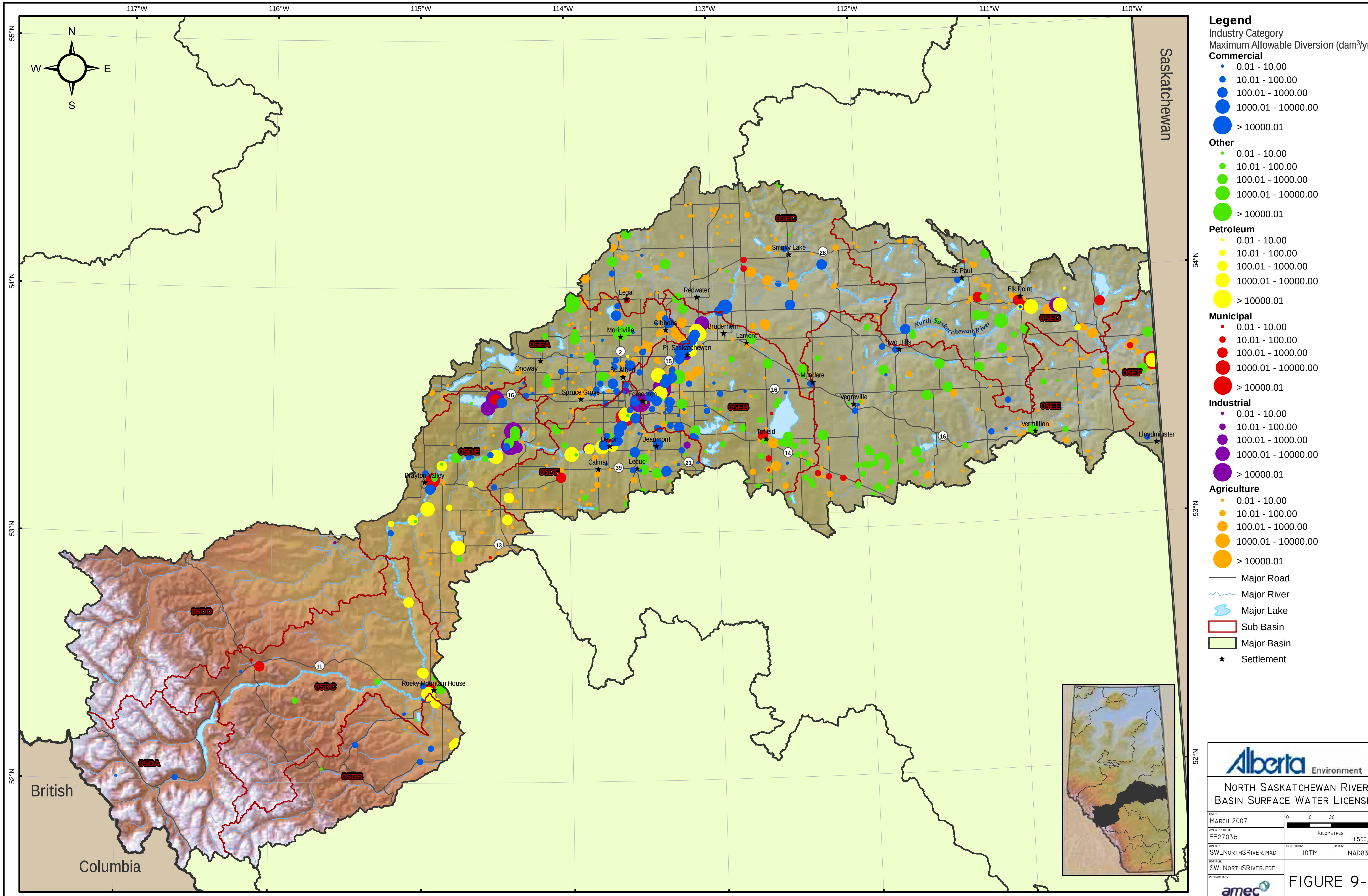
The population of North Saskatchewan Basin is primarily urban, dominated by the City of Edmonton and its satellite urban communities, but it also has a large rural and a significant Aboriginal settlement population. As shown in Table 9-1, 82 percent of the Basin population in 2001 lived in urban municipalities, with 17 percent in rural areas and one percent on reserves and Métis settlements. All three categories of municipalities are growing quite quickly in North Saskatchewan Basin. Between 1996 and 2001 the population of the Basin increased by 8.0 percent, and the urban population grew faster than the population of rural areas.

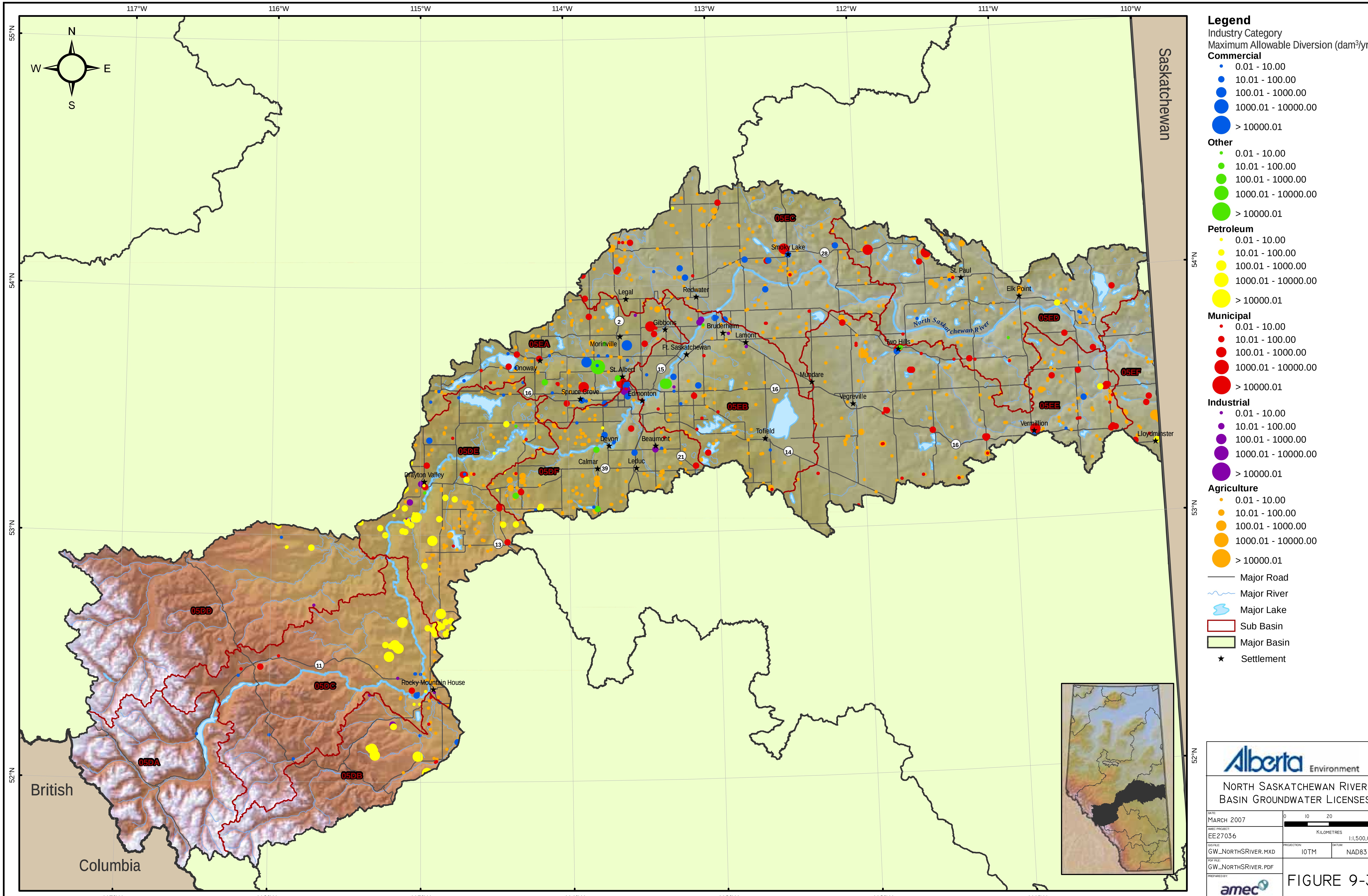
Table 9-1: Population Distribution and Growth in North Saskatchewan River Basin, 2001

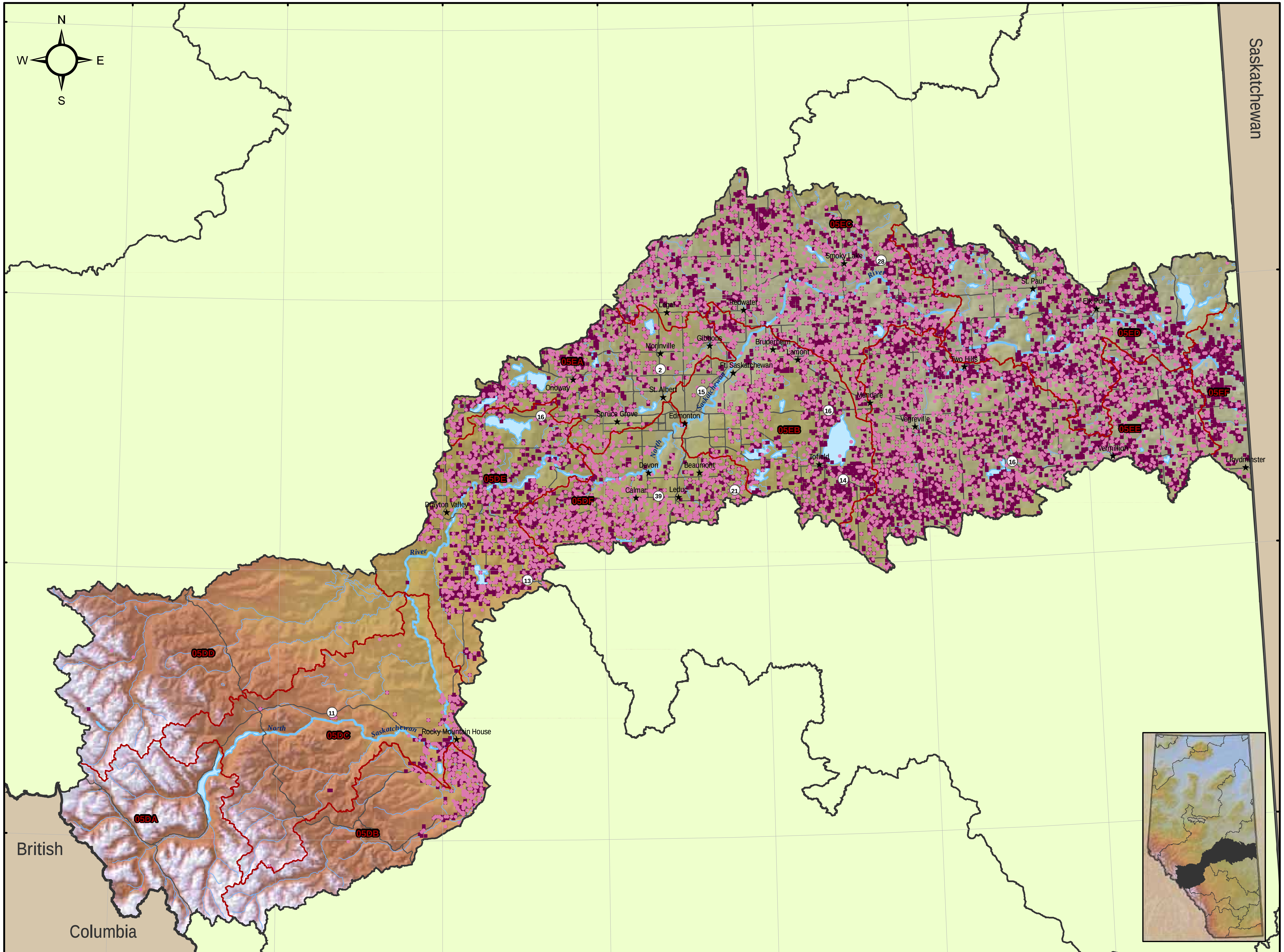
	2001		1996	1996 to 2001 Population Change
	Population	**Percent**	**Population**	**Percent**
Urban Municipality	856,466	81.8%	792,135	8.1%
Rural or Regional Municipality	179,129	17.1%	166,682	7.5%
First Nations and Métis Settlements	11,422	1.1%	10,226	11.7%
Total	**1,047,017**	**100%**	**969,043**	**8.0%**

Table 9-2 lists all urban municipalities situated in the North Saskatchewan River Basin, their estimated 2001 populations, and a summary of water licence information for those communities that have licences for 100 dam^3 or more. The major population centres include the cities of Edmonton (666,104 residents), St. Albert (53,081), Spruce Grove (15,983), Leduc (15,032) and the Fort Saskatchewan (13,182). It should be noted that many of the communities around Edmonton do not have their own water licences because they obtain their water from the capital region water supply system.

Table 9-3 identifies the rural or regional municipalities in the basin, including information on their 2001 population and water licence information. The rural municipalities with the largest populations include Strathcona County (71,986), Parkland County (26,142) and Sturgeon County (18,067). The most populated Aboriginal jurisdiction is Saddle Lake First Nation (4,132).


Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Petroleum
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Municipal
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Industrial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Agriculture
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
Saskatchewan
British
Columbia
05EC
05EA
05EB
05ED
05EE
05EF
05DE
05DF
05DD
05DC
05DA
05DB
Smoky Lake
St. Paul
Elk Point
Legal
Redwater
Gibbons
Bruderheim
Morinville
Lamont
Ft. Saskatchewan
Two Hills
Onoway
St. Albert
Mundare
Spruce Grove
Edmonton
Vegreville
Vermillion
Lloydminster
Tofield
Devon
Beaumont
Calmar
Leduc
Drayton Valley
Rocky Mountain House
North Saskatchewan River
Alberta Environment
North Saskatchewan River Basin Surface Water Licenses
March 2007
EE27036
SW_NorthSRiver.mxd
SW_NorthSRiver.pdf
10TM
NAD83
Kilometres
1:1,500,000
amec
FIGURE 9-2


Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Petroleum
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Municipal
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Industrial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Agriculture
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
Saskatchewan
British
Columbia
North Saskatchewan River
Smoky Lake
St. Paul
Elk Point
Legal
Redwater
Gibbons
Bruderheim
Lamont
Morinville
Ft. Saskatchewan
Two Hills
Onoway
St. Albert
Mundare
Spruce Grove
Edmonton
Vegreville
Vermillion
Lloydminster
Tofield
Devon
Beaumont
Calmar
Leduc
Drayton Valley
Rocky Mountain House
05EC
05ED
05EA
05EF
05EB
05EE
05DE
05DF
05DD
05DC
05DA
05DB
Alberta Environment
NORTH SASKATCHEWAN RIVER BASIN GROUNDWATER LICENSES
MARCH 2007
EE27036
GW_NORTHSRIVER.MXD
GW_NORTHSRIVER.PDF
KILOMETRES
1:1,500,000
10TM
NAD83
amec
FIGURE 9-3



Legend

Agriculture

Maximum Allowable Diversion (dam³/yr)

Groundwater Registrations

0.01 - 6.25

Surface Water Registrations

0.01 - 6.25

Major Road

Major River

Major Lake

Sub Basin

Major Basin

Settlement

Alberta Environment

NORTH SASKATCHEWAN RIVER BASIN REGISTRATIONS

DATE: March 2007	0 10 20 40 Kilometres 1:1,500,000		
AMEC PROJECT: EE27036			
GIS FILE: RG_NorthSRiver.mxd	PROJECTION: 10TM	DATUM: NAD83	
PDF FILE: RG_NorthSRiver.pdf			
PREPARED BY: amec	FIGURE 9-4		

Table 9-2 2001 Urban Municipal Populations and Water Allocations within North Saskatchewan River Basin

Municipal Name		2001 Population	Source	2005 Allocation (dam^3)
Cities	EDMONTON	666,104	Surface	135,802
	ST. ALBERT	53,081	Groundwater	170
	SPRUCE GROVE	15,983		
	LEDUC	15,032		
	FORT SASKATCHEWAN	13,121		
	LLOYDMINSTER	7,840	Surface	11,101
Towns	STONY PLAIN	9,589		
	BEAUMONT	7,006		
	MORINVILLE	6,540		
	ROCKY MOUNTAIN HOUSE	6,208	Surface	2,188
	DRAYTON VALLEY	5,801	Surface	3,633
	VEGREVILLE	5,376		
	ST. PAUL	5,061	Surface	938
	DEVON	4,969	Surface	1,233
	VERMILION	3,919	Groundwater	1,313
	GIBBONS	2,654		
	REDWATER	2,172		
	CALMAR	1,902		
	TOFIELD	1,818	Surface	746
	LAMONT	1,692		
	BON ACCORD	1,532	Groundwater	220
	ELK POINT	1,440	Surface	760
	BRUDERHEIM	1,202		
	TWO HILLS	1,091	Groundwater	213
	LEGAL	1,058		
	SMOKY LAKE	1,011	Groundwater	555
	ONOWAY	847		
	MUNDARE	653		
Villages	THORSBY	799	Surface	497
	ALBERTA BEACH	762		
	MANNVILLE	722	Groundwater	142
	KITSCOTY	671	Groundwater	185
	WABAMUN	601	Surface	327

Municipal Name		2001 Population	Source	2005 Allocation (dam^3)
Villages	BRETON	573	Groundwater	127
	WARBURG	560		
	MARWAYNE	495	Groundwater	127
	CLYDE	491		
	ANDREW	485		
	THORHILD	462		
	SPRING LAKE	457		
	RYLEY	437		
	NEW SAREPTA	382	Groundwater	131
	HOLDEN	374	Surface	123
	MYRNAM	322		
	WILLINGDON	287	Groundwater	150
	VILNA	269	Groundwater	152
	WASKATENAU	252	Surface	151
	CHIPMAN	247		
	INNISFREE	219		
	DEWBERRY	200		
	DERWENT	111		
	MINBURN	88		
	HAIRY HILL	0		
Summer Villages	SANDY BEACH	201		
	HORSESHOE BAY	199		
	SUNSET POINT	176		
	VAL QUENTIN	143		
	SILVER SANDS	126		
	ROSS HAVEN	109		
	SEBA BEACH	109		
	WEST COVE	105		
	YELLOWSTONE	98		
	SUNRISE BEACH	95		
	SOUTH VIEW	87		
	KAPASIWIN	15		
	LAKEVIEW	15		
	BETULA BEACH	10		
	POINT ALISON	10		
Total		**856,466**		**160,984**

Table 9-3 2001 Rural Municipal Populations and Water Allocations within North Saskatchewan River Basin

Municipal Name		2001 Population	Source	2005 Allocation (dam^3)
Rural or Regional	STRATHCONA COUNTY	71,986		
	PARKLAND COUNTY	26,142		
	STURGEON COUNTY	18,067		
	LEDUC COUNTY	11,282		
	CLEARWATER COUNTY	7,299		
	COUNTY OF VERMILION RIVER	4,699	Groundwater	160
	COUNTY OF ST. PAUL NO. 19	4,499	Groundwater	144
	BRAZEAU COUNTY	4,393		
	LAMONT COUNTY	4,167		
	SMOKY LAKE COUNTY	4,132		
	BEAVER COUNTY	3,968		
	COUNTY OF WETASKIWIN NO. 10	3,137		
	COUNTY OF MINBURN NO. 27	3,115		
	LAC STE. ANNE COUNTY	3,026		
	COUNTY OF THORHILD NO. 7	2,902		
	COUNTY OF TWO HILLS NO. 21	2,614		
	WESTLOCK COUNTY	1,850	Groundwater	102
	YELLOWHEAD COUNTY	649		
	CAMROSE COUNTY	633		
	IMPROVEMENT DISTRICT NO. 9	275		
	MD OF BONNYVILLE NO. 87	196		
	COUNTY OF BARRHEAD NO. 11	38		
	IMPROVEMENT DISTRICT NO. 13	27		
	FLAGSTAFF COUNTY	25		
	COUNTY OF ATHABASCA NO. 12	10		
Aboriginal	SADDLE LAKE FIRST NATION	4,132		
	FROG LAKE FIRST NATION	1,410	Surface	136
	ENOCH CREE NATION	1,343		
	PAUL BAND	1,119		
	ALEXANDER FIRST NATION	856		
	ALEXIS BAND	831		
	O'CHIESE BAND	576		
	SUNCHILD FIRST NATION	552		
	FISHING LAKE METIS SETTLEMENT	440	Groundwater	292
	STONEY BAND	163		
	ELIZABETH METIS SETTLEMENT	0		
	MAKAOO	0		
Total		**190,553**		**834**

9.1.2 Water Allocations

As of 2005, there were 239 active municipal water licences for 104 licensees in the North Saskatchewan Basin. These licences allow maximum withdrawals of 164,401 dam^3 per year. As shown in Figure 9-1, municipal water uses account for eight percent of all licensed water

allocations in the basin. About 99 percent of municipal allocations are for Edmonton and the surrounding communities.

Surface water licences account for 96 percent of total municipal water allocations. The maximum amount of surface water that can be withdrawn in North Saskatchewan Basin by the municipal sector is 158,476 dam^3. Urban municipalities account for the majority of surface water allocations (32 licences for 158,116 dam^3). In contrast, surface water allocations for rural communities amounted to only 48 dam^3 with 312 dam^3 for other municipal uses.

Groundwater licences represent four percent of total municipal water allocations. Licensees allow withdrawals of up to 5,925 dam^3, of which urban users can withdraw up to 5,082 dam^3 over 112 licences. Rural communities have 51 licences that allow withdrawals of up to 568 dam^3 of groundwater.

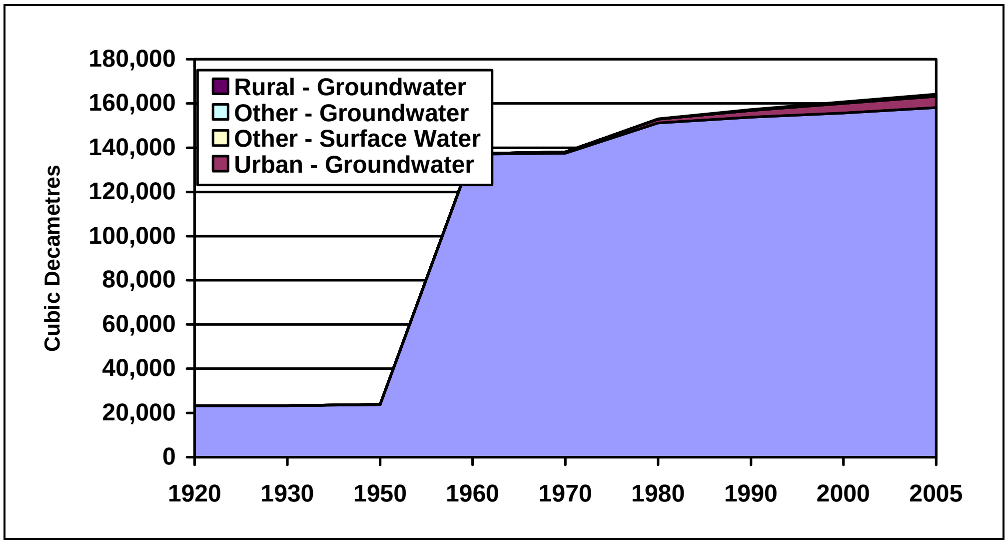
Table 9-4 lists other municipal water users that are entitle to withdraw large amounts of water (100 dam^3 or more) from the North Saskatchewan River Basin. It should be noted that the Regional Municipality of Wood Buffalo draws part of its water from the North Saskatchewan Basin but is located within the Athabasca, Peace/Slave and Beaver Basins. Also, the Town of Millet draws groundwater from the North Saskatchewan Basin but is located within the Battle Basin.

Table 9-4 Other Large Municipal Water Licences in the North Saskatchewan Basin

Approval Holder	Water Source	Allocation (dam^3)
REGIONAL MUNICIPALITY OF WOOD BUFFALO	Surface	317
EDMONTON REGIONAL AIRPORTS AUTHORITY	Surface	230
PARKLAND VILLAGE COMMUNITIES INC.	Groundwater	192
TOWN OF MILLET	Groundwater	162
ALBERTA INFRASTRUCTURE AND TRANSPORTATION	Surface	125
CONDOMINIUM CORPORATION NO. 882 0814	Groundwater	121
HUTTERIAN BRETHREN CHURCH OF PLAIN LAKE COLONY	Groundwater	114

Figure 9-5 shows historical cumulative allocations for municipal water use by source type in North Saskatchewan Basin up to 2005. Municipal uses accounting for less than 0.1 percent of MAD are not included. Almost all municipal allocations have been surface water allocations for urban communities, with rapid growth in allocations occurring in the 1950's. Urban groundwater allocations have remained very small but have grown steadily since 1970.

Figure 9-5 North Saskatchewan Basin Historical Water Allocations for Municipal Purposes



9.1.3 Licensed Water Use

Table 9-5 summarizes licensed water use for the municipal sector in the North Saskatchewan River Basin. These licences assume that a maximum of 46,102 dam^3 will be used (i.e. 28 percent of allocations can be consumed and/or lost) and that the remainder (72 percent or 118,298 dam^3) will be returned. Return flow allowances for surface water licences range from 92 percent of other municipal uses to 73 percent of urban licences. There are no return flow allowances for rural surface water allocations. Groundwater licences expect that 62 percent withdrawals by urban municipalities will be returned; this compares to return flows of 10 percent for rural communities and four percent for other groundwater allocations.

9.1.4 Actual Water Use

In 2005, only 12 or 11.5 percent of municipal licence holders reported their water diversions to the provincial government through the Water Use Reporting System. The total allocation for those licences in 2005 was 150,560 dam^3; this represents 92 percent of all municipal allocations in the North Saskatchewan River Basin. Reported diversions in 2005 were 141,597 dam^3, which represents 94 percent of the maximum entitlement. These licensees had maximum allocations of 149,092 dam^3 which account for 91 percent of total municipal allocations in the basin. Given that licensees who reported accounted for such a high proportion of total municipal allocations, the WURS information was concluded to be suitable for providing a reasonable estimate of total municipal water use in the entire basin, with one qualification.

With respect to return flow, only three municipal licensees (Edmonton, Lloyd Minster and Rocky Mountain House) reported return flow totaling 4,636 dam^3 in 2005. The City of Edmonton, however, diverted 100 percent of its allocation but reported no return flows throughout 2005, although its licence include an allowance for returning 114,805 dam^3.

Table 9-5 Licensed Municipal Allocations and Use and Reported Actual Use, North Saskatchewan River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return Flow	Diversion	Estimated Use	Return Flow
Urban*	Surface	32	158,116	43,311	114,805	141,362	136,179	4,636
	Groundwater	112	5,082	1,946	3,136	133	N/A	N/A
	Subtotal	**144**	**163,199**	**45,257**	**117,942**	**141,495**	**136,179**	**4,636**
Rural**	Surface	8	48	48	0	N/A	N/A	N/A
	Groundwater	51	568	510	59	4	N/A	N/A
	Subtotal	**59**	**617**	**558**	**59**	**4**	**N/A**	**N/A**
Other***	Surface	4	312	23	288	N/A	N/A	N/A
	Groundwater	32	274	264	10	98	N/A	N/A
	Subtotal	**36**	**585**	**286**	**298**	**98**	**N/A**	**N/A**
Total	Surface	44	158,476	43,382	115,094	141,362	136,179	4,636
	Groundwater	195	5,925	2,720	3,204	235	N/A	N/A
	Total	**239**	**164,401**	**46,102**	**118,298**	**141,597**	**136,179**	**4,636**

* Urban includes villages, summer villages, towns, cities, hamlets;
** Rural includes condominiums / townhouses / mobile homes / complexes, hotels / motels, cooperatives, farmsteads, single-multi homes, colonies and subdivisions
*** Other includes camps, institutions, senior/correctional centres, nursing/children's homes, hospitals

The primary reason for this is that EPCOR operates under the City's licence but is not responsible for the return flow. EPCOR sells the water to multiple communities and users within the Capital Region, including the Capital Region Vegreville Corridor Water Services Commission. About 90 percent of the water is collected from many of these communities and treated at the Goldbar and Alberta Capital Region Wastewater Treatment Plants. However, some of the treated effluent from the Goldbas seage treatment facility is passed to industrial operations that use the water, such as the Petro-Canada refinery, which uses the water to manufacture hydrogen. Currently the city is selling five dam^3 per day to Petro-Canada, although next year it plans to sell 15 dam^3 per day, with a licensed potential future maximum of 31 dam^3 per day. No returns flows are associated with this water use because the water molecules are cracked to make hydrogen. Additionally, as occurs for many communities, return flow data may include runoff from precipitation that enters the municipal drainage system. Determination of return flows for the City of Edmonton will require a more detailed study that is beyond the scope of this assessment.

Due to the fact that WURS-reported return flow for Edmonton was zero in 2005, in order to gauge municipal water use in the North Saskatchewan Basin it was necessary to use the City of Edmonton's MUD return-flow data. The estimate for the Basin was calculated by applying the ratios of actual diversions to allocations and actual water use to diversions of those reporting to the total municipal allocations.

Table 9-6 Estimated Municipal Water Use in the North Saskatchewan River Basin

Municipal Use	Source	Withdrawals (dam^3)	Use (dam^3)	Return Flow (dam^3)
Urban	Surface	148,843	8,612	140,232
	Groundwater	2,037	780	1,257
	Subtotal	**150,881**	**9,392**	**141,489**
Rural	Surface	8	8	0
	Groundwater	92	83	9
	Subtotal	**100**	**90**	**9**
Other	Surface	817	61	756
	Groundwater	717	691	26
	Subtotal	**1,534**	**752**	**782**
Total Use	Surface	149,668	8,680	140,988
	Groundwater	2,847	1,554	1,293
	Total	**152,514**	**10,234**	**142,280**
Licensed Use	Surface	158,476	43,382	115,094
	Groundwater	5,925	2,720	3,204
	Total	**164,401**	**46,102**	**118,298**
Percent of Licensed Use	Surface	94.4%	20.0%	122.5%
	Groundwater	48.1%	57.1%	40.3%
	Total	**92.8%**	**22.2%**	**120.3%**

As shown in Table 9-6, the estimated actual municipal surface water use for the Basin is calculated to 22 percent of the water use allowed in the licences. Groundwater utilization is

estimated to be 57 percent of the allocated amount and surface water use is estimated to be 20 percent of the allocated amount.

9.1.5 Future Water Use Forecasts

Figure 9-6 shows low, medium and high population projection scenarios for North Saskatchewan Basin based on Alberta Finance Census Division projections. The population forecasts in Figure 9-6 have been used to predict future municipal surface and groundwater use. The resulting forecasts of water use are provided in Table 9-7, and are based on the estimated per capita water use in 2005.

Figure 9-6 North Saskatchewan Basin Population Growth Forecast

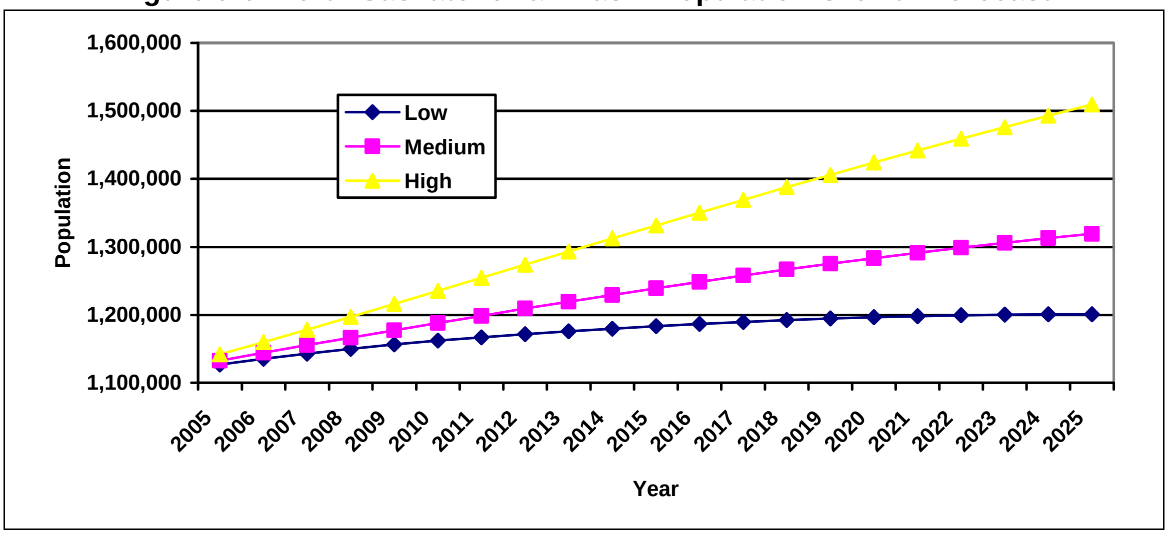


Table 9-7 Projected Municipal Water Use in the North Saskatchewan Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Population Growth	Surface	8,680	8,953	9,117	9,220	9,251
	Groundwater	1,554	1,603	1,632	1,651	1,656
	Total	**10,234**	**10,556**	**10,749**	**10,870**	**10,908**
Medium Population Growth	Surface	8,680	9,107	9,496	9,837	10,112
	Groundwater	1,554	1,630	1,700	1,761	1,810
	Total	**10,234**	**10,737**	**11,196**	**11,598**	**11,922**
High Population Growth	Surface	8,680	9,390	10,122	10,825	11,475
	Groundwater	1,554	1,681	1,812	1,938	2,054
	Total	**10,234**	**11,071**	**11,934**	**12,763**	**13,529**

Under the low population growth scenario, municipal water use in 2025 is expected to be seven percent greater than at present, total diversions will be almost equal to the maximum allowed in current licences and actual water use will be 24 percent of the licensed use amount. Under the high population growth scenario, water use will increase by 32 percent over current levels and total diversions of surface and groundwater are expected to be 17 percent higher than the

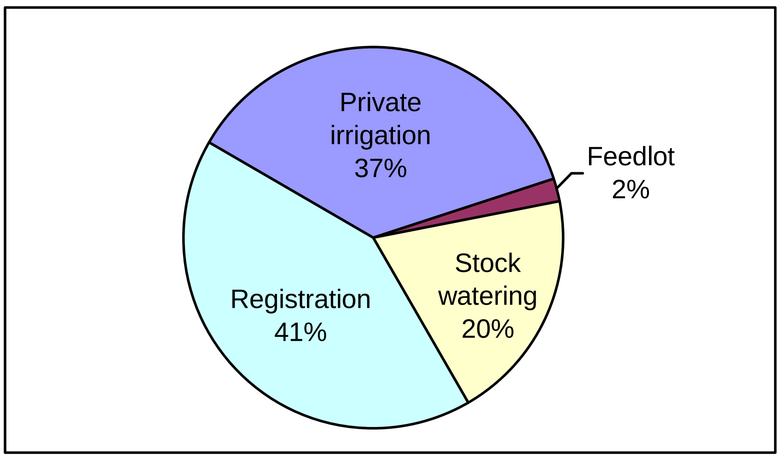
maximum allowable in current municipal licences. Actual water use is expected to be 29 percent of the amount allowed in the licences.

9.2 AGRICULTURE SECTOR

As of December 2005 a total of 26,774 dam^3 had been allocated to the agricultural sector in the North Saskatchewan River Basin. This includes 19,385 registrations representing 11,351 dam^3 and 1,527 licences representing 15,423 dam^3 of water. Water allocated to agriculture accounts for 1.3 percent of all allocations in the North Saskatchewan River Basin.

Figure 9-7 shows how this water is distributed among the different agricultural uses in the Basin. The largest allocation is for registration (41 percent). Private irrigation accounts for 37 percent, stockwatering accounts for 20 percent and feedlot accounts for two percent of the total allocation.

Figure 9-7 Water Allocation for Agricultural Activities in the North Saskatchewan Basin, 2005



A total of 11,013 registrations and 545 licences allow withdrawals of up to 15,677 dam^3 of surface water; this accounts for 60 percent of water allocations for the agricultural sector. Groundwater accounts for the other 40 percent of total agricultural allocations, with 10,715 dam^3 allocated through 982 licences and 8,372 registrations.

9.2.1 Overview of Agriculture in the North Saskatchewan Basin

Based on information from the 2001 Census of Agriculture, there were about 12,300 farms in the North Saskatchewan Basin (23 percent of the Alberta total) with an average size of 625 acres. At the provincial level there are about 53,000 farms with an average size of 970 acres. Farms in the North Saskatchewan Basin cover an area of nearly 5.7 million acres; this is equivalent to about 31,000 km^2 or about 55 per cent of the basin. As shown in Table 9-8, 54 percent of the land in the Basin is used to raise crops. About 35 per cent of agricultural land is pasture. The rest of the lands are in summer fallow or other uses.

Table 9-8 Agricultural Land Use in the North Saskatchewan River Basin, 2001

Land Use	Acres	Percent
Crop Land	4,131,334	53.8%
Summerfallow	240,990	3.1%
Tame/Seeded Pasture	1,092,394	14.2%
Natural Pasture	1,645,369	21.4%
Other	564,320	7.4%
Total	**7,674,406**	**100.0%**

The types of farming activity vary within the North Saskatchewan River Basin. Table 9-9 shows the classification of farms based on the commodity groups that accounted for 51 per cent or more of total gross farm receipts. The table shows that about 45 percent of the farms in the Basin raise beef cattle and about 20 percent are grain and oilseed farms. Specialty farms make up about 13 percent of the farms. Like Alberta, cattle (beef) farms are most common farm type in the North Saskatchewan Basin. The general mix of other types of farms is similar for both Alberta and the North Saskatchewan Basin although there are proportionally fewer wheat farms in the North Saskatchewan River Basin.

Table 9-9 Classifications of Farms in the North Saskatchewan Basin and Alberta, 2001

Farm Type (Farms with Gross Receipts >$2,500)	Percent of Farms in the Basin	Percent Share of Alberta	Alberta Farm Type (Percent)
Dairy Farms	1.9%	28.4%	1.5%
Cattle (beef) Farms	45.8%	22.7%	45.4%
Hog Farms	1.4%	19.4%	1.7%
Poultry & Egg Farms	1.1%	27.2%	0.9%
Wheat Farms	4.2%	12.9%	7.4%
Grain & Oilseed Farms	19.6%	23.9%	18.4%
Field Crop Farms	8.6%	20.8%	9.3%
Fruit Farms	0.2%	27.2%	0.1%
Misc. Specialty Farms	12.9%	26.7%	10.9%
Sum of Livestock Comb. Farms	2.6%	25.1%	2.3%
Sum of Vegetable Farms	0.1%	21.9%	0.1%
Sum of Other Comb Farms	1.5%	16.8%	2.0%
Total	**100%**	**22.5%**	**100%**

9.2.2 Stockwatering

As noted in Table 9-9 about 50 percent of the farms in the North Saskatchewan Basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species in 2001 are provided in Table 9-10. The table shows that there about 1.3 million cattle and calves which, together, accounted for about 85 percent of livestock population in the North Saskatchewan Basin. This is about 24 percent larger than the human population of the BRB. Other livestock in the North Saskatchewan Basin included pigs, sheep and lamb, horses and ponies, bison, deer and elk.

Table 9-10 Estimated Livestock Populations in the North Saskatchewan Basin, 2001

Livestock Species	Basin Total	Alberta	% Alberta
Hens and Chicken	3,090,930	12,175,246	25.4%
Turkey	41,519	864,438	4.8%
Cattle	990,169	6,615,201	15.0%
Calves	365,725	2,169,607	16.9%
Pigs	232,169	2,027,533	11.5%
Sheep and Lamb	55,204	307,302	18.0%
Horse and Ponies	35,172	159,962	22.0%
Bison	18,906	79,731	23.7%
Deer	2,864	8,331	34.4%
Elk	6,426	31,304	20.5%

9.2.2.1 Water Allocation

Overall 20,756 licences and registrations have been issued for livestock watering with total allocation amounting to 17,062 dam^3. In addition to these allocations, farmers are able to obtain up to 1,250 m^3 of water for household purposes. The numbers of such households in the Basin is not known. Furthermore, the numbers of “exempted agricultural” users are also not known in the North Saskatchewan Basin.

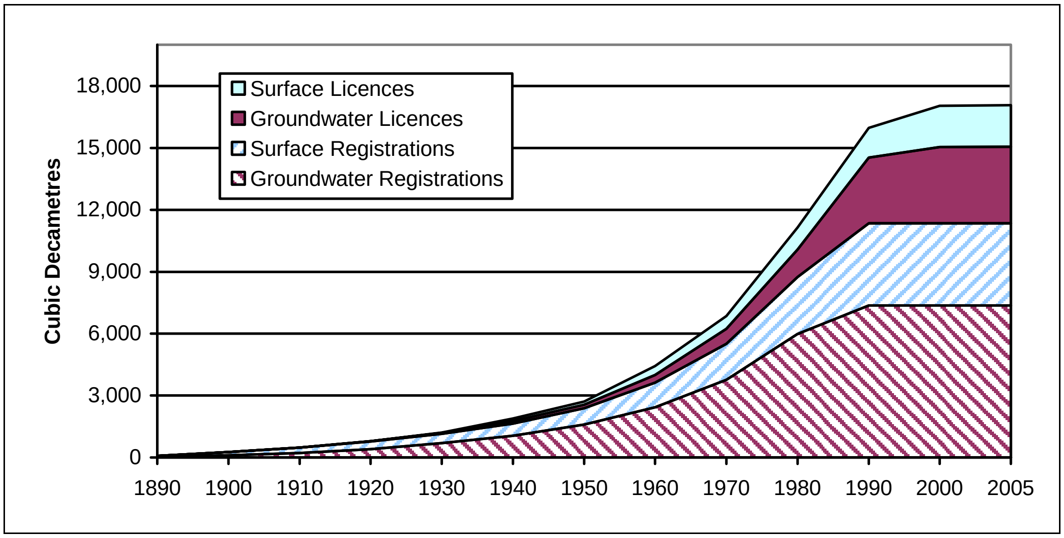
A historical perspective on water used for livestock is provided in Figure 9-8. The figure shows that some registrations were issued with priority dates in the 1890s while licences for stockwatering began to be issued from the early 1900s. Allocations for stockwatering have risen steadily since the 1920s, with substantial increases occurring in groundwater registration. Since 1990 water allocations from registrations has remained relatively unchanged while allocations from licences has increased. There are 15 licences for feedlots representing an allocation of 480 dam^3. This allocation reflects the fact that livestock industry has gone through intensification in operations over the last few decades. Feedlot licences began to be issued in the Basin in the 1970s.

Table 9-11 summarizes current water licences and registrations issued for livestock according to the water source. It shows that surface water accounts for about 35 percent of allowable diversions for livestock and that registrations account for 66 percent of the allocations.

Table 9-11 Summary of Water Licenses and Registrations Issued for Livestock Watering in the North Saskatchewan River Basin,

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use (dam^3)
Feedlot	Surface	1	32.7	32.7	0.0	0	N/A
	Groundwater	14	446.5	446.5	0.0	0	N/A
	Subtotal	**15**	**479.2**	479.2	**0.0**	**0**	**N/A**
Stockwatering	Surface	392	1,961.7	1,961.7	0.0	0	N/A
	Groundwater	964	3,270.5	3,270.5	0.0	0	N/A
	Subtotal	**1,356**	**5,232.2**	5,232.2	**0.0**	**0**	**N/A**
Registration	Surface	11,013	3,989.1	3,989.1	0.0	0	N/A
	Groundwater	8,372	6,979.2	6,979.2	0.0	0	N/A
	Subtotal	**19,385**	**10,968.3**	10,968.3	**0.0**	**0**	**N/A**
Total	Surface	11,406	5,983.5	5,983.5	0.0	0	N/A
	Groundwater	9,350	10,696.1	10,696.1	0.0	0	N/A
	Total	**20,756**	**16,679.6**	**16,679.6**	**0.0**	**0**	**N/A**

Figure 9-8 Historical Trends in Water Allocation for Livestock in the North Saskatchewan Basin



9.2.2.2 Licensed Water Use

Table 9-11 shows that there are no return flow allowances in licences and registration issued for stockwatering. All of allocation is expected to be used.

9.2.2.3 Actual Water Use

There is no information in Alberta Environment's WURS that indicates the extent to which water allocations are actually used in the North Saskatchewan Basin. However, a reasonable estimate of water use can be derived using the actual animal population in the Basin as shown in Table 9-10. Based on livestock populations for the North Saskatchewan Basin in 2001, the total water required for livestock was estimated to be 12,543 dam^3, or about 70 percent of the licensed allocation.[1] The calculations for this estimate are provided also in Table 9-12 which shows livestock populations in the Basin and the daily water requirements for various livestock species as provided by Alberta Environment in its "Guide to Calculate Quantities for Water for Raising Animals".[2] In terms of water requirements by species, cattle accounts for about 86 percent of the total, about five percent is required by pigs, two percent is required by poultry and all other species accounted for the remaining seven percent.

While the estimated actual consumption based on livestock populations (12,543 dam^3) appears to be significantly less than the amount of water allocated (16,680 dam^3), the data in Table 9-12 do not include an allowance for the evaporative and seepage losses associated with storing water for livestock use. Typically, licensed consumption accounts for only 35 per cent of surface water allocated for livestock use while losses account for 65 per cent (Watrecon 2005).

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1 This approach to estimating water use for stockwatering was employed in the 1986 Battle River Basin water use study undertaken by Stanley Associates in 1985.

2 http://www3.gov.ab.ca/env/water/Legislation/Approvals_Licences/CalculationChart.doc.

Table 9-12 Estimated Livestock Water Requirements for 2001

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chickens	3,090,930	0.045	230.7
Turkey	41,519	0.15	10.3
Bulls	20,417	9.0	304.7
Milk Cows	16,477	30.0	819.7
Beef Cows	390,266	9.0	5,824.7
Heifers	135,934	6.0	1,352.5
Steers	61,351	6.0	610.4
Calves	365,725	3.0	1,819.5
Boars	1,450	6.5	15.6
Sows and Gilts - Breeding	23,299	6.5	251.1
Nursing and Weaner Pigs	75,965	0.5	63.0
Grower and Finishing Pigs	131,455	1.5	327.0
Sheep and Lambs	55,204	2.0	183.1
Horse and Ponies	35,172	10.0	583.3
Bison	18,906	2.0	62.7
Deer	2,864	10.0	47.5
Elk	6,426	3.5	37.3
Total			**12,543.3**

Since 64 percent of livestock water consumption comes from groundwater (no losses) and the balance comes from surface water with 65 percent losses, a total allocation of 14,974 dam^3 would be required to support the animal populations in Table 9-12. This water requirement is about 90 percent of the water allocation through licenses and registrations. Consequently, it is assumed that actual water use is equivalent to the amount of water allocated for livestock. It is also assumed that surface water withdrawals occurred during April when dugouts and storage dams were filled and flows were at their peak.

9.2.2.4 <u>Forecasts of Future Stockwatering Water Use</u>

The key factor affecting future livestock water demand is changes in cattle populations in the basin. Cattle accounts for about 86 percent of livestock water demand in the North Saskatchewan Basin, so changes in the populations of other livestock species will have a minimal overall impact on future water demand. The historical trend analysis in Figure 9-8 shows that the amount of water allocated for livestock has been increasing over time, including the last decade, suggesting an increasing livestock population. The data from the Census of Agriculture corroborates this finding as it shows that the cattle population increased between 1996 and 2001.

Some indication of the potential for expansion of cattle populations in the North Saskatchewan River Basin can be determined by examining applications for new and expanded confined feeding operations, which must be approved by the NRCB in accordance with *AOPA*.

Information from the NRCB indicates that, as of December 31, 2005, there had been no applications from farmers throughout the Basin for cattle and dairy operations.

A study undertaken by Alberta Agriculture in the late 1990s also provides some insights regarding the potential for expansion of the beef industry in the province. That study identified several criteria – manure, odour and population densities, local silage supplies, water supply, landscape characteristics and land for manure spreading – to be considered in evaluating the capability of supporting a 5,000-head back grounding operation and a 20,000-head operation. Townships suitable for livestock expansions are shown in Figures 2-2 and 2-3 in Section 2.3. The figures show that more townships on the North Saskatchewan River Basin meet more of the criteria for backgrounding operations than for finishing operations. For most townships that meet some of the criteria limiting factors include groundwater and landscape for backgrounding operations. For finishing operations, relatively few townships in the Basin meet any of the criteria, however, some townships meet some criteria but are limited by groundwater and landscape. Based on Alberta Agriculture's assessment, it would appear that livestock expansion in the North Saskatchewan River Basin could occur and would most likely consist of 5,000-head operations. While this assessment shows that there is potential for future expansion of livestock operations, the information from the NRCB suggests that this expansion has not yet occurred, probably due to the fact that the cattle industry is still adjusting to changes in markets associated with the effects of BSE.

Projections are based on the expectations that cattle populations will increase at annual rates somewhere between 0.5 percent (Low Growth) and 2.2 percent (High Growth) which reflects average annual growth rate in cattle population in Alberta during 1958-2005. For the Base Growth scenario, the annual rate is assumed to be 1.2 percent. The forecasts also assume that the current mix of livestock water use (86 percent cattle) and balance of surface and groundwater use will remain unchanged over the forecast period. The resulting projections based on estimated actual use are shown in Table 9-13.

Table 9-13 Projected Water Use for Livestock in the North Saskatchewan River Basin, (dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	6,947	7,122	7,302	7,487	7,676
	Groundwater	8,028	8,230	8,438	8,651	8,870
	Total	**14,974**	**15,353**	**15,740**	**16,138**	**16,545**
Medium Growth	Surface	6,947	7,374	7,827	8,308	8,819
	Groundwater	8,028	8,521	9,045	9,600	10,190
	Total	**14,974**	**15,895**	**16,872**	**17,908**	**19,009**
High Growth	Surface	6,947	7,745	8,636	9,628	10,735
	Groundwater	8,028	8,950	9,979	11,126	12,405
	Total	**14,974**	**16,696**	**18,615**	**20,755**	**23,140**

Under the Low Growth scenario, water demand is projected to increase to 16,545 dam^3 by 2025; this represents a 10 percent increase over current use and is about the same as current allocations. Under the High Growth, livestock water use would increase to 23,140 dam^3 by

2025. This increase is 1.5 times higher than current livestock use and would exceed current allocations by about 5,000 dam^3.

9.2.3 Irrigation

The other major use of water for agricultural purposes is irrigation or crop watering. Unlike rivers basins in southern Alberta, there are no licences for district irrigation in the North Saskatchewan River Basin. Irrigation in this Basin is done by private irrigators who have their own water licences and divert water using their own pumps and water distribution equipment.

When aggregate information from the 2001 Census of Agriculture for individual counties and municipal districts is modified to reflect river Basin boundaries, the resulting estimates suggest that about 8,000 acres of land in the North Saskatchewan River Basin were irrigated in 2001. Another approach for estimating irrigated acres involves dividing water allocations by irrigation water requirement of about 450 mm (18 inches) per acre. Based on this method it is estimated that water allocations are sufficient to support irrigation on about 8,000 acres, which corroborates the estimates based on Census data. There is no information on the mix of crops grown by private irrigators; however, AAFRD has indicated that most private irrigation in Alberta is used to raise supplemental forages to feed livestock.

9.2.3.1 Water Allocation

There are 156 private licences that allocate approximately 9,700 dam^3 for irrigation purposes. Over 99 percent of this allocation is from surface water. This Basin accounts for about one percent of total private allocation and about five percent of the private licences issued in the province. A historical perspective on water used for irrigation is provided in Figure 9-9. The figure shows that allocations for irrigation date from the 1940s, which have increased substantially since that time, particularly from the 1950s to 1990s. As of 2005, about 9,700 dam^3 had been allocated which is virtually unchanged from 2000.

Figure 9-9 Historical Trends in Surface Water Allocation for Irrigation in the North Saskatchewan Basin

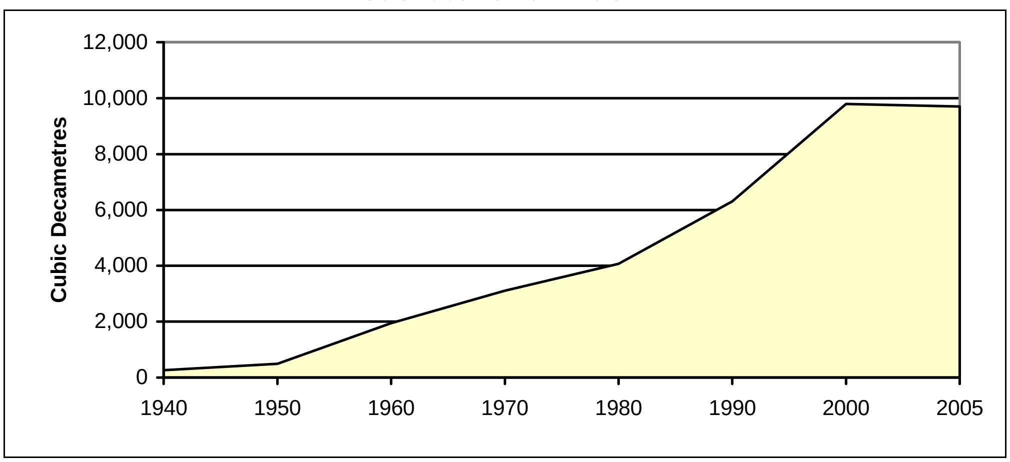


Table 9-14 Irrigation Allocations and Use and Reported Actual Water Use, North Saskatchewan River Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
Private irrigation	Surface	152	9,692.9	9,555.9	137.1	0	N/A
	Groundwater	4	18.6	18.6	0.0		
	Subtotal	**156**	**9,711.5**	9,574.5	**137.1**	**0**	**N/A**
Total	Surface	152	9,692.9	9,555.9	137.1	0	N/A
	Groundwater	4	18.6	18.6	0.0		
	Total	**156**	**9,711.5**	9,574.5	**137.1**	**0**	**N/A**

9.2.3.2 Licensed Water Use

Table 9-14 summarizes the water licences issued for irrigation according to water source. The licences assume that up to 98 percent of the total allocation of surface water will be used and that two percent (137 dam^3) will to be returned to surface sources. No return flow is associated with groundwater allocation.

9.2.3.3 Actual Water Use

Neither Alberta Agriculture nor Alberta Environment has any information on actual water use by private irrigators. For the purposes of this study it is assumed that actual use is equal to licensed water use, for users except the three licensees who are required to return some of their diversions. However, actual water use in any given year will depend on how much of the crop water demand can be satisfied by natural precipitation. It is noteworthy that actual stockwatering use in the Basin (14,974 dam^3) is 1.6 times the amount of water used for crop watering.

9.2.3.4 Forecasts of Future Irrigation Water Use

With expansion of livestock, additional demand for livestock forage is expected. The historical trend provided in Figure 9-9 shows that water allocation for irrigation has increased over time, suggesting that past increases in livestock have led to increased water demand for expansion in irrigated crop areas. However, since 2000 there has been a decline in allocation and Census data showed that between 1996 and 2001 irrigated acres had declined by about 30 percent. Further, given climatic conditions and limited land base in many parts of the Basin, additional expansion of irrigation acreage is not likely. Also, irrigation is a capital intensive operation but the net returns from forage production are not great (Watrecon 2005). These factors suggest that expansion irrigation is not likely. It is assumed that available forage will be able to support modest increases in livestock populations. Irrigation water use is projected to remain at 9,575 dam^3 over the forecast period.

9.2.4 Summary

In summary, current agricultural water use in the North Saskatchewan Basin is estimated to be about 24,549 dam^3, of which 62 percent is for livestock and 38 percent is for irrigation. In the future, agricultural water demand in the Basin is expected to increase as a result of expansion of livestock populations. Demand for irrigation is expected to remain constant. A summary of future agricultural water demand is provided in Table 9-15.

Agricultural water use in 2025 would be about 26,120 dam^3 (an increase of six percent from 2005) under the Low Case. Under High Case, water use is projected to be 32,715 dam^3 by 2025; this represents (an increase of 33 percent from 2005). For the Base Case, agricultural water use in 2025 is expected to increase by 16 percent over current levels.

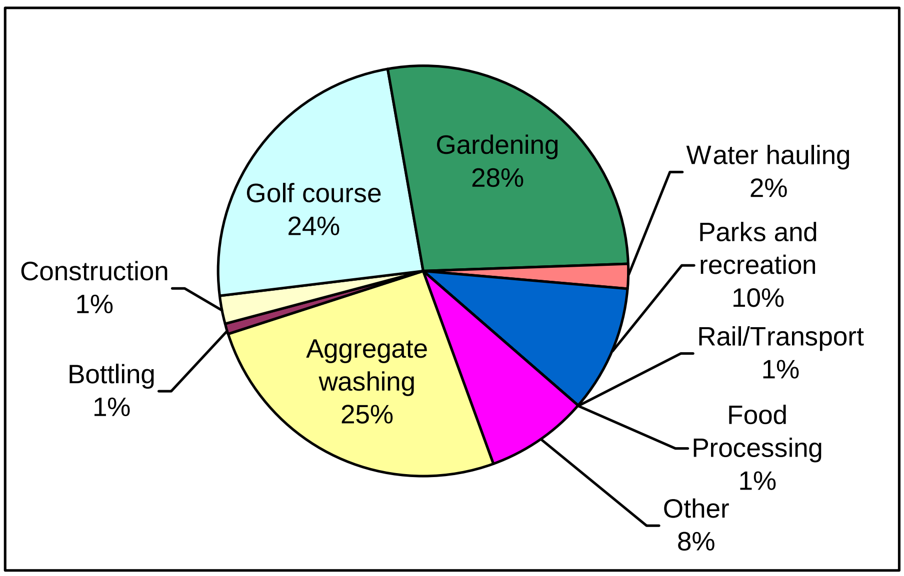
Table 9-15 Projected Water Use for Agriculture in the North Saskatchewan River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	16,503	16,678	16,858	17,042	17,231
	Groundwater	8,046	8,249	8,457	8,670	8,888
	Total	**24,549**	**24,927**	**25,315**	**25,712**	**26,120**
Medium Growth	Surface	16,503	16,930	17,383	17,864	18,375
	Groundwater	8,046	8,540	9,063	9,619	10,209
	Total	**24,549**	**25,469**	**26,446**	**27,483**	**28,584**
High Growth	Surface	16,503	17,301	18,192	19,184	20,291
	Groundwater	8,046	8,969	9,998	11,145	12,424
	Total	**24,549**	**26,270**	**28,189**	**30,329**	**32,715**

9.3 COMMERCIAL SECTOR

There are 255 licences that allow diversion of about 15,835 dam^3 of water in the North Saskatchewan Basin. This allocation accounts for only 0.8 percent of total allocations in the basin.

Figure 9-10 Water Allocation for Commercial Activities in the North Saskatchewan Basin



9.3.1 Water Allocations

As shown in 9-10, the three largest allocations (gardening (28 percent), aggregate washing (25 percent) and golf courses (24 percent)) together account for about 77 percent of the total allocations for commercial purposes.

Licences issued for the commercial sector allow maximum withdrawals of about 14,070 dam^3 of surface water and this represents about 90 percent of total allocations for commercial purposes.

The largest allocation is for gardening which accounts for about 30 percent of total surface water allocations. Licences issued for the commercial sector allow maximum withdrawals of 1,481 dam^3 of groundwater (10 percent of allocation). The largest allocation of groundwater is for golf courses which account for about 30 percent of the total groundwater allocation.

A historical trend of commercial sector allocation in the North Saskatchewan Basin is provided in Figure 9-11. The earliest allocation began in the 1920s and consisted of surface water. These allocations remained unchanged until the 1930s but declined through to the 1950s. Since 1960s surface water allocations have steadily increased, driven by golf course and gardening activities. Surface water allocations peaked in 2000 and remained constant since then. Groundwater allocations began in the 1970s and increased until 2000 but have remained constant since then. Overall, groundwater allocations make up a small proportion of water allocations for commercial purposes.

Figure 9-11 Historical Trend in Commercial Sector Water Allocation in the North Saskatchewan

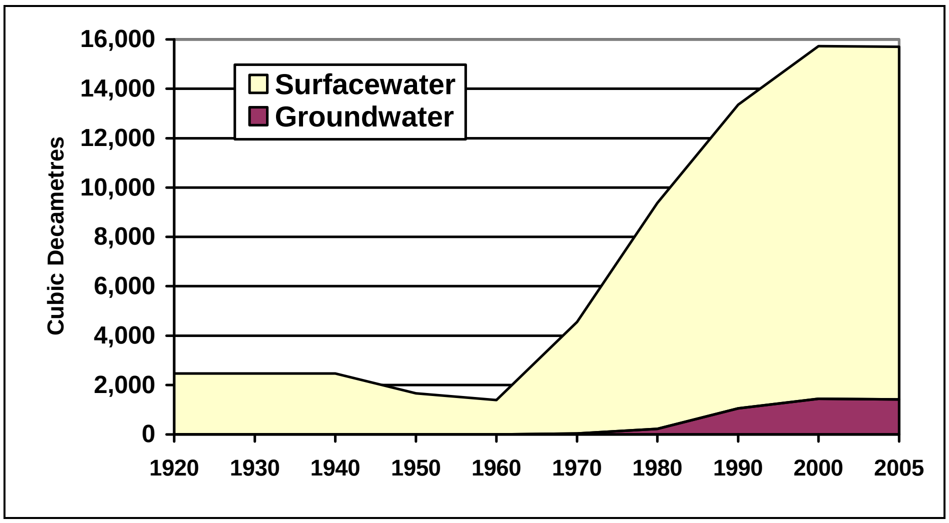


Table 9-16 Licensed Commercial Allocations and Reported Actual Water Use, North Saskatchewan Basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Licensees Reporting	Reported Use	Percent of Allocation
Aggregate washing	Surface	17	3,681.9	1,257.7	2,424.3	0	N/A	N/A
	Groundwater	9	346.8	346.8	0.0	0	N/A	N/A
	Subtotal	**26**	**4,028.8**	**1,604.5**	**2,424.3**	**0**	**N/A**	**N/A**
Bottling	Surface	7	118.0	118.0	0.0	0	N/A	N/A
	Groundwater	4	41.6	41.6	0.0	0	N/A	N/A
	Subtotal	**11**	**159.6**	**159.6**	**0.0**	**0**	**N/A**	**N/A**
Construction	Surface	6	345.41	76.5	268.9	0	N/A	N/A
	Groundwater	2	6.9	6.9	0.0	0	N/A	N/A
	Subtotal	**8**	**352.31**	**68.6**	**268.9**	**0**	**N/A**	**N/A**
Golf course	Surface	45	3,350.0	3,350.0	0.0	0	N/A	N/A
	Groundwater	9	463.5	463.5	0.0	0	N/A	N/A
	Subtotal	**54**	**3,813.6**	**3,813.6**	**0.0**	**0**	**N/A**	**N/A**
Gardening	Surface	47	4,258.4	4,258.4	0.0	3	6.23	0.14
	Groundwater	11	36.4	36.4	0.0	0	N/A	N/A
	Subtotal	**58**	**4,294.7**	**4,294.7**	**0.0**	**3**	**6.23**	**0.14**
Water hauling	Groundwater	6	328.5	328.5	**0.0**	0	N/A	N/A
	Subtotal	**6**	**328.5**	**328.5**	**0.0**	**0**	**N/A**	**N/A**
Parks and Recreation	Surface	34	1,343.4	1,105.3	238.1	0	N/A	N/A
	Groundwater	34	223.4	223.4	0.0	0	N/A	N/A
	Subtotal	**68**	**1,566.7**	**1,328.7**	**238.1**	**0**	**N/A**	**N/A**
Rail/Transport	Surface	1	10.0	10.0	0.0	0	N/A	N/A
	Groundwater	1	7.3	7.3	0.0	0	N/A	N/A
	Subtotal	**2**	**17.3**	**17.3**	**0.0**	**0**	**N/A**	**N/A**
Food processing	Groundwater	2	10.6	10.6	0.0	0	N/A	N/A
	Subtotal	**2**	**10.6**	**10.6**	**0.0**	**0**	**N/A**	**N/A**
Other	Surface	14	1,247.0	907.8	339.2	0	N/A	N/A
	Groundwater	8	16.1	16.1	0.0	0	N/A	N/A
	Subtotal	**22**	**1,263.1**	**923.9**	**339.2**	**0**	**N/A**	**N/A**
Total	Surface	171	14,354.1	11,083.7	3,270.4	0	N/A	N/A
	Groundwater	83	1,481.1	1,481.1	0.0	0	N/A	N/A
	Total	**254**	**15,835.2**	**12,563.4**	**3,270.4**	**0**	**N/A**	**N/A**

9.3.2 Licensed Water Use

Table 9-16 provides a summary of licensed water allocations, use and return for various activities within the commercial sector in the North Saskatchewan Basin. The table shows that licences issued for commercial purposes assume that 3,001 dam^3 (21 percent of allocation) will be returned to surface water sources. There are no allowances for return flows in the groundwater licences.

9.3.3 Actual Water Use

At the present time Alberta Environment's Water Use Reporting System (WURS) contains very little information on actual water use in 2005 by the any of the licensees in commercial sector in the North Saskatchewan Basin. Only one activity, gardening, has reported actual water (6 dam^3) and this represents about 0.1 percent of total allocation for gardening (see Table 9-16). Given the lack of information on actual water use for this sector it is assumed that all licensees are withdrawing and using the full amounts of water to which they are entitled. While this assumption may overstate actual water use in the basin, the commercial sector accounts for 0.8 percent of total allocations so it will not appreciably affect overall water use estimate for the North Saskatchewan Basin.

9.3.4 Forecasts of Future Water Use

Since most of the allocation (77 percent) is for three activities – gardening, aggregate washing and golf course, forecasts of future demand will focus on those activities.

9.3.4.1 Gardening

Future water use for gardening is projected assuming average annual growth rate ranging between 0.5 percent (Low Growth) and 3.0 percent (High Growth). Under the Base Growth scenario an annual increase of 1.9 percent is assumed; this is the average annual growth rate of greenhouse farms in the Basin between 1996 and 2001, as calculated using information in the Census of Agriculture. Projections using these assumptions are shown in Table 9-17.

Table 9-17 Projected Water Use for Gardening, North Saskatchewan Basin

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	4,258	4,366	4,476	4,589	4,705
	Ground water	36	37	38	39	40
	Total	**4,295**	**4,403**	**4,514**	**4,628**	**4,745**
Medium Growth	Surface	4,258	4,679	5,140	5,648	6,205
	Ground water	36	40	44	48	53
	Total	**4,295**	**4,719**	**5,184**	**5,696**	**6,258**
High Growth	Surface	4,258	4,937	5,723	6,634	7,691
	Ground water	36	42	49	57	66
	Total	**4,295**	**4,979**	**5,772**	**6,691**	**7,757**

Water demand is expected to increase to 4,745 dam^3 by 2025 under Low Growth, which is a 10 percent increase from current use. Using High Growth, water demand is projected to increase to 7,757 dam^3 by 2025 which is almost double the current water use.

9.3.4.2 Aggregate Washing

Projections of water used for aggregate washing are based on actual water use listed in Table 9-16. Demand for aggregate material (and water use) is related to the level of economic activity, particularly construction so the projections are related to change in economic activity (GDP growth rate). Although Alberta is experiencing higher than average rate of GDP growth relative to historic levels, the water use forecasts use long term annual growth rates of 1.2 percent (Low Growth), 2.2 percent (Base Growth) and 3.2 percent (High Growth). Projections using these assumptions are shown in Table 9-18.

Table 9-18 Projected Water Use for Aggregate Washing, North Saskatchewan Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,258	1,335	1,417	1,504	1,597
	Groundwater	347	368	391	415	440
	Total	**1,605**	**1,703**	**1,808**	**1,919**	**2,037**
Medium Growth	Surface	1,258	1,402	1,563	1,743	1,944
	Groundwater	347	387	431	481	536
	Total	**1,605**	**1,789**	**1,995**	**2,224**	**2,480**
High Growth	Surface	1,258	1,472	1,723	2,017	2,361
	Groundwater	347	406	475	556	651
	Total	**1,605**	**1,878**	**2,199**	**2,574**	**3,013**

Water use is expected to increase to 2,037 dam^3 by 2025 under Low Growth, which is a 25 percent increase from current use. Using High Growth, water demand is projected to increase to 3,013 dam^3 by 2025 which is almost double the current water use.

9.3.4.3 Golf Courses

Water demand forecast for golf courses are based on the approach outlined in Watrecon (2005) which ties the demand for water to expansion in the number of golf courses which is assumed to increase based on population growth. Water use is forecasted using those scenarios and adjusting for population levels for the North Saskatchewan Basin. This method assumes that the proportion of surface and groundwater use would not change over the forecast period relative to 2005. The resulting projections are shown in Table 9-19.

Table 9-19 Projected Water Use for Golf Course, North Saskatchewan Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	3,350	3,670	3,862	3,983	4,020
	Groundwater	464	508	534	551	556
	Total	**3,814**	**4,178**	**4,396**	**4,534**	**4,576**
Medium Growth	Surface	3,350	4,355	5,273	6,077	6,724
	Groundwater	464	603	730	841	930
	Total	**3,814**	**4,958**	**6,003**	**6,917**	**7,655**
High Growth	Surface	3,350	5,880	8,490	10,995	13,310
	Groundwater	464	814	1,175	1,521	1,842
	Total	**3,814**	**6,693**	**9,664**	**12,517**	**15,151**

Water use is expected to increase to 4,576 dam^3 by 2025 under the Low Growth scenario, which is a 20 percent increase from current use. Using High Growth, water demand is projected to increase to 15,151 dam^3 by 2025 which is almost four times the current water use. Water use in 2025 under the Base Case would double current water use.

9.3.4.4 Summary

A summary of projected water demand for the commercial sector in the North Saskatchewan Basin is provided in Table 9-20. Note that this forecast combines the estimates in Tables 3-17 to 3-19 for gardening, aggregate washing and golf course(which together account for 80 percent of allocation in the Basin), with the assumption that the all of the water use allowed for other commercial activities is being fully utilized.

Under the Low Growth scenario, water demand is projected to rise to 14,194 dam^3, a 13 percent increase from current levels by 2025. Under the High Growth scenario, water demand is projected to rise to 28,757 dam^3, a 230 percent increase from current levels by 2025.

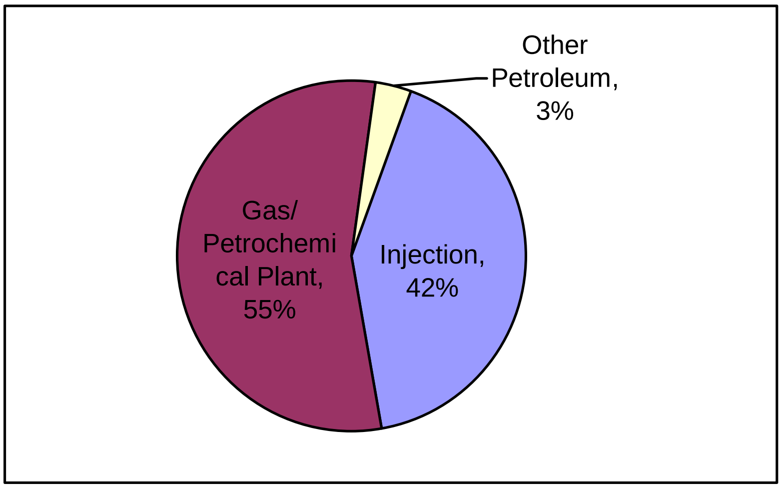
Table 9-20 Projected Water Use for the Commercial Sector in the North Saskatchewan Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	11,084	11,574	11,958	12,279	12,525
	Groundwater	1,480	1,547	1,597	1,639	1,670
	Total	**12,564**	**13,120**	**13,554**	**13,917**	**14,194**
Medium Growth	Surface	11,084	12,639	14,179	15,671	17,076
	Groundwater	1,480	1,664	1,839	2,004	2,153
	Total	**12,564**	**14,302**	**16,018**	**17,673**	**19,229**
High Growth	Surface	11,084	14,492	18,139	21,849	25,565
	Groundwater	1,480	1,896	2,333	2,768	3,193
	Total	**12,564**	**16,386**	**20,471**	**24,618**	**28,757**

9.4 PETROLEUM SECTOR

In the North Saskatchewan Basin, there are 151 active licences which allocate 93,358 dam^3 of water to the petroleum sector. This accounts for five percent of total allocations in the basin. The majority (95 percent) of allocations for the petroleum sector is for surface water (88,828 dam^3). As shown in Figure 9-12, the petroleum sector includes water allocations for oilfield injection, gas and petrochemical plants, and various other activities.

Figure 9-12 Petroleum Water Allocation by Use in the North Saskatchewan Basin



9.4.1 Injection

9.4.1.1 <u>Water Allocations</u>

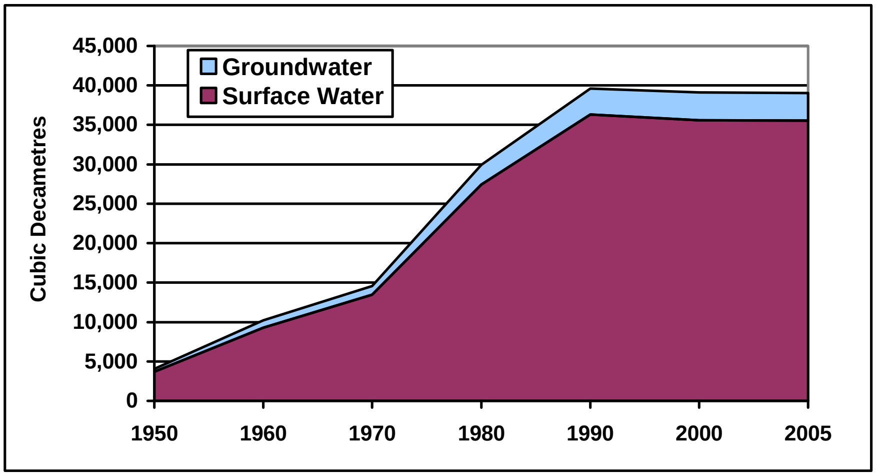
About 42 percent of the allocations are for injection purposes for enhanced oil and gas recovery (39,034 dam^3). Details of the licences issued to the petroleum sector in the North Saskatchewan River Basin are provided in Table 9-21. The table shows that 102 licences have been issued for injection purposes, with nearly 60 percent of these for groundwater. However, surface water accounts for 91 percent of allocations.

Water use for injection commenced in the 1950s but grew rapidly in the 1970s and 1980s. Figure 9-13 shows that there has actually been a slight decline in licensed allocations for surface water since 1990, but allocations of groundwater have remained constant during that period.

9.4.1.2 <u>Licensed Water Use</u>

As shown in Table 9-21, the licences issued for injection purposes assume that 99 percent of allocations will be used. Return flow allowances in licences only amounted to 361 dam^3.

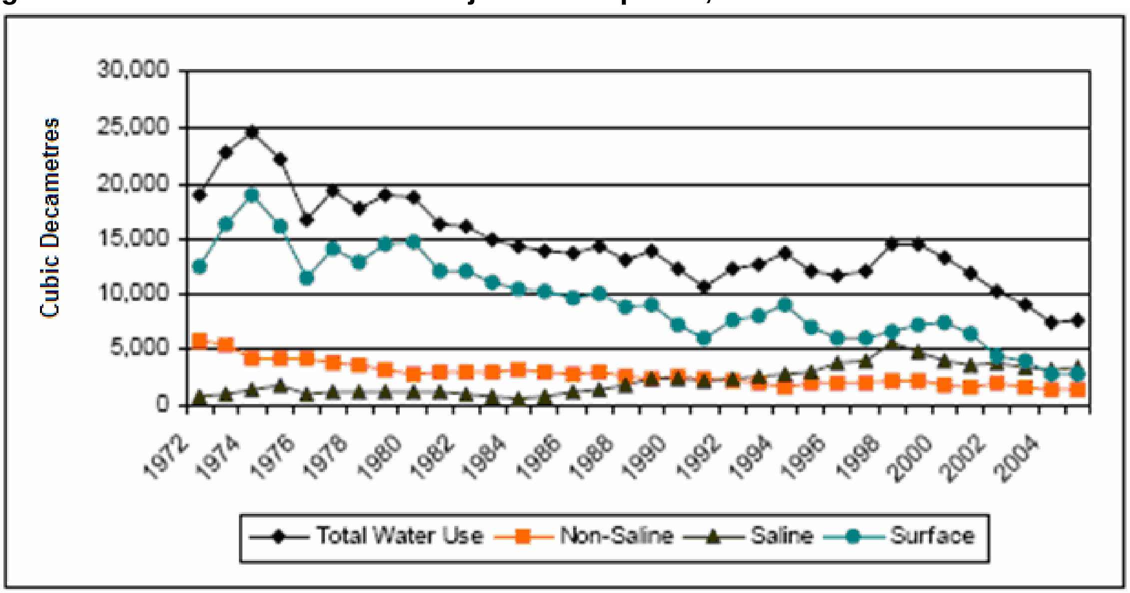
Figure 9-13 Historical Trends in Water Allocations for Injection



9.4.1.3 Actual Water Use

Detailed summary of reported water used for injection have been prepared by Geowa based on EUB data and are presented in Figure 9-14. These estimates show that, although the amount of water allocated to injection in the North Saskatchewan Basin has increased over time, the amount actually diverted has been decreasing since the late 1990s. In 2005, an estimated 3,820 dam^3 of fresh water was diverted for injection purposes. This volume includes 2,630 dam^3 of surface water (69 percent) and 1,190 dam^3 of groundwater (31 percent). About 210 dam^3 of saline water was also used for injection.

Figure 9-14 Water Diversions for Injection Purposes, North Saskatchewan River Basin



Source: Alberta Environment, Water Use for Injection Report, 2006

Table 9-21 Licensed Allocations and Estimated Actual Water Use for the Petroleum Sector, North Saskatchewan River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Injection	Surface	39	35,533.6	35,172.2	361.4	2,628.9	7.5%	7.4%
	Groundwater	63	3,500.8	3,500.8	0.0	1,191.0	34.0%	34.0%
	Subtotal	**102**	**39,034.4**	**38,673.0**	**361.4**	**3,819.9 ***	**9.9%**	**9.8%**
Gas/ Petrochemical Plant	Surface	17	50,265.6	39,366.6	10,898.9	23,500.6	59.7%	46.8%
	Groundwater	25	1,010.7	1,010.7	0.0	483.3	47.8%	47.8%
	Subtotal	**42**	**51,276.3**	**40,377.4**	**10,898.9**	**23,983.9 ****	**59.4%**	**46.8%**
Other petroleum	Surface	4	3,028.7	3,028.7	0.0	3,028.7	100.0%	100.0%
	Groundwater	2	5.2	5.2	0.0	5.2	100.0%	100.0%
	Subtotal	**6**	**3,033.9**	**3,033.9**	**0.0**	**3,033.9**	**100.0%**	**100.0%**
Total	Surface	60	88,827.8	77,567.5	11,260.3	29,158.1	37.6%	32.8%
	Groundwater	90	4,516.7	4,516.7	0.0	1,679.5	37.2%	37.2%
	Total	**150**	**93,344.5**	**82,084.3**	**11,260.3**	**30,837.6**	**37.6%**	**33.0%**

* EUB water use data provided by Geowa.
** Estimates based on WURS data.
*** Estimates assume 100 percent consumption of licensed use.

Based on the estimates of actual water use in Table 9-21, injection activities in the Basin are currently diverting and using approximately 10 percent of their licensed allocations and use.

9.4.1.4 Forecasts of Future Water Use

The general trend in Alberta is for conventional crude oil production to decline as existing fields mature and there are fewer new finds. The most recent forecast from the EUB and CAPP have oil production decreasing by between 30 and 38 percent between 2005 and 2015, and a further decline of about 23 percent by 2020. Oil production in the North Saskatchewan Basin is expected to follow the overall Alberta production trend since most of the basin's production is from existing wells. The forecast of future water use for injection in the North Saskatchewan Basin in Table 9-22 assumes declining rates of water use required that match the rates at which oil production in Alberta is expected to decline.

Table 9-22 Forecast of Injection Water Use in the North Saskatchewan River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
High Decline	Surface	2,629	2,629	1,540	1,540	919
	Groundwater	1,191	1,191	698	698	417
	Total	**3,820**	**3,820**	**2,238**	**2,238**	**1,336**
Medium Decline	Surface	2,629	2,629	1,621	1,621	968
	Groundwater	1,191	1,191	735	735	438
	Total	**3,820**	**3,820**	**2,356**	**2,356**	**1,406**
Low Decline	Surface	2,629	2,629	1,841	1,841	1,099
	Groundwater	1,191	1,191	834	834	498
	Total	**3,820**	**3,820**	**2,675**	**2,675**	**1,597**

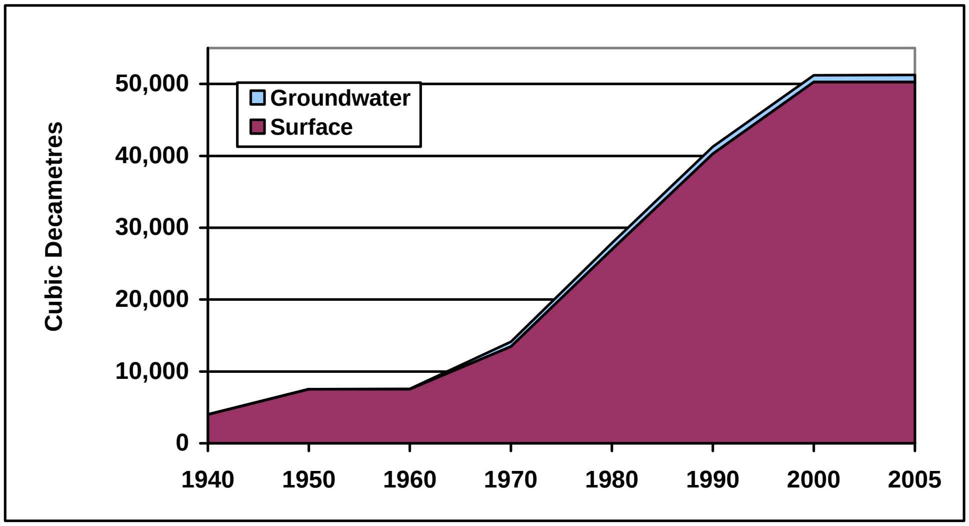
No petroleum forecasts are available for 2010 and 2020, so for the purposes of this analysis it is assumed that production for these time periods is the same as the previous five years. Forecasts also assume that the current ratio of surface to groundwater consumption will remain the same. Under the Low Decline scenario, water use for injection in 2025 will decline by 58 percent from current levels. Under the High Decline scenario, the decline will be 65 percent.

9.4.2 Gas/Petrochemical Plants

9.4.2.1 Water Allocations

Just over half (55 percent) of the allocations for the petroleum sector in the North Saskatchewan River Basin are for gas/petrochemical plants (51,276 dam^3). This includes a relatively large number of groundwater licences (25) with a small total allocation (1011 dam^3) and a smaller number of surface water allocations (17) with an allocation of 50,266 dam^3. As shown in Figure 9-15, allocations of surface water for gas/petrochemical plants commenced in the 1940s, increased significantly between the 1970 and 2000, and has remained constant since then

Figure 9-15 Historical Trends in Water Allocations for Gas/Petrochemical Plants



9.4.2.2 <u>Licensed Water Use</u>

As shown in Table 9-21, the groundwater licences issued to gas/petrochemical plants include allowances for no return flow (100 percent consumption) and it is expected that 78 percent of diversions of surface water will be consumed.

9.4.2.3 <u>Actual Water Use</u>

The WURS database has water use information for 29 of the 42 water licences issued for gas/petrochemical plants in the North Saskatchewan River basin. These licences account for 82 percent of licensed allocations and 83 percent of licensed use. Analysis of the WURS database indicates that plants with surface water allocations were using an average of 60 percent of their allocations and 47 percent of the water that they are entitled to consume. Plants with groundwater allocations reported withdrawing and consuming 48 percent of the amounts specified in their licences. The water use estimates in Table 9-21 were calculated assuming that these percentages apply to all gas/petrochemical plants in the North Saskatchewan River basin. Based on this assumption, the total water use by gas/petrochemical plants in 2005 is estimated to be 23,980 dam^3, consisting of 23,500 dam^3 of surface water and 480 dam^3 of groundwater.

9.4.2.4 <u>Forecasts of Future Water Use</u>

It is expected that all of the existing gas and petrochemical plants in the North Saskatchewan River Basin plants will continue to operate for the foreseeable future and that their water use will remain the same as at present. However, there are currently plans to construct as many as five new upgraders in the Basin in the near future (Table 9-23). While additional upgraders may eventually be required in the basin, potential development beyond 2015 and water requirements are unknown.

The amount of water required by these facilities will depend on their production capacity and technology. Once completed, the five upgraders will process approximately 1.3 million barrels of heavy oil per day and will withdraw approximately 52,000 dam^3 from the North Saskatchewan Basin. Given the volumes of water required, it is expected that upgraders will use surface water sources rather than groundwater. Upgraders typically have a seasonal water demand which is higher in May to October and lower in November to April.

Table 9-23 List of Proposed Upgraders & Gas Plants in the North Saskatchewan Basin3

Company	Name of Project	Status	Timeline	Amount of Product	Water Required (dam^3)
North American Oil Sands Corporation	Upgrader Project	Proposed Terms of Reference	Phase 1-operational by 2012 Phase 2-operational by 2015 Operate for over 50 years	Phase 1- 12,000 m^3 (76,000 barrels) per day of bitumen feed Phase 2- 26,000 m^3 per day Total: 40,000 m^3 per day –bitumen	2,628.0 dam^3 per year by 2012 21,640.3 dam^3 per year by 2015 (Popoff, Craig, pers.comm. June 4, 2007)
Petro-Canada	Fort Hills Sturgeon Upgrader Project	EIA submitted	Phase 1- operational by 2011 Phase 2 & 3- by 2014/15	Phase 1- 165,000 BPD Phas1 1-3 340,000 BPD	14,454.0 dam^3 per year diverted from NSR
Shell Canada	Scotford Upgrader 2 Project	Proposed Terms of Reference	Would operate for 30 yrs	400,000 bbl/day	21,024 dam^3 per year (Estimated based on Scotford's current licensed and production capacity).
Synenco Energy Inc.	Northern Lights Upgrader Project	EIA/ Application submitted	Operational by 2010	150,900 m^3 per day of synthetic crude oil	10,300.0 dam^3 per year from NSR 652.0 dam^3 per year for surface runoff
North West Upgrading Inc.	North West upgrader Project	EIA submitted	Phase 1-operational by 2010 Phase2&3-operational by 2015	Phase 1-77,000 barrels of bitumen Phase 2&3 - 154,000 bpd (23,8500 m^3)	6,570.0 dam^3 diverted from NSR 875.0 dam^3 for surface water/ perception
Sherritt International Corporation	Dodds-Roundhill Coal Gasification Project	Preparing Terms of Reference	Operational by 2011	270 MM scfd of pipeline grade hydrogen	2,400 to 9,500 dam^3 per year likely from NSR

[3] Alberta Environment. May 8, 2007. Register of Environmental Assessment Information: Summary of Environmental Assessment Activity. Website available at http://www3.gov.ab.ca/env/protenf/assessment/pub/EA_Activity_Summary.pdf

Although it is expected that the five upgraders will be built in the North Saskatchewan Basin, the forecasts reflect different assumptions about when the will become fully operational. In Table 9-24 the high growth scenario assumes that the Northern Lights and North West Upgraders are full operational by 2010, and that the three remaining upgraders fully operational by 2015 and the gasification plant requires 9,500 dam^3. The Medium Growth Scenario (as proposed by the companies) illustrates the scenario where the five upgraders are fully operation by 2015 and the gasification plant requires 2,400 dam^3. The Low Growth Scenario assumes that construction on the Northern Lights and North West Upgraders does not begin until 2015, the three remaining upgraders only require half the water they are estimated to need and there is no gasification plant.

Table 9-24 Forecast of Water Use by Upgraders in the North Saskatchewan River Basin (dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	23,501	23,501	65,494	70,457	70,457
	Groundwater	483	483	483	483	483
	Total	**23,984**	**23,984**	**65,977**	**70,940**	**70,940**
Medium Growth	Surface	23,501	36,935	101,416	101,416	101,416
	Groundwater	483	483	483	483	483
	Total	**23,984**	**37,418**	**101,899**	**101,899**	**101,899**
High Growth	Surface	23,501	41,898	108,516	108,516	108,516
	Groundwater	483	483	483	483	483
	Total	**23,984**	**42,381**	**108,999**	**108,999**	**108,999**

9.4.3 Other Petroleum Activities

Six licences have been issued for other petroleum activities. They allow withdrawals of up to 3,029 dam^3 of surface water and 5.2 dam^3 of groundwater. Licensees are expected to consume all of the water they withdraw. There is no information on actual water diversions and consumption for these other petroleum uses and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the petroleum sector, it is assumed that water used by other petroleum activities in the North Saskatchewan Basin will remain constant for the forecast period.

9.4.4 Summary

The petroleum sector in the North Saskatchewan River Basin is dominated by water allocated for gas/petrochemical plants. These plants account for 55 percent of allocations but 82 percent of actual water use in 2005. Water use data shows that although water licensees allow up to 38,673 dam^3 of water to be consumed for injection purposes, licensees are only using 10 percent of this amount.

In the future, there is expected to be considerable growth in water requirements for gas/petroleum plants as new heavy oil upgraders are to be constructed in Sturgeon and Strathcona counties. At the same time, water requirements for injection are expected to

continue to decline as oil production from existing oilfields declines. The overall water use projections for the petroleum sector are provided in Table 9-24.

Table 9-25 Forecast of Petroleum Water Use in the North Saskatchewan River Basin
(dam^3)

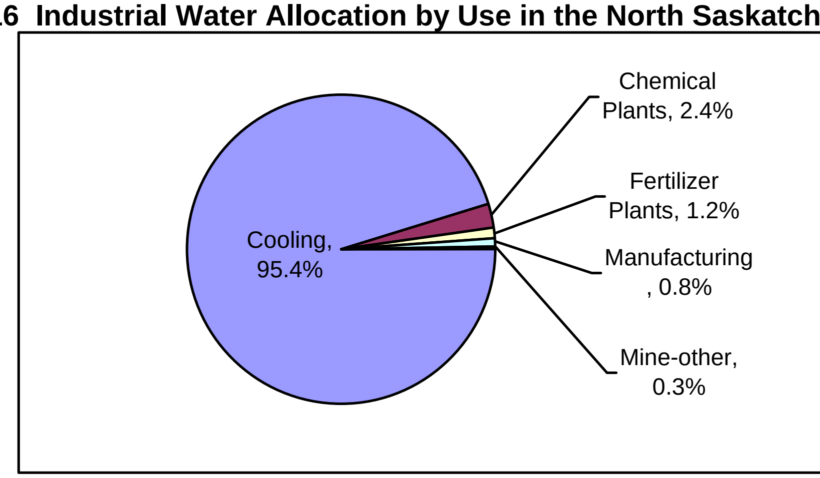
Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	29,158	29,158	29,158	70,063	75,026
	Groundwater	1,693	1,693	1,693	1,200	1,200
	Total	**30,851**	30,851	30,851	71,262	76,225
Medium Growth	Surface	29,158	29,158	42,592	106,066	106,066
	Groundwater	1,693	1,693	1,693	1,236	1,236
	Total	**30,851**	30,851	44,285	107,302	107,302
High Growth	Surface	29,158	29,158	47,555	113,385	113,385
	Groundwater	1,693	1,693	1,693	1,336	1,336
	Total	**30,851**	30,851	49,248	114,721	114,721

Table 9-24 shows that, for all three scenarios, the overall demand for water in the North Saskatchewan Basin is expected to increase over the forecast period largely due to the increase in water required for upgraders. The decline in water required for injection will likely not be enough to off set the increasing need for water to supply the upgraders.

9.5 INDUSTRIAL SECTOR

In the North Saskatchewan River Basin, there are 73 active licences which allocate 1,660,575 dam^3 of water to the industrial sector. Industrial allocations accounts for over 62 percent of total allocations in the basin. Almost all of the water allocated is for surface water (1,659,880 dam^3) which accounts for 62 percent of the industrial licences.

Figure 9-16 Industrial Water Allocation by Use in the North Saskatchewan Basin



As shown in Figure 9-16, the industrial sector includes water allocations for cooling, chemical plants, fertilizer plants, manufacturing, and mining other than coal. There is also a small amount of water licensed to coal mining, forestry, hydro, and other industrial activities.

9.5.1 Cooling

9.5.1.1 Water Allocations

About 95 percent of the allocations are for cooling purposes for thermal power generation or cooling such as air conditioning (1,583,627 dam^3). Details of the licensees issued to the industrial sector in the North Saskatchewan River Basin are provided in Table 9-25. The table shows that 24 licences have been issued for cooling purposes, with nearly 92 percent of this allocation being for surface water. Only two licences have been issued for groundwater (87.6 dam^3). Water use for cooling commenced in the 1950s but grew rapidly in the 1970s and 1980s. Figure 9-17 shows that there has actually been a slight decline in licensed allocations for surface water since 1990, but allocations of groundwater have remained constant during that period.

Figure 9-17 Historical Trends in Water Allocations for Cooling

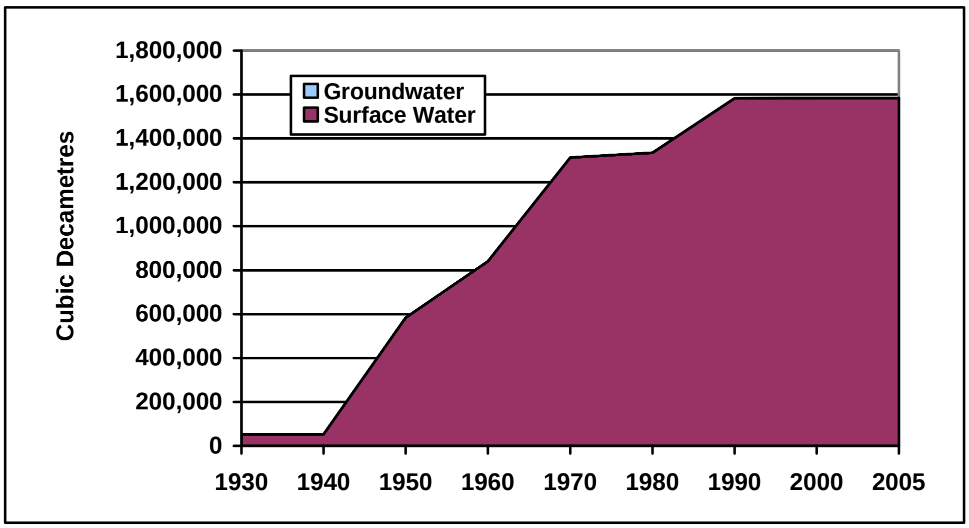


Table 9-26 Licensed Allocations and Estimated Actual Water Use for the Industrial Sector, North Saskatchewan Basin

Water Use	Source	Number of licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Cooling	Surface	22	1,583,539.9	155,552.1	1,427,987.8	64,944.8	41.8%	4.1%
	Groundwater	2	87.6	7.4	80.2	7.4	100.1%	8.5%
	Subtotal	**24**	**1,583,627.4**	**155,559.4**	**1,428,068.0**	**64,952.2**	**41.8%**	**4.1%**
Forestry	Surface	0	0.0	0.0	0.0	0.0	0.0%	0.0%
	Groundwater	5	85.7	85.7	0.0	85.7	100.0%	100.0%
	Subtotal	**5**	**85.7**	**85.7**	**0.0**	**85.7**	**100.0%**	**100.0%**
Chemical Plants	Surface	6	39,347.9	30,093.5	9,254.4	12,802.9	42.5%	32.5%
	Groundwater	1	5.5	5.5	0.0	5.5	100.0%	100.0%
	Subtotal	**7**	**39,353.4**	**30,099.0**	**9,254.4**	**12,808.4**	**42.6%**	**32.5%**
Fertilizer Plants	Surface	5	19,455.2	16,558.1	2,897.1	11,654.2	70.4%	59.9%
	Groundwater	5	172.4	172.4	0.0	172.5	100.1%	100.1%
	Subtotal	**10**	**19,627.6**	**16,730.5**	**2,897.1**	**11,826.7**	**70.7%**	**60.3%**
Manufacturing	Surface	4	12,186.8	1,351.9	10,834.9	1,351.9	100.0%	11.1%
	Groundwater	7	304.0	304.0	0.0	304.0	100.0%	100.0%
	Subtotal	**11**	**12,490.8**	**1,655.9**	**10,834.9**	**1,655.9**	**100.0%**	**13.3%**
Mine-other	Surface	4	5,277.7	3,351.3	1,926.3	1,917.1	57.2%	36.3%
	Groundwater	2	6.2	6.2	0.0	6.2	100.0%	100.0%
	Subtotal	**6**	**5,283.8**	**3,357.5**	**1,926.3**	**1,923.3**	**57.3%**	**36.4%**
Mine-coal	Surface	1	12.3	12.3	0.0	12.3	100.0%	100.0%
	Groundwater	2	30.8	30.8	0.0	30.8	100.0%	100.0%
	Subtotal	**3**	**43.2**	**43.2**	**0.0**	**43.1**	**100.0%**	**100.0%**
Hydro	Surface	2	0.0	0.0	0.0	0.0	100.0%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**2**	**0.0**	**0.0**	**0.0**	**0.0**	**100.0%**	**100.0%**

Table 9-25 Licensed Allocations and Estimated Actual Water Use for the Industrial Sector for the North Saskatchewan Basin (continued).

Water Use	Source	Number of licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Other Industrial	Surface	1	60.5	60.5	0.0	60.5	100.0%	100.0%
	Groundwater	4	2.1	2.1	0.0	2.1	100.0%	100.0%
	Subtotal	**5**	**62.6**	**62.6**	**0.0**	**62.6**	**100.0%**	**100.0%**
Total	Surface	45	1,659,880.3	206,979.7	1,452,900.5	92,743.7	44.8%	5.6%
	Groundwater	28	694.3	614.1	80.2	614.2	100.0%	88.5%
	Total	**73**	**1,660,574.5**	**207,593.8**	**1,452,980.7**	**93,357.9**	**45.0%**	**5.6%**

* Estimates of water use are based on WURS data and information provided to AMEC by licence holders.
** Estimates of water use are based on WURS data.
*** Actual water use is assumed to be 100 percent of licensed consumption.

9.5.1.2 Licensed Water Use

As shown in Table 9-25, the licences issued for cooling purposes assume that about 10 percent of surface water allocations and eight percent of groundwater allocations will be used. Return flow allowances in licences amounted to 1,427,988 dam^3 for surface water and 80 dam^3 for groundwater.

9.5.1.3 Actual Water Use

The actual water use data available for cooling is a combination of the WURS database and data provided to AMEC by licence holders. There is water use information for 16 of the 22 surface water licences issued for cooling plants in the North Saskatchewan basin. Analysis of the data indicates that plants with surface water allocations were using an average of 4.1 percent of their allocations and 42 percent of the water that they are entitled to consume. Plants with groundwater allocations are assumed to consume 100 percent of the amounts specified in their licences. The water use estimates in Table 9-25 were calculated assuming that these percentages apply to all plants in the North Saskatchewan basin. Based on this assumption, the total water use by cooling plants in 2005 is estimated to be 64,952 dam^3, consisting of 64,945 dam^3 of surface water and 7.4 dam^3 of groundwater. Cooling plants in the North Saskatchewan have a reported using a slightly smaller percentage of their allocation and licensed consumption than the province average for cooling plants.

9.5.1.4 Forecasts of Future Water Use

For the forecast period, there are three upgrades are proposed for existing plants (Clover Bar, Sundance, and Keephills) and one plant is scheduled to retire (Wabamun). The forecast of future water use for cooling in the North Saskatchewan Basin in Table 9-26 assumes water use will decline. Forecasts assume that groundwater consumption will remain the same. The Low Growth scenario includes the retiring of Wabamun, and the plants at Clover Bar, Sundance, and Keephills are fully functional. The Medium Growth scenario includes the plants at Clover Bar, Sundance, and Keephills remain fully functional and Wabamun does not retire. The High Growth scenario is based on the assumption that the plants increase their consumption to the full capacity of their licences.

Table 9-27 Forecast of Cooling Water Use in the North Saskatchewan River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	64,945	64,945	38,843	38,843	38,841
	Groundwater	7	7	7	7	7
	Total	**64,952**	**64,952**	**38,850**	**38,850**	**38,848**
Medium Growth	Surface	64,945	64,945	64,237	64,237	64,235
	Groundwater	7	7	7	7	7
	Total	**64,952**	**64,952**	**64,244**	**64,244**	**64,243**
High Growth	Surface	64,945	64,945	155,559	155,559	155,559
	Groundwater	7	7	7	7	7
	Total	**64,952**	**64,952**	**155,567**	**155,567**	**155,567**

Under the low growth scenario, water use for cooling in 2025 will decline by almost 60 percent from current levels. Under the high growth scenario, water use could increase by 240 percent.

9.5.2 Forestry

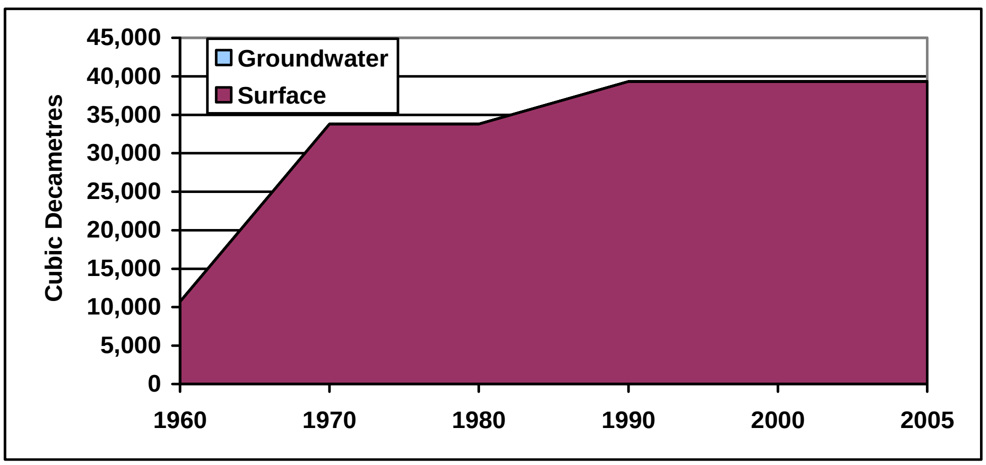
Five licences have been issued for forestry use. They allow withdrawals of up to 86 dam^3 of groundwater. Forestry water allocations commenced in the 1990s and increased only slightly in 2005. Licensees are expected to consume 100 percent of the groundwater they are entitled to withdraw. There is no information on actual water diversions and consumption for the forestry sector and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by forestry activities in the North Saskatchewan Basin will remain constant for the forecast period.

9.5.3 Chemical Plants

9.5.3.1 <u>Water Allocations</u>

Just over two percent of the allocations for the industrial sector in the North Saskatchewan River Basin are for chemical plants (39,353 dam^3). This includes one groundwater licence for 5.5 dam^3 and a smaller number of surface water allocations (six) with an allocation of 39,348 dam^3. As shown in Figure 9-18, allocations of surface water for chemical plants commenced in the 1960s, increased significantly between the 1970s and 1990s, and has remained constant since then.

Figure 9-18 Historical Trends in Water Allocations for Chemical Plants



9.5.3.2 <u>Licensed Water Use</u>

As shown in Table 9-25, the groundwater licence issued to chemical plants assume that no return flow will be (100 percent consumption). It is expected that 77 percent of diversions of surface water will be consumed. Return flow allowances in licences amounted to 9,254 dam^3.

9.5.3.3 Actual Water Use

The WURS database has water use information for five of the seven water licences issued for chemical plants in the North Saskatchewan River basin. These licences account for just over 99 percent of licensed allocations and licensed use. Analysis of the WURS database indicates that plants with surface water allocations were using an average of 33 percent of their allocations and five percent of the water that they are entitled to consume. Plants with groundwater allocations are assumed to use 100 percent of the amounts specified in their licences. The water use estimates in Table 9-25 were calculated assuming that these percentages apply to all chemical plants in the North Saskatchewan River basin. Based on this assumption, the total water use by chemical plants in 2005 is estimated to be 12,808 dam^3, consisting of 12,802 dam^3 of surface water and 6 dam^3 of groundwater.

9.5.3.4 Forecasts of Future Water Use

In the absence of information about this component of the industrial sector, it is assumed that water used by chemical plant activities in the North Saskatchewan Basin will remain constant for the forecast period.

9.5.4 Fertilizer Plants

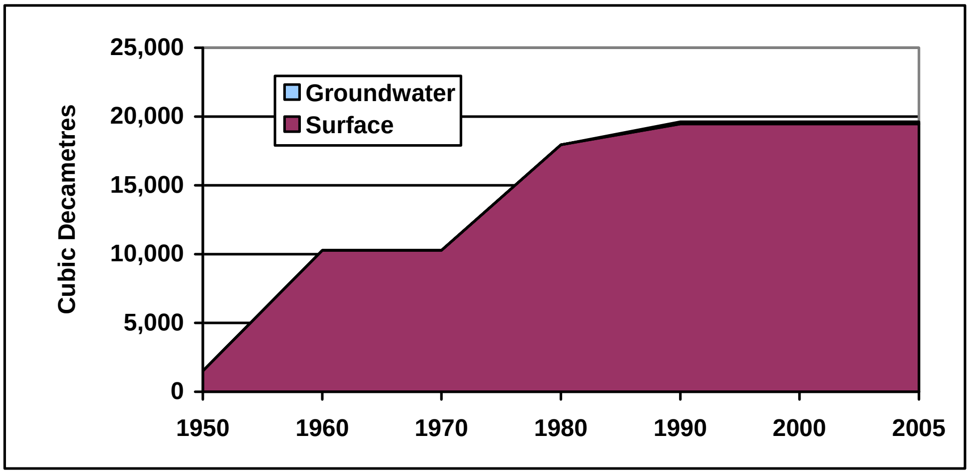
9.5.4.1 Water Allocations

Just over one percent of the allocations for the industrial sector in the North Saskatchewan River Basin are for fertilizer plants (19,628 dam^3). This includes five groundwater licences for a total of 172 dam^3 and five surface water licences for a total of 19,455 dam^3. As shown in Figure 9-19, allocations of surface water for fertilizer plants commenced in the 1950s, increased significantly between the 1970s and 1990s, and has remained constant since then.

9.5.4.2 Licensed Water Use

As shown in Table 9-25, the groundwater licence issued to fertilizer plants assumes that there will be no return flow. It is expected that 85 percent of diversions of surface water will be consumed. Return flow allowances in surface water licences amounted to 2,897 dam^3.

Figure 9-19 Historical Trends in Water Allocations for Fertilizer Plants



9.5.4.3 Actual Water Use

The WURS database has water use information for nine of the 10 water licences issued for fertilizer plants in the North Saskatchewan River basin. These licences account for all but 1 dam^3 of ground water. Analysis of the WURS database indicates that plants with surface water allocations were using an average of 60 percent of their allocations and 70 percent of the water that they are entitled to consume. It is estimated that plants with groundwater allocations are using 100 percent of the amounts specified in their licences. The water use estimates in Table 9-25 assume that the one water licence for one dam^3 uses 100 percent of the licensed use. The total water used by fertilizer plants in 2005 is estimated to be 11,827 dam^3, consisting of 11,654 dam^3 of surface water and 173 dam^3 of groundwater.

9.5.4.4 Forecasts of Future Water Use

In the absence of information about this component of the industrial sector, it is assumed that water used by fertilizer plant activities in the North Saskatchewan Basin will remain constant for the forecast period.

9.5.5 Manufacturing

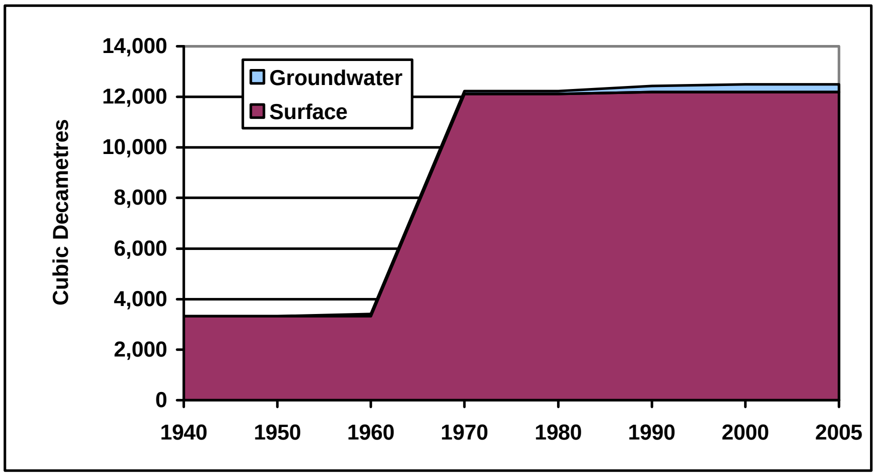
9.5.5.1 Water Allocations

Less than one percent of the allocations for the industrial sector in the North Saskatchewan River Basin are for manufacturing (12,491 dam^3). This includes seven groundwater licences for a total of 304 dam^3 and four surface water licences for a total of 12,187 dam^3. As shown in Figure 9-20, allocations of surface water for manufacturing activities commenced in the 1940s, increased significantly between the 1960s and 1970s, and has remained constant since then. Since the 1990s, there has been a slight increase in the amount of groundwater allocated to manufacturing activities.

9.5.5.2 Licensed Water Use

As shown in Table 9-25, the groundwater licences issued to manufacturing assume that there will be no return flow (100 percent consumption). It is assumed that 11 percent of diversions of surface water will be consumed. Return flow allowances in licences amounted to 10,835 dam^3.

Figure 9-20 Historical Trends in Water Allocations for Manufacturing



9.5.5.3 Actual Water Use

There is no information on actual water diversions and consumption for manufacturing uses and, for purposes of this analysis, it is assumed that licensees are using their full entitlement.

9.5.5.4 Forecasts of Future Water Use

In the absence of information about this component of the industrial sector, it is assumed that water used by manufacturing activities in the North Saskatchewan Basin will remain constant for the forecast period.

9.5.6 Mining Other Than Coal

9.5.6.1 Water Allocations

Less than 0.5 percent of the allocations for the industrial sector in the North Saskatchewan River Basin are for mining products other than coal (5,284 dam^3). This includes two groundwater licences for a total of six dam^3 and four surface water licences for a total of 5,278 dam^3. Allocations of surface water for mining other than coal activities commenced in the 1960s and steadily increased since then especially since the 1990s. Groundwater allocations have remained the same since the 1950s.

9.5.6.2 Licensed Water Use

As shown in Table 9-25, the groundwater licences issued to mining other than coal assume that there will be no return flow (100 percent consumption). It is expected that 64 percent of diversions of surface water will be consumed. Return flow allowances in licences amounted to 1,926 dam^3.

9.5.6.3 Actual Water Use

The WURS database has water use information for three of the four surface water licences issued for mining other than coal in the North Saskatchewan River basin. No data was available for groundwater use in 2005. The surface water licences where WURS data was available account for 96 percent of licensed use. Analysis of the WURS database indicates that facilities with surface water allocations were using an average of 55 percent of the water that they are entitled to consume. Facilities with groundwater allocations were assumed to use 100 percent of their licensed consumption. The water use estimates in Table 9-25 were calculated assuming that these percentages apply to all mining other than coal facilities in the North Saskatchewan River basin. Based on this assumption, the total water use by mining other than coal facilities in 2005 is estimated to be 1,923 dam^3, consisting of 1,917 dam^3 of surface water and 6 dam^3 of groundwater.

9.5.6.4 Forecasts of Future Water Use

In the absence of information about this component of the industrial sector, it is assumed that water used by mining other than coal activities in the North Saskatchewan Basin will remain constant for the forecast period.

9.5.7 Coal Mining

Three licences have been issued for coal mining purposes. They allow withdrawals of up to 12 dam^3 of surface water and 31 dam^3 of groundwater. Coal mining water allocations commenced in the 1950s for groundwater and in the 1960s for surface water. Total allocation has remained the same since. Licensees are expected to consume 100 percent of the water they are allocated. There is no information on actual water diversions and consumption for the coal mining sector and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by coal mining activities in the North Saskatchewan Basin will remain constant for the forecast period.

9.5.8 Hydroelectricity

Two licences have been issued for hydroelectricity (hydro) use. They allow withdrawals of up to 0.02 dam^3 of surface water and no groundwater. Water allocations for hydroelectric power commenced in the 1950s, increased slightly in the 1960s, and have remained the same since. Licensees are expected to consume 100 percent of the surface water they are allocated. There

is no information on actual water diversions and consumption for the hydro sector and, for purposes of this analysis, it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by hydro activities in the North Saskatchewan Basin will remain constant for the forecast period.

9.5.9 Other Industrial

Two licences have been issued for other industrial purposes. They allow withdrawals of up to 61 dam^3 of surface water and two dam^3 of groundwater. Other industrial groundwater allocations commenced in the 1980s and have increased slightly overtime. Surface water allocations commenced in the 1990s and remained the same since. Licensees are expected to consume 100 percent of the surface water they are allocated. There is no information on actual water diversions and consumption for the other industrial activities and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by other industrial activities in the North Saskatchewan Basin will remain constant for the forecast period.

9.5.10 Summary

The industrial sector in the North Saskatchewan River Basin is dominated by water allocated for cooling plants. These plants account for 95 percent of allocations but five percent of actual water use in 2005. Water use data shows that although water licences allow up to 207,609 dam^3 of water to be consumed for industrial purposes, licensees are only using 14 percent of this amount.

In the future, there is expected to be light growth in water requirements for cooling plants as existing plants are upgraded and Wabamun retires. The forecasts in Table 9-27 assume that future water use by all industrial activities except for cooling will remain the same over the forecast period.

Table 9-28 Forecast of Industrial Water Use in the North Saskatchewan River Basin (dam^3)

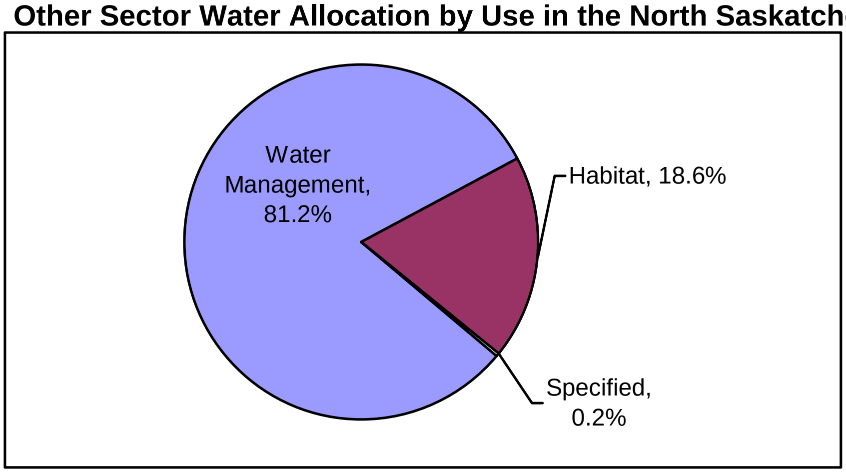
Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	92,744	92,744	66,642	66,642	66,640
	Groundwater	614.20	614.20	614.20	614.20	614.20
	Total	**93,358**	**93,358**	**67,256**	**67,256**	**67,254**
Medium Growth	Surface	92,744	92,744	92,036	92,036	92,034
	Groundwater	614.20	614.20	614.20	614.20	614.20
	Total	**93,358**	**93,358**	**92,650**	**92,650**	**92,649**
High Growth	Surface	92,744	92,744	183,358	183,358	183,358
	Groundwater	614.20	614.20	614.20	614.20	614.20
	Total	**93,358**	**93,358**	**183,973**	**183,973**	**183,973**

Table 9-27 shows that, for all three scenarios, the overall demand for water in the North Saskatchewan Basin is expected to increase over the forecast period due to the increase in water required for generating power.

9.6 OTHER SECTOR

In the North Saskatchewan Basin there are 212 active licences which allocate 36,009 dam^3 of water to the other sector, 27.6 percent of which is required to be returned. The other sector activities account for about two percent of licensed water use in the North Saskatchewan. Almost all of the water allocated is for surface water (33,9148 dam^3) accounting for 91 percent of the other licences. Other sector uses include water management for flood control and lake stabilization, fish, wildlife and habitat enhancement, and specified use by a director with AENV (Figure 9-21). It should be noted that Alberta Environment and Ducks Unlimited both hold licences issued for other purposes and that these licences could be either for water management or habitat enhancement. Thus, any differences between these two activities could simply reflect inconsistencies in licensing practices rather than a real difference in the way water is being used. Figure 9-21 illustrates the water use by other sector activities in the North Saskatchewan Basin. Table 9-28 summarizes the water allocation, use, and return associated with the licences for each activity in the North Saskatchewan Basin.

Figure 9-21 Other Sector Water Allocation by Use in the North Saskatchewan Basin



9.6.1 Water Management

9.6.1.1 Water Allocations

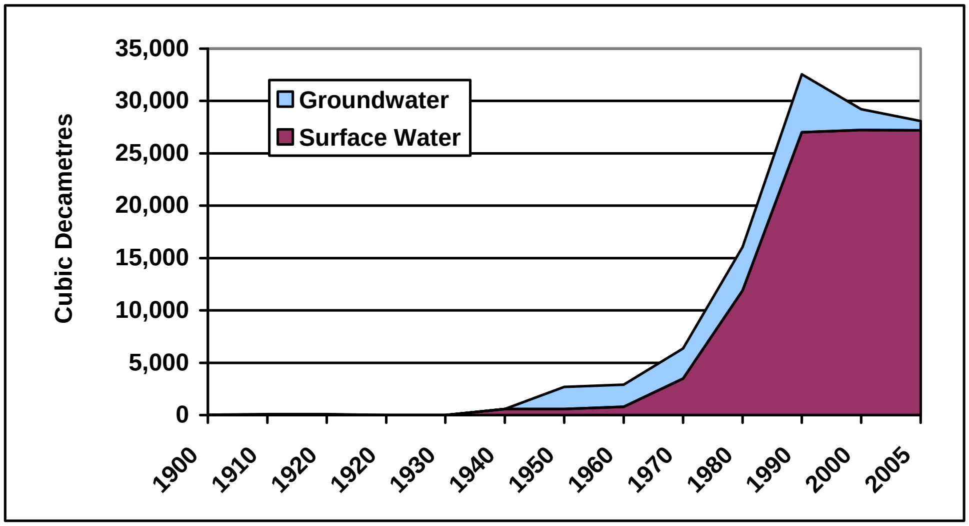
About 81 percent of the allocations are for water management purposes such flood control and lake stabilization (29,230 dam^3). Details of the licences issued to the other sector in the North Saskatchewan River Basin are provided in Table 9-28. The table shows that 89 licences have been issued for water management purposes, with about 91 percent of these for surface water. Eight licences have been issued for groundwater with allocations of 1,995 dam^3. Groundwater use for water management commenced in the 1900s but grew rapidly from the 1990s.

Table 9-29 Licensed Allocations and Estimated Actual Water Use for the Other Sector, North Saskatchewan Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Water Management	Surface	81	27,235.5	19,371.5	7,864.0	19,371.5	100%	71.1%
	Groundwater	8	1,994.6	127.2	1,867.4	127.2	100%	6.4%
	Subtotal	**89**	**29,230.1**	**19,498.7**	**9,731.4**	**19,498.7**	**100%**	**66.7%**
Habitat	Surface	109	6,626.9	6,476.4	150.5	6,476.4	100%	97.7%
	Groundwater	10	65.1	21.3	43.7	21.3	100%	32.8%
	Subtotal	**119**	**6,692.0**	**6,497.8**	**194.2**	**6,497.8**	**100%**	**97.1%**
Specified	Surface	3	51.3	51.3	0.0	51.3	100%	100.0%
	Groundwater	1	35.2	35.2	0.0	35.2	100%	100.0%
	Subtotal	**4**	**86.5**	**86.5**	**0.0**	**86.5**	**100%**	**100.0%**
Total	Surface	193	33,913.8	25,899.3	8,014.4	25,899.3	100%	76.4%
	Groundwater	19	2,094.8	183.7	1,911.1	183.7	100%	8.8%
	Total	**212**	**36,008.6**	**26,083.0**	**9,925.6**	**26,083.0**	**100%**	**72.4%**

Since the 1990s groundwater allocations have decreased (Figure 9-22). Surface water allocations commenced in the 1940 and grew especially between the 1970s and the early 2000s. In 2005 the amount of surface water allocated to water management decreased slightly.

Figure 9-22 Historical Trends in Water Allocations for Water Management



9.6.1.2 Licensed Water Use

As shown in Table 9-28, the licences issued for water management purposes assume that about 71 percent of surface water allocations and six percent of groundwater allocations will be used. Return flow allowances in licences amounted to 7,864 dam^3 for surface water and 1,867 dam^3 for groundwater.

9.6.1.3 Actual Water Use

There is no information on actual water diversions and consumption for water management activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement.

9.6.1.4 Forecasts of Future Water Use

Forecasts of future water use by the other sector are based on consultation with large licence holders. Neither Ducks Unlimited nor Alberta Environment have formal forecasts of their future water needs. The number of projects that Ducks Unlimited implements depend on a number of factors such as their budget, the state of the economy, and environment objectives. It is anticipated that there will be an increased emphasis on restoring drained wetlands to pre-drainage or natural conditions. These types of projects will not require new water licences. In terms of new water licences, Ducks Unlimited foresees a yearly increase of about three new water licences for water management of about 300 dam^3 per year each. Forecasts assume the ratio of Ducks Unlimited water management and habitat enhancement projects will remain the same over the forecast period. Water use by Alberta Environment is not expected to change in

the period forecasted (Jim Lewis, AENV, personal communication Feb 2007). Forecasts assume that new projects are for surface water use, this is appropriate given the current distribution of surface to groundwater licences.

For a sensitivity analysis, forecasts in Table 9-29 present a Low Scenario of two percent increase in water demand every five years and a Medium Scenario of five percent increase in water demand every five years. The High Scenario assumes that the three new Ducks Unlimited projects are constructed by 2010 and that water use increases by 1.3 percent every five years thereafter.

Table 9-30 Forecast of Water Use by Water Management Projects in the North Saskatchewan
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	19,372	19,761	20,159	20,565	20,979
	Groundwater	127	127	127	127	127
	Total	**19,499**	**19,889**	**20,286**	**20,692**	**21,106**
Medium Growth	Surface	19,372	20,346	21,370	22,445	23,574
	Groundwater	127	127	127	127	127
	Total	**19,499**	**20,474**	**21,497**	**22,572**	**23,701**
High Growth	Surface	19,372	28,372	28,761	29,159	29,565
	Groundwater	127	127	127	127	127
	Total	**19,499**	**28,499**	**28,889**	**29,286**	**29,692**

Under the Low growth scenario, water use for water management projects in 2025 will increase by 8.2 percent from current levels. Under the High Growth scenario, water use could increase by 22 percent.

9.6.2 Habitat

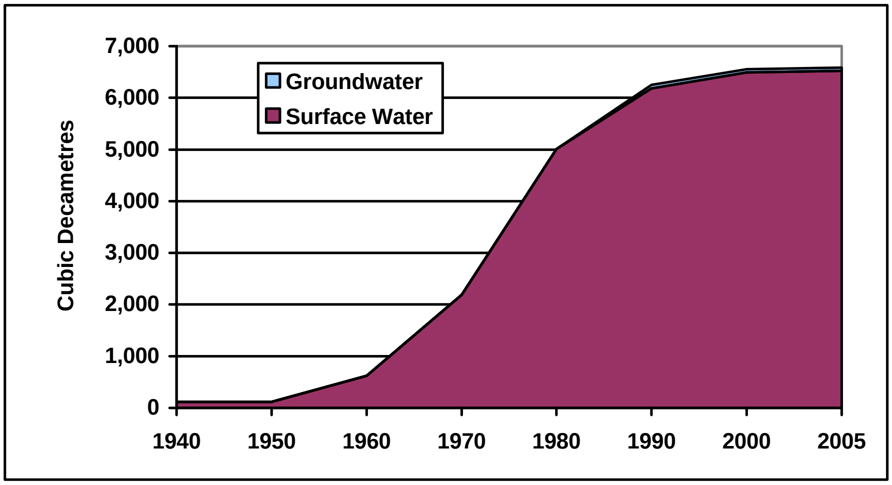
9.6.2.1 <u>Water Allocations</u>

About 19 percent of the allocations are for fish, wildlife and habitat enhancement (6,692 dam^3). Details of the licences issued to the other sector in the North Saskatchewan Basin are provided in Table 9-28. The table shows that 119 licences have been issued for habitat projects, with nearly 92 percent of these for surface water. Ten licences have been issued for groundwater with allocations of 65 dam^3. Surface water use for habitat commenced in the 1940s, and grew over the years especially since the 1970s. Figure 9-23 shows that a small amount of groundwater has been allocated, commencing in the 1980s and growing slightly over time.

9.6.2.2 <u>Licensed Water Use</u>

As shown in Table 9-28, the licences issued for habitat enhancement purposes assume that about 98 percent of surface water allocations and 33 percent of groundwater allocations will be used. Return flow allowances in licences amounted to 1501 dam^3 for surface water and 44 dam^3 for groundwater.

Figure 9-23 Historical Trends in Water Allocations for Habitat Enhancement



9.6.2.3 Actual Water Use

There is no information on actual water diversions and consumption for habitat enhancement activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement.

9.6.2.4 Forecasts of Future Water Use

As licences issued for water management and for habitat enhancement appear to be synonymous, the forecast methodology described in Section 9.6.1.4 has also been used to forecast future water use for enhancement projects. These forecasts (Table 9-30) include a Low Growth scenario of two percent increase in water demand every five years while the High Growth scenario assumes a five percent increase in water demand every five years. The Medium Growth scenario assumes 3.5 percent growth every five years.

Under the Low Growth scenario, water use for water management projects in 2025 will increase by just over eight percent from current levels. Water use would increase by 15 percent above current levels for the Medium Growth scenario and by 22 percent under the High Growth scenario.

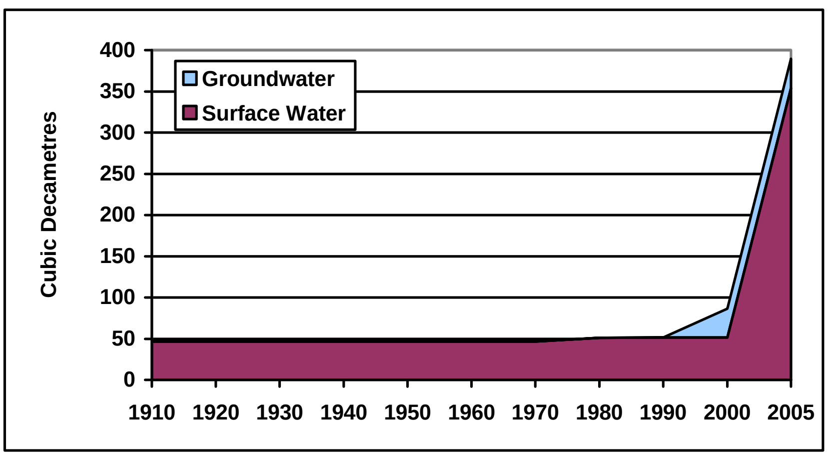
Table 9-31 Forecast of Water Use by Habitat Enhancement Projects in the North Saskatchewan River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	6,476	6,606	6,739	6,874	7,012
	Groundwater	21	21	21	21	21
	Total	**6,498**	**6,628**	**6,760**	**6,896**	**7,033**
Medium Growth	Surface	6,476	6,703	6,937	7,180	7,431
	Groundwater	21	21	21	21	21
	Total	**6,498**	**6,724**	**6,958**	**7,201**	**7,452**
High Growth	Surface	6,476	6,801	7,142	7,501	7,877
	Groundwater	21	21	21	21	21
	Total	**6,498**	**6,823**	**7,164**	**7,522**	**7,898**

9.6.3 Specified Activities

Four water licences have been issued for specified use by a director with AENV, representing total allocations of 87 dam^3. Details of the licences issued to the other sector in the North Saskatchewan are provided in Table 9-28. The table shows that three surface water licences have been issued for specified activities (51 dam^3) and one groundwater licence (35 dam^3). The first surface water allocations for specified activities were issued in the 1910s, with a major increase occurring since 2000 (Figure 9-24). Licensees allowing groundwater for use for specified activities were only issued after 1990.

Figure 9-24 Historical Trends in Water Allocations for Specified Activities



As shown in Table 9-28, the licences issued for specified purposes assume that 100 percent of water allocations will be used. There is no information on actual water diversions and consumption for specified activities and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the other sector, it is assumed that water used by activities specified by the director in the North Saskatchewan will remain constant for the forecast period.

9.6.4 Summary

The other sector in the North Saskatchewan is dominated by water allocated for water management. These projects account for 81 percent of the water allocation and 75 percent of the licensed water use.

In the future, there is expected to be an increase in the amount of water used for other sector activities. The overall water use projections for the other sector are provided in Table 9-31 and are based on the projections in sections 9.6.1.4, 9.6.2.4, and 9.6.3. Forecasts assume that new projects are for surface water use, this is appropriate given the current distribution of surface to groundwater licences.

Table 9-32 Forecast of Water Use for the Other Sector in the North Saskatchewan Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	25,899	26,418	26,949	27,490	28,042
	Groundwater	183	183	183	183	183
	Total	**26,084**	**26,604**	**27,133**	**27,675**	**28,226**
Medium Growth	Surface	25,899	27,100	28,359	29,676	31,057
	Groundwater	183	183	183	183	183
	Total	**26,084**	**27,284**	**28,542**	**29,860**	**31,240**
High Growth	Surface	25,899	35,224	35,954	36,711	37,493
	Groundwater	183	183	183	183	183
	Total	**26,084**	**35,409**	**36,140**	**36,895**	**37,677**

Table 9-31 shows that, for all three scenarios, the overall demand for water in the North Saskatchewan Basin is expected to increase over the forecast period. This increase could be as low as eight percent for the Low Growth scenario or as high as 44 percent for the High Growth scenario.

9.7 SUMMARY

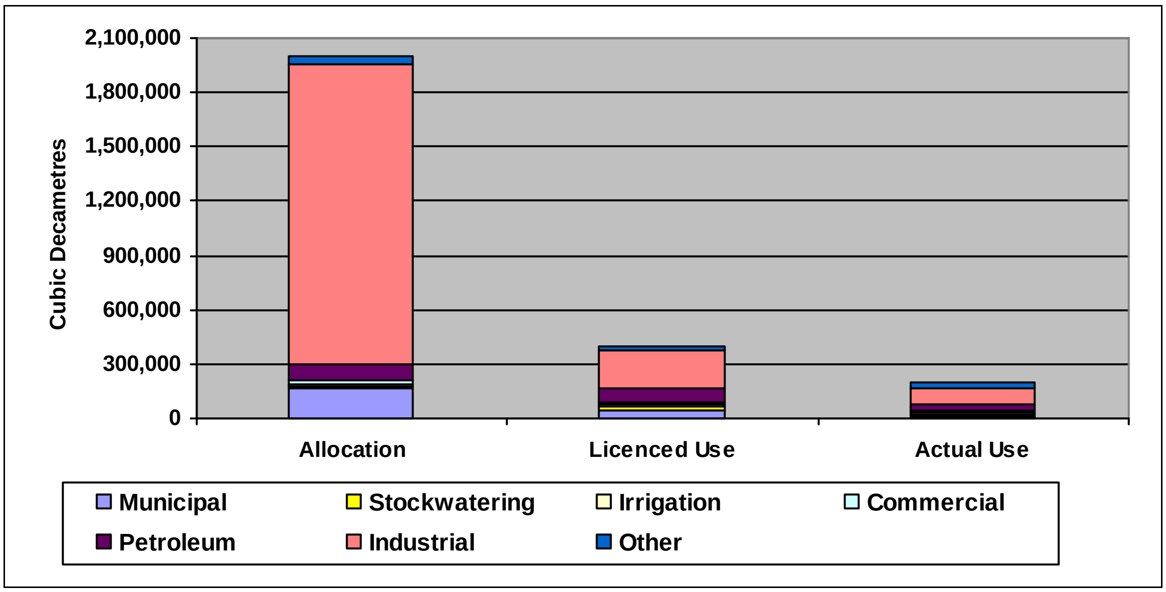
Table 9-32 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the North Saskatchewan River basin. In total, existing licences and registrations allow a maximum of 1,996,840 dam^3 of water to be withdrawn for use. Of this, up to 400,696 dam^3 (20 percent) is expected to be used and 1,596,141 dam^3 (80 percent) will be returned to surface water. While water allocations for the industrial sector, particularly for cooling, are by far the largest in the North Saskatchewan River Basin (83 percent of total allocations), the very large return flow allowances for this sector mean that, in terms of licensed use (consumption and losses), licensed water use by the industrial sectors accounts for only 52 percent of licensed use in the entire basin.

Table 9-33 Summary of Allocations and Estimated Water Use, North Saskatchewan River Basin

Sector		Licensed Allocation and Use (dam^3)				Estimated Water Use (dam^3)		
		Allocation	Water Use	Return	Percent of Total Use	Use	Percent of Licensed Use	Percent of Total Use
Municipal		164,401	46,102	118,298	12%	10,234	22%	5%
Agricultural	Stockwatering	16,680	16,680	0	4%	14,974	90%	8%
	Irrigation	9,712	9,575	137	2%	9,575	100%	5%
Commercial		15,835	12,563	3,270	3%	12,563	100%	6%
Petroleum		93,345	82,084	11,260	20%	30,838	38%	16%
Industrial		1,660,858	207,609	1,453,250	52%	92,017	44%	47%
Other		36,009	26,083	9,926	7%	26,083	100%	13%
Total		**1,996,840**	**400,696**	**1,596,141**	**100%**	**196,285**	**49%**	**100%**

With respect to actual use, the exact volumes withdrawn and used in 2005 are not precisely known because not all major water users filed few water use reports with Alberta Environment. However, based on the information and assumptions used in the previous sections, it is estimated that 196,285 dam^3 were actually used in 2005. This represents 39 percent of water use allowed in existing licences and registrations. As noted previously, the percentage may not be entirely correct because there is no return flow information related to diversions by the City of Edmonton. As shown in Table 9-33, estimated actual consumption is estimated to be 22 percent of licensed consumption for the entire municipal sector and the municipal sector accounts for only five percent of all water use in the basin. Based on estimated use, the industrial sector accounted for 47 percent of total water use in the North Saskatchewan River Basin in 2005. Figure 9-25 shows how actual use compares to licensed allocations and use for each of the water use sectors.

Figure 9-25 Water Allocations and Actual Use, by Sector, North Saskatchewan River Basin



Forecasts of future water use in the North Saskatchewan River Basin are provided in Tables 9-33 to 9-35 for the low, medium and high growth scenarios. Predicted water use under the Medium growth scenario is shown in Figure 9-26. This figure shows that most of the growth in water use will occur in the petroleum sector as a result of proposed development of a number of up graders. The petroleum sector is expected to account for 31 percent of total water use by 2025, up from 16 percent in 2005. Under the Medium Growth scenario, water demand in 2025 will be about 33.8 percent higher than at present. For the other scenarios, the increase in water demand over 20 years will range from 15 percent for Low Growth scenario and 118 percent for the High Growth scenario. For all scenarios, actual water use will be less than the amount that can be consumed under the terms of existing licences.

Figure 9-26 Forecast Water Use in the North Saskatchewan River Basin: Medium Scenario

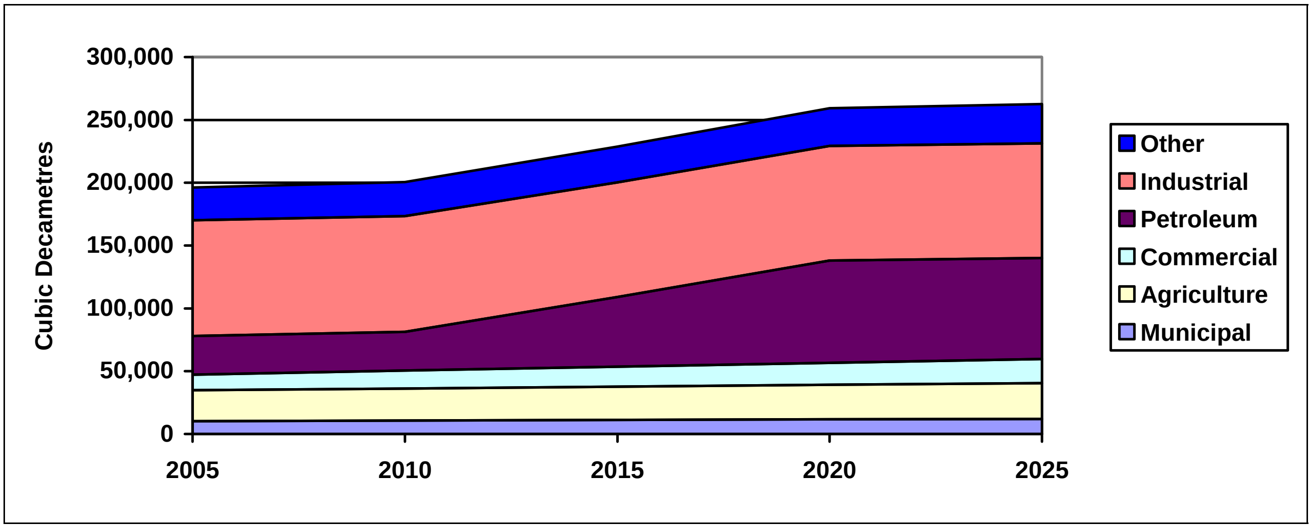


Table 9-34 Forecast Water Use, By Sector, North Saskatchewan River Basin: Low Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	8,680	8,953	9,117	9,220	9,251
	Agricultural	16,503	16,678	16,858	17,042	17,231
	Commercial	11,069	11,574	11,958	12,279	12,525
	Petroleum	29,159	29,159	28,070	80,070	79,449
	Industrial	91,404	91,404	65,302	65,302	65,300
	Other	25,899	26,418	26,949	27,490	28,042
	Total	182,714	184,186	158,254	211,403	211,798
Groundwater	Municipal	1,554	1,603	1,632	1,651	1,656
	Agricultural	8,046	8,249	8,457	8,670	8,888
	Commercial	1,481	1,547	1,597	1,639	1,670
	Petroleum	1,679	1,679	1,186	1,186	905
	Industrial	614	614	614	614	614
	Other	183	183	183	183	183
	Total	13,557	13,875	13,669	13,943	13,916
Total	Municipal	10,234	10,556	10,749	10,871	10,907
	Agricultural	24,549	24,927	25,315	25,712	26,119
	Commercial	12,550	13,121	13,555	13,918	14,195
	Petroleum	30,838	30,838	29,256	81,256	80,354
	Industrial	92,018	92,018	65,916	65,916	65,914
	Other	26,082	26,602	27,133	27,674	28,226
	Total	196,271	198,062	171,924	225,347	225,715

Table 9-35 Forecast Water Use, By Sector, North Saskatchewan River Basin: Medium Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	8,680	9,107	9,496	9,837	10,112
	Agricultural	16,503	16,930	17,383	17,864	18,375
	Commercial	11,069	12,639	14,179	15,671	17,076
	Petroleum	29,159	29,159	54,151	80,151	79,498
	Industrial	91,404	91,404	90,696	90,696	90,694
	Other	25,899	27,100	28,359	29,676	31,057
	Total	182,714	186,339	214,264	243,895	246,812
Groundwater	Municipal	1,554	1,630	1,700	1,761	1,810
	Agricultural	8,046	8,540	9,063	9,619	10,209
	Commercial	1,481	1,664	1,839	2,004	2,153
	Petroleum	1,679	1,679	1,223	1,223	926
	Industrial	614	614	614	614	614
	Other	183	183	183	183	183
	Total	13,557	14,310	14,622	15,404	15,895
Total	Municipal	10,234	10,737	11,196	11,598	11,922
	Agricultural	24,549	25,470	26,446	27,483	28,584
	Commercial	12,550	14,303	16,018	17,675	19,229
	Petroleum	30,838	30,838	55,374	81,374	80,424
	Industrial	92,018	92,018	91,310	91,310	91,308
	Other	26,082	27,283	28,542	29,860	31,240
	Total	196,271	200,649	228,886	259,300	262,707

Table 9-36 Forecast Water Use, By Sector, North Saskatchewan River Basin: High Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	8,680	9,390	10,122	10,825	11,475
	Agricultural	16,503	17,301	18,192	19,184	20,291
	Commercial	11,069	14,492	18,139	21,849	25,565
	Petroleum	29,159	29,159	80,371	80,371	79,629
	Industrial	91,404	91,404	182,018	182,018	182,018
	Other	25,899	35,224	35,954	36,711	37,493
	Total	182,714	196,970	344,796	350,958	356,471
Groundwater	Municipal	1,554	1,681	1,812	1,938	2,054
	Agricultural	8,046	8,969	9,998	11,145	12,424
	Commercial	1,481	1,896	2,333	2,768	3,193
	Petroleum	1,679	1,679	53,322	53,322	52,986
	Industrial	614	614	614	614	614
	Other	183	183	183	183	183
	Total	13,557	15,022	68,262	69,970	71,454
Total	Municipal	10,234	11,071	11,934	12,763	13,529
	Agricultural	24,549	26,270	28,190	30,329	32,715
	Commercial	12,550	16,388	20,472	24,617	28,758
	Petroleum	30,838	30,838	133,693	133,693	132,615
	Industrial	92,018	92,018	182,632	182,632	182,632
	Other	26,082	35,408	36,138	36,895	37,677
	Total	196,271	211,993	413,059	420,929	427,926

Beaver River Basin

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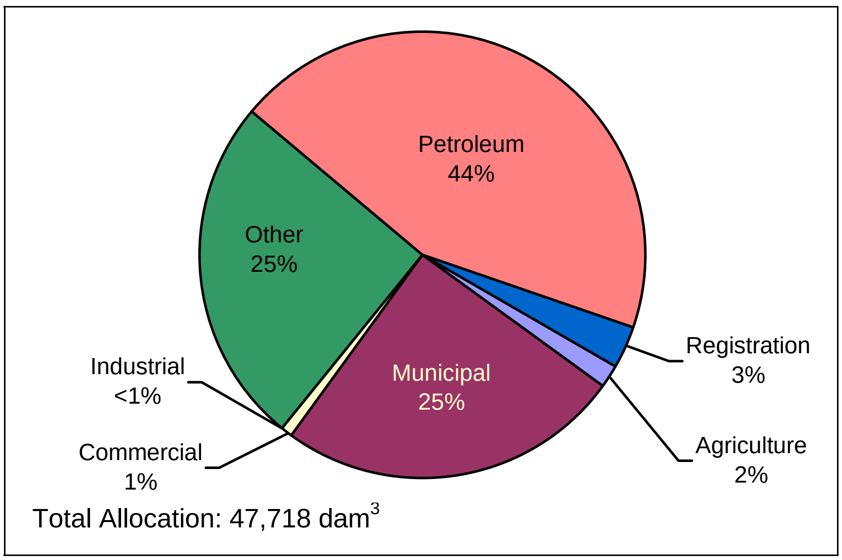
10.0 BEAVER RIVER BASIN

The Beaver River Basin is about 16,000 km^2 in area and occupies three percent of Alberta. The mean annual natural river discharge of the Beaver River is 613,000 dam^3 at the Saskatchewan border. It is the only basin in Alberta that is part of the Churchill River system. In 2001, the basin had a population of 38,300 people, or 1.3 percent of the provincial population. The basin had a population density of 2.4 people per square kilometre. The Beaver River Basin consists of all or parts of eight rural or regional municipalities, and includes seven urban centres and four First Nations. There are also four Métis settlements in the Beaver River Basin.

An overview of current surface and groundwater allocations is provided in Figure 10-1. It shows that in 2005 the sector petroleum accounts for 44 percent of total allocations or 21,112 dam^3. Allocations for the other and municipal sectors each account for about 25 percent; licences for the other sector to withdraw up to 12,114 dam^3 and the municipal sector to withdraw up to 11,708 dam^3. Total allocations in the basin in 2005 were 47,718 dam^3

Figure 10-1 Distribution of Active Water Allocations in the Beaver Basin



Figures 10-2 and 10-3 show the location, allocation and sector of all active surface and groundwater licences in Beaver River Basin, respectively. The location of all registrations issued for the Beaver River Basin is shown in Figure 10-4.

10.1 MUNICIPAL AND RESIDENTIAL SECTOR

10.1.1 Population

In 2001, the Beaver River Basin had a population of about 38,300 people. Nearly half the population is urban (47 percent), with most of the remainder residing in rural or regional municipalities (37 percent). The basin also had a large Aboriginal population, with over 6,000 people living on the three reserves. Table 10-2 shows that the population has been growing very slowly compared to the rest of Alberta. Between 1996 and 2001, the population only increased by 3.1 percent (0.6 percent per year). The population growth rates were quite similar for the urban, rural and First Nation populations, with the highest growth in the rural areas.

Table 10-1 Population Distribution and Growth in Beaver River Basin, 2001

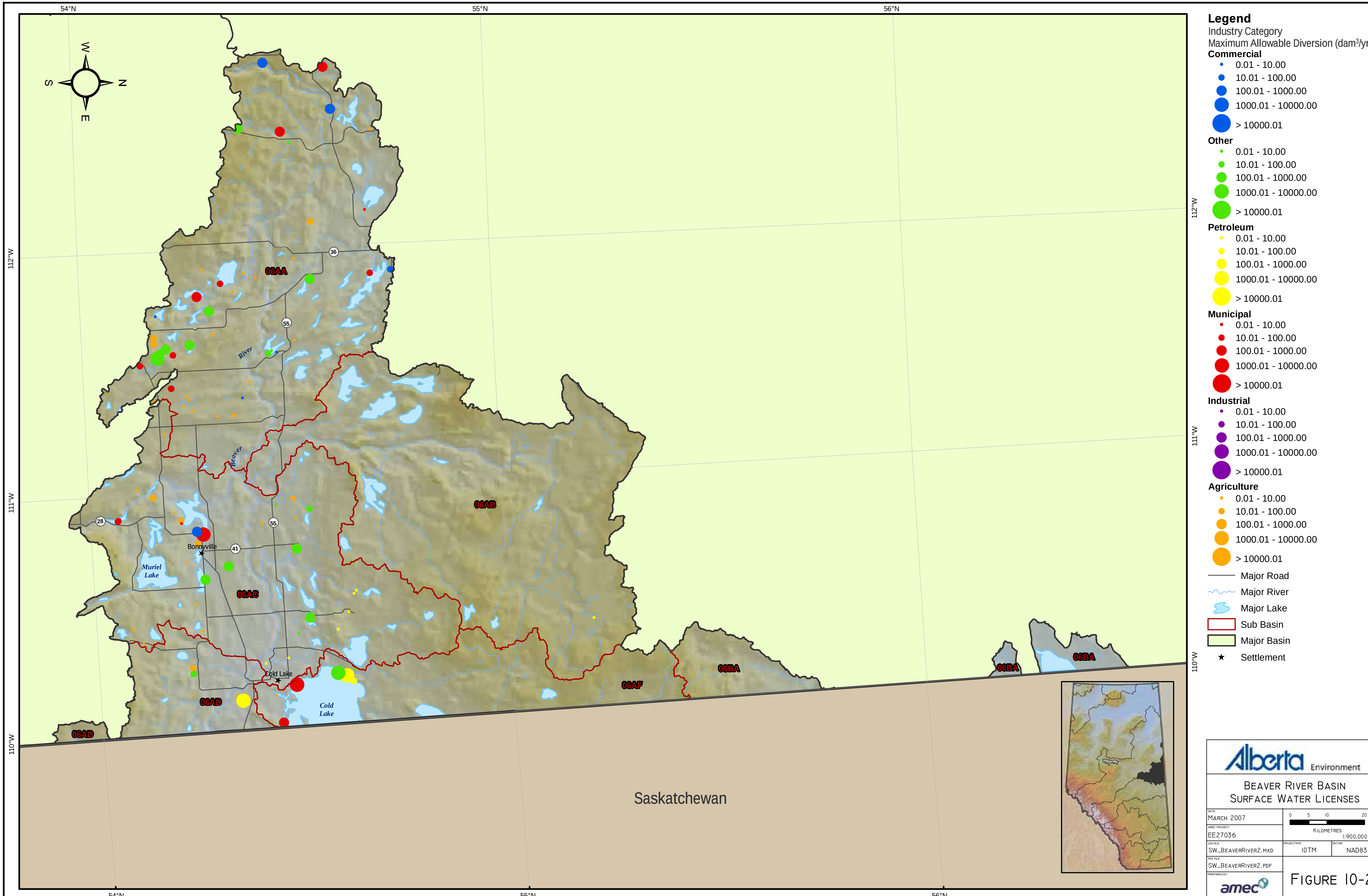
	2001		1996	1996 to 2001 Population Change
	Population	Percent	Population	Percent
Urban Municipality	18,079	47.2%	17,641	2.5%
Rural or Regional Municipality	14,152	37.0%	13,615	3.9%
First Nations and Métis Settlements	6,067	15.8%	5,895	2.9%
Total	**38,297**	**100%**	**37,151**	**3.1%**

Table 10-3 lists all municipalities in the Beaver River Basin, their estimated 2001 populations, and the water allocations for those municipalities with licences of 100 dam^3 or more. The major population centres include the City of Cold Lake (11,520 residents) and the Town of Bonnyville (5,709). The largest rural or regional municipality is the Municipal District of Bonnyville No. 87 (9,277), followed by Lakeland County (2,159) and the County of St. Paul No. 19 (1,646). The most populous Aboriginal communities are Saddle Lake First Nation (1,473) and Cold Lake First Nations (1,142).

10.1.2 Allocations

As of 2005, 35 municipal water licences had been issued to 21 licensees. These licences allow maximum diversions of up to 11,708 dam^3. Municipal water allocations account for 25 percent of licensed water allocations in Beaver River Basin. Licences issued to urban municipalities account for 97 percent of allocations. Rural communities (cooperatives, farmsteads, single-multi homes and colonies) only account for two percent of municipal allocations. Other municipal users (mostly camps) account for one percent of the total.

Municipal licences allow withdrawals of up to 11,325 dam^3 of surface water; this accounts for 97 percent of total municipal water allocations. Urban users have 16 surface water licences with allocations for 11,176 dam^3. Rural users have three licences that allow withdrawals of up to 149 dam^3.



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Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Petroleum
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Municipal
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Industrial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Agriculture
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
Alberta Environment
Beaver River Basin
Surface Water Licenses
March 2007
EE27036
SW_BeaverRiver2.mxd
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Kilometres
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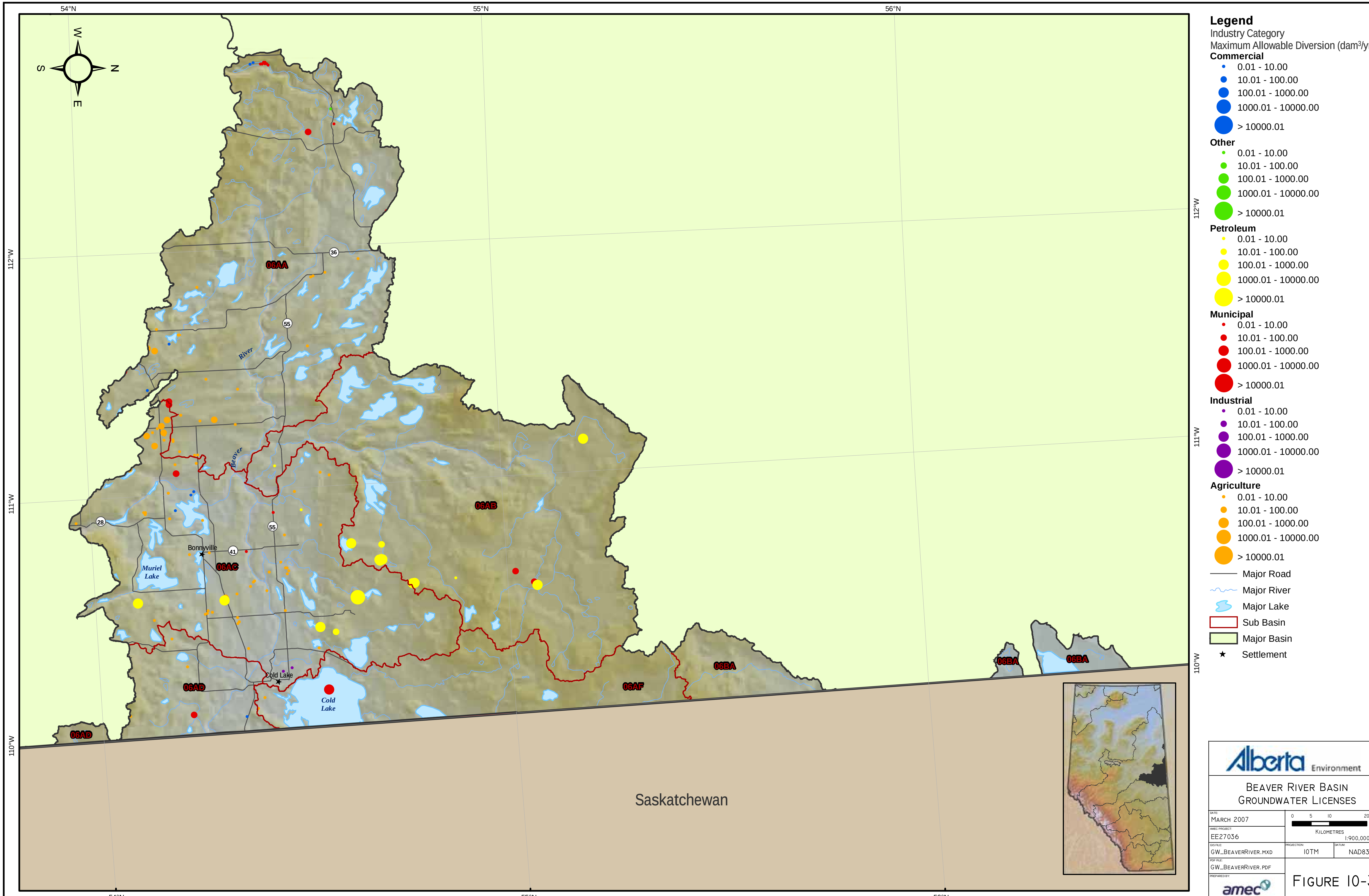
Figure 10-2



54°N
55°N
56°N
112°W
111°W
110°W
N
S
E
W
06AA
06AB
06AC
06AD
06AF
06BA
06EA
River
Beaver
Bonnyville
Muriel Lake
Cold Lake
36
55
28
41
Saskatchewan
Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Petroleum
0.01 - 10.00
10.01 - 100.00
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Municipal
0.01 - 10.00
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Industrial
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Agriculture
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Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
Alberta Environment
Beaver River Basin Groundwater Licenses
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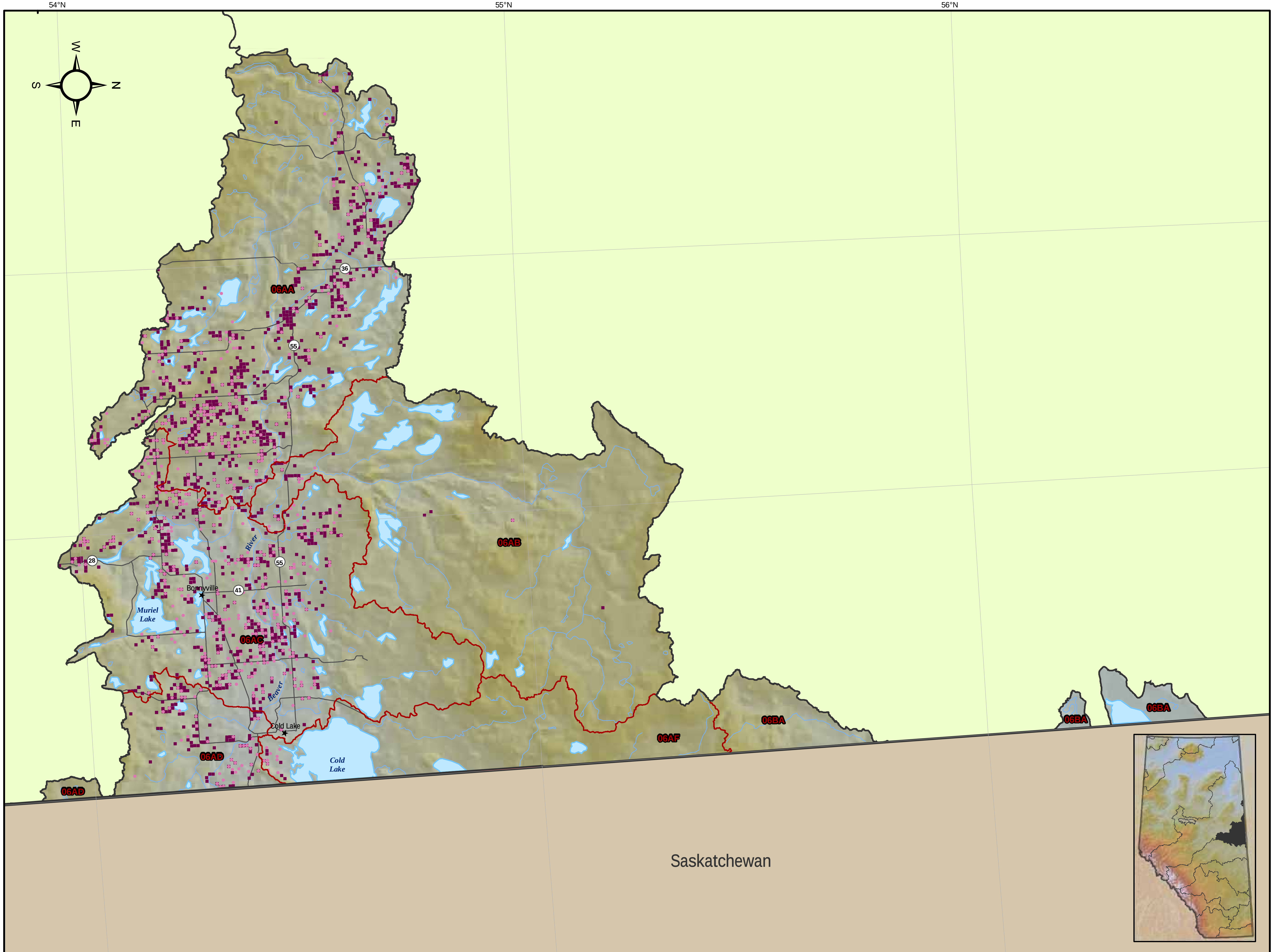
Figure 10-3



Legend

Agriculture

Maximum Allowable Diversion (dam³/yr)

Groundwater Registrations

0.01 - 6.25

Surface Water Registrations

0.01 - 6.25

Major Road

Major River

Major Lake

Sub Basin

Major Basin

Settlement

Alberta Environment

BEAVER RIVER BASIN REGISTRATIONS

DATE: MARCH 2007	0 5 10 20 KILOMETERS 1:900,000	
AMEC PROJECT: EE27036		
GIS FILE: RG_BEAVERRIVER.MXD	PROJECTION: 10TM	DATUM: NAD83
PDF FILE: RG_BEAVERRIVER.PDF		
PREPARED BY: amec	FIGURE 10-4	

Table 10-2 2001 Municipal Populations within Beaver River Basin

Municipal Name		2001 Population Within Basin	Source	Allocation (dam^3)
Urban Municipalities	City Of Cold Lake	11,520	Surface	7,401
	Town Of Bonnyville	5,709	Surface	3,182
	Village Of Glendon	459	Groundwater	146
	Summer Village Of Bondiss	104		
	Summer Village Of Mewatha Beach	101		
	Summer Village Of Bonnyville Beach	74		
	Summer Village Of Pelican Narrows	112		
	Subtotal	**18,079**		**10,729**
Rural and Regional Municipalities	Municipal District Of Bonnyville No. 87	9,277	Surface	115
	Lakeland County	2,159		
	County Of St. Paul No. 19	1,646		
	County Of Athabasca No. 12	424		
	Smoky Lake County	285		
	Regional Municipality Of Wood Buffalo	254		
	County Of Thorhild No. 7	106		
	County Of Vermilion River	0		
	Subtotal	**14,151**		**115**
First Nations	Saddle Lake First Nation	1,473		
	Cold Lake First Nations	1,142		
	Kikino Metis Settlement	922		
	Kehewin Cree Nation	872	Surface	141
	Buffalo Lake Metis Settlement	722	Surface	105
	Elizabeth Metis Settlement	596		
	Beaver Lake First Nation	302		
	Fishing Lake Metis Settlement	38		
	Subtotal	**5,727**		**246**
Total		**38,297**		**11,090**

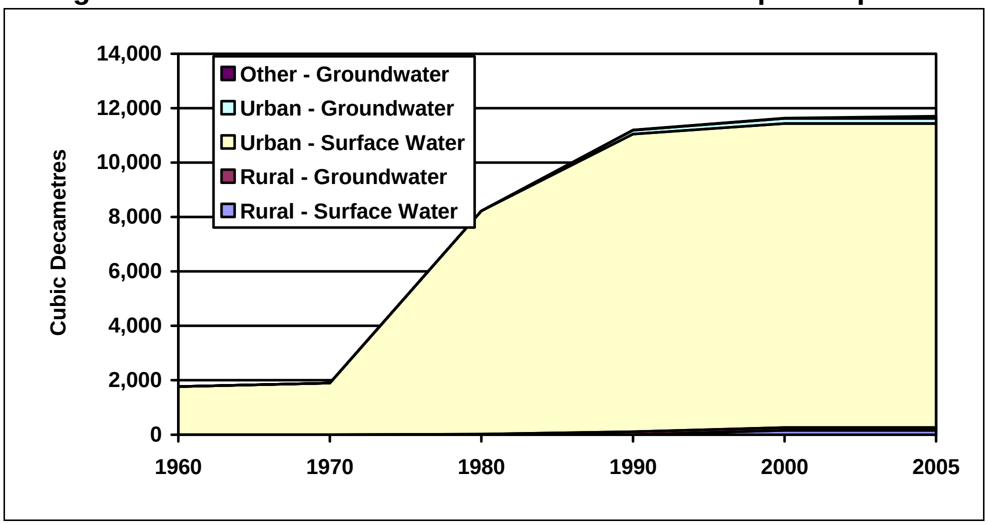
Municipal licensees are allowed to withdraw a maximum of 383 dam^3 of groundwater licences, accounting for three percent of total municipal water allocations. Urban users have four licences that allow withdrawals of 185 dam^3 while rural users have two licences allowing withdrawals of 84 dam^3. Five groundwater licences with allocations of 77 dam^3 have been issued to camps.

Table 10-2 identifies the water allocations for those urban and rural municipalities in the basin that have allocations of 100 dam^3. Large surface water licences have also been issued to the Village Of Boyle (185 dam^3), which is situated in the Athabasca River Basin, and the Whitefish Lake Band #459 (148 dam^3), which is part of the Saddle Lake First Nation. Together, these

large licences account for 98 percent of the total municipal allocations.

Figure 10-5 shows how allocations for municipal water use in the Beaver River Basin have changed since 1960. Municipal uses accounting for less than 0.1 percent of total allocations are not shown. Prior to 1970, all municipal allocations were for surface water; groundwater allocations commenced in the 1980s and have grown slowly since then. Surface water allocations grew rapidly in the 1970's and 1980's but has grown very little since 1990.

Figure 10-5 Historical Water Allocations for Municipal Purposes



10.1.3 Licensed Water Use

Table 10-3 summarizes licensed water use for the municipal sector in the Beaver River Basin. These licences assume that about 2,281 dam^3 will be used. This means that 19 percent of withdrawals will be consumed and/or lost and the remainder (91 percent or 9,427 dam^3) is to be returned. Return flow allowances range from 80 percent for urban surface and groundwater allocations to 66 percent of rural surface water withdrawals and 26 percent of rural groundwater withdrawals. Only four percent of other groundwater is expected to be returned.

10.1.4 Actual Water Use

In 2005, only two licence holders reported their surface water diversions to the provincial government through the WURS. These licences had allocations of 7,478 dam^3, which represents 64 percent of municipal allocations in the basin, and reported actual diversions of 2,395 dam^3. Actual diversions amounted to 32 percent of maximum diversions.

Table 10-3 Licensed and WURS Reported Diversions, Water Use and Returns by Type of Municipal Use for Beaver Basin

Water Use	Source	No. of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Diversion	Water Use	Return
Urban*	Surface	16	11,176	2,027	9,149	2,362	N/A	N/A
	Groundwater	4	185	37	148	N/A	N/A	N/A
	Subtotal	**20**	**11,361**	**2,064**	**9,297**	**2,362**	**N/A**	**N/A**
Rural**	Surface	3	149	51	99	N/A	N/A	N/A
	Groundwater	4	112	83	29	N/A	N/A	N/A
	Subtotal	**7**	**261**	**134**	**127**	**N/A**	**N/A**	**N/A**
Other***	Surface	0	0	0	0	N/A	N/A	N/A
	Groundwater	8	86	83	3	34	34	0
	Subtotal	**8**	**86**	**83**	**3**	**34**	**34**	**0**
Total	Surface	19	11,325	2,077	9,247	2,362	N/A	N/A
	Groundwater	16	383	204	180	34	34	0
	Total	**35**	**11,708**	**2,281**	**9,427**	**2,395**	**34**	**0**

* Urban includes villages, summer villages, towns, cities, hamlets;

** Rural includes condominiums / townhouses / mobile homes / complexes, hotels / motels, cooperatives, farmsteads, single-multi homes, colonies and subdivisions

*** Other includes camps, institutions, senior/correctional centres, nursing/children's homes, hospitals

In terms of groundwater use, only one licensee reported actual water use. This licensee accounted for 87 percent of allocations for other municipal uses and actual use was reported to be 44 percent of allocations and 43 percent of licensed use. None of the municipal licensees reported return flows, so it is not possible to estimate actual municipal water use for the Beaver River Basin using WURS data.

Environment Canada's Municipal Water Use database has water use information for two municipalities representing 45 percent of Beaver Basin's 2001 population. While there is diversion information for both Cold Lake and Bonnyville, neither reported return flow. This means that Environment Canada's information also cannot be used to determine actual municipal water for the Beaver River Basin.

Estimates of actual water use were calculated assuming that municipalities withdrew and used 32 percent of their surface water allocations; this percentage reflects reported withdrawals in 2005. Groundwater users were assumed to be diverting 44 percent and using 43 percent of their allocations; these percentages reflect reported use in 2005 by a single licensee. The resulting estimates of water use are provided in Table 10-4. Overall, municipalities in the Beaver River Basin are estimated to be withdrawing and using 33 percent of their entitlements.

Table 10-4 Estimated Municipal Water Use in the Beaver River Basin

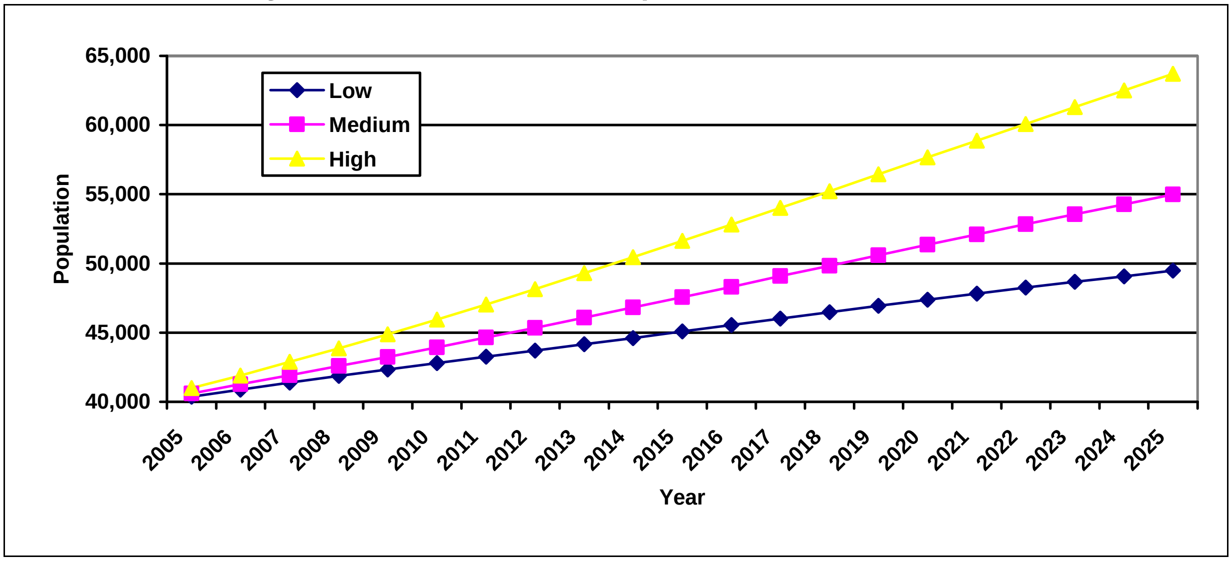
Municipal Use	Source	Withdrawals (dam^3)	Use (dam^3)	Return Flow (dam^3)
Urban	Surface	3,567	647	2,920
	Groundwater	82	16	65
	Subtotal	**3,648**	**663**	**2,985**
Rural	Surface	48	16	31
	Groundwater	49	37	13
	Subtotal	**97**	**53**	**44**
Other	Surface	0	0	0
	Groundwater	38	34	0
	Subtotal	**38**	**34**	**0**
Total	Surface	3,614	663	2,951
	Groundwater	169	87	78
	Total	**3,783**	**750**	**3,029**
Licensed Use	Surface	11,325	2,077	9,247
	Groundwater	383	204	180
	Total	**11,708**	**2,281**	**9,427**
Percent of Licensed Use	Surface	31.9%	31.9%	31.9%
	Groundwater	44.2%	42.6%	43.4%
	Total	**32.3%**	**32.9%**	**32.1%**

10.1.5 Future Water Use Forecasts

Figure 10-6 shows the low, medium and high population projection scenarios for the Beaver River Basin based on Alberta Finance Census Division projections. The population forecasts in Figure 10-6 have been used to predict future municipal surface and groundwater use. The

resulting forecasts of water use are provided in Table 10-5, and assume that per capita water use in 2005 continues for the forecast period.

Figure 10-6 Beaver Basin Population Growth Forecast



Under the Low Growth scenario, municipal water use in 2025 is expected to be 23 percent greater than at present and actual diversions and use will be well the maximums established in existing licences. Under the High Growth scenario, water use in 2025 will increase by 55 percent over current levels and total diversions and use of both surface and groundwater will still not exceed the maximum withdrawals and use stated in the licences.

Table 10-5 Projected Water Use for the Municipal Sector in the Beaver Basin
(dam^3)

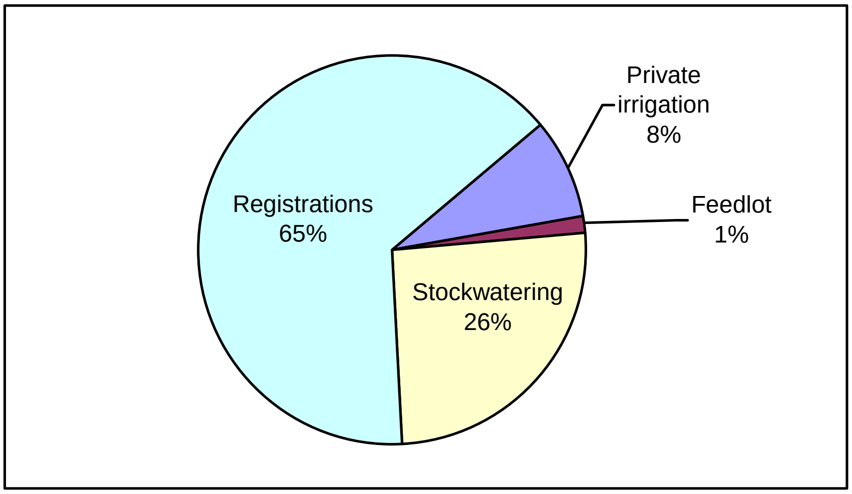
Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	663	703	740	778	813
	Groundwater	87	92	97	102	107
	Total	**750**	**795**	**838**	**881**	**919**
Medium Growth	Surface	663	717	777	839	898
	Groundwater	87	94	102	110	118
	Total	**750**	**812**	**879**	**949**	**1,016**
High Growth	Surface	663	743	835	933	1,031
	Groundwater	87	98	110	122	135
	Total	**750**	**841**	**945**	**1,055**	**1,166**

10.2 AGRICULTURAL SECTOR

As of December 2005, a total of 2,198 dam^3 had been allocated to the agricultural sector in the Beaver Rive Basin. This includes 2,425 registrations with allocations of 1,424 dam^3 and 141 licences that allow diversions of up to 774 dam^3 of water. Water allocated to the agricultural sector accounts for seven percent of all allocations in the Beaver River Basin.

Figure 10-7 shows how water allocations are distributed among the different agricultural uses in the Beaver River Basin. It shows that registrations account for 65 percent of agricultural water allocations. Stockwatering accounts for 26 percent; private irrigation accounts for about eight percent; and feedlots account for about one percent of the total allocation.

Figure 10-7 Water Allocations for Agricultural Activities in the Beaver Basin



A total of 1,688 registrations and 46 licences have been issued for agricultural purposes and allow withdrawals of up to 971 dam^3 of surface water. Surface water accounts for 44 percent of all allocations for the agricultural sector. Ninety five licences and 878 registrations have been issued for groundwater and allow withdraws of up to 1,228 dam^3 which represents 56 percent of total agricultural allocations.

10.2.1 Overview of Agriculture in the Beaver River Basin

Based on estimates derived from the 2001 Census of Agriculture, there were about 1,608 farms in the Beaver River Basin. These farms account for about three percent of all farms in Alberta. Farms in the Beaver River Basin averaged 898 acres in size, and were slightly smaller than the provincial average (970 acres). Farms in the Beaver River Basin cover an area of nearly 1.4 million acres and this is equivalent to about 5,800 km^2 or about 33 percent of the basin. Table 10-6 shows that about 36 percent of agricultural land is used for raising crops. About 52 percent of agricultural land is pasture and about three percent is summer fallowed.

Table 10-6 Agricultural Land Use in the Beaver River Basin, 2001

Land Use	Acres	Percent
Crop Land	526,057	36.4%
Summerfallow	36,638	2.5%
Tame/Seeded Pasture	215,450	14.9%
Natural Pasture	532,395	36.9%
Other	133,098	9.2%
Total	**1,443,638**	**100.0%**

Table 10-7 shows the classification of farms based on the commodity groups that accounted for 51 percent or more of total gross farm receipts. About 57 percent of the farms raise beef cattle in the Beaver River Basin; this percentage is about 10 percent higher than the provincial average. There are also proportionately more field crop farms and speciality farms in the Basin than in Alberta. However, the basin has proportionately fewer wheat and grain and oilseed farms.

Table 10-7 Classifications of Farms in the Beaver Basin and Alberta, 2001

Farm Type (Farms with Gross Receipts >$2,500)	Percent of Farms in the Beaver Basin	Percent Share of Alberta	Percent Alberta Farm Type
Dairy Farms	0.4%	2.9%	1.5%
Cattle (beef) Farms	56.8%	0.7%	45.4%
Hog Farms	0.7%	3.7%	1.7%
Poultry & Egg Farms	0.3%	1.2%	0.9%
Wheat Farms	1.1%	1.2%	7.4%
Grain & Oilseed Farms	10.8%	0.4%	18.4%
Field Crop Farms	13.4%	1.7%	9.3%
Fruit Farms	0.1%	4.2%	0.1%
Miscellaneous Speciality Farms	12.4%	1.8%	10.9%
Sum of Livestock Comb. Farms	1.9%	3.3%	2.3%
Sum of Vegetable Farms	0.1%	2.4%	0.1%
Sum of Other Comb Farms	2.1%	2.1%	2.0%
Total	**100.0%**	**3.0%**	**100.0%**

10.2.2 Stockwatering

As noted in Table 10-7 about 58 percent of the farms in the Beaver Basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species in 2001 are provided in Table 10-8. The table shows that there about 200,000 cattle and calves, which together, accounted for about 90 percent of livestock population in the basin. This is about 5.2 times the human population of the Basin. Other livestock in the Beaver Basin included pigs, sheep and lamb, horses and ponies, bison, deer and elk.

Table 10-8 Estimated Livestock Populations in the Beaver Basin and Alberta, 2001

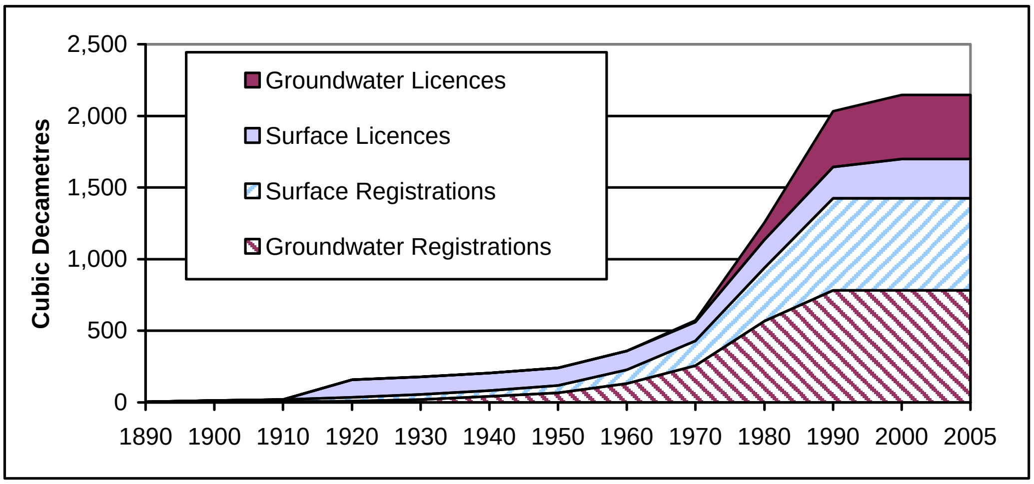
Livestock Species	Total Basin	Alberta	Percent of Alberta
Hens and Chicken	56,621	12,175,246	0.5%
Turkey	773	864,438	0.1%
Cattle	159,904	6,615,201	2.4%
Calves	61,178	2,169,607	2.8%
Pigs	12,198	2,027,533	0.6%
Sheep and Lamb	5,376	307,302	1.7%
Horse and Ponies	5,367	159,962	3.4%
Bison	4,509	79,731	5.7%
Deer	1,019	8,331	12.2%
Elk	1,197	31,304	3.8%

10.2.2.1 Water Allocation

Overall, 2,560 licences and registrations have been issued for livestock watering, with total allocation amounting to 2,016 dam^3. Registrations account for 66 percent of this allocation. In addition to these allocations, farmers are able to obtain up to 1,250 m^3 of water for household purposes. The numbers of such households in the basin is not known. Furthermore, the numbers of "exempted agricultural" users are also not known in the Beaver Basin.

A historical perspective on water allocations for livestock is provided in Figure 10-8. The figure shows that some registrations were issued with priority dates in the 1890s while licences for stockwatering were first issued around 1910.

Figure 10-8 Historical Trends in Water Allocation for Livestock in the Beaver Basin



Allocations for stockwatering have risen steadily since the 1900s, with substantial increases occurring since 1960s. Allocations from groundwater began to increase in the 1970s and currently account for about 60 percent of the livestock allocation. While there is a general trend toward more intensive livestock operations in Alberta, feedlot licences account for about 1.2 percent of total livestock allocation in the Beaver Basin.

Table 10-9 summarizes the water licences and registrations issued for livestock according to the water source. The table shows that groundwater allocations account for 60 percent of allowable diversions and registrations represent 68 percent of allocations for livestock in the Basin.

10.2.2.2 Licensed Water Use

Table 10-9 shows that there are no returns flow allowances in either registrations or licences issued for livestock watering. It is expected that, all water diverted for livestock watering can be consumed or lost.

Table 10-9 Summary of Water Licences and Registrations Issued for Livestock Watering in the Beaver Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensee Reporting	Reported Use
Feedlot	Surface	0	0.0	0.0	0.0	0	N/A
	Ground	2	31.0	31.0	0.0	0	N/A
	Subtotal	**2**	**31.0**	**31.0**	**0.0**	**0**	**N/A**
Stockwatering	Surface	40	146.2	146.2	0.0	0	N/A
	Ground	93	414.4	414.4	0.0	0	N/A
	Subtotal	**133**	**560.6**	**560.6**	**0.0**	**0**	**N/A**
Registration	Surface	1,642	642.0	642.0	0.0	0	N/A
	Ground	783	782.2	782.2	0.0	0	N/A
	Subtotal	**2,425**	**1,424.2**	**1,424.2**	**0.0**	**0**	**N/A**
Total	Surface	1,682	788.1	788.1	0.0	0	N/A
	Ground	878	1,227.7	1,227.7	0.0	0	N/A
	Total	**2,560**	**2,015.8**	**2,015.8**	**0.0**	**0**	**N/A**

10.2.2.3 Actual Water Use

There is no information in Alberta Environment's WURS that indicates the extent to which water allocations are actually used in the Beaver Basin. However, a reasonable estimate of water use can be derived using the actual animal population in the basin as shown in Table 10-8. Based on livestock populations for the Beaver Basin in 2001, the total water required for livestock was estimated to be 1,830 dam^3, or about 90 per cent of the licensed allocation. The calculations for this estimate are provided also in Table 10-10 which shows livestock populations in the basin and the daily water requirements for various livestock species as provided by Alberta Environment in its "Guide to Calculate Quantities for Water for Raising Animals". In terms of water requirements by species, cattle account for about 90 per cent of the total, about two percent is required by pigs, and all other species accounted for the remaining eight percent.

While the estimated actual consumption based on livestock populations (1,830 dam^3**)** appears to be less than the amount of water allocated (2,016 dam^3), the data in Table 10-10 do not include an allowance for the evaporative and seepage losses associated with storing water for livestock use. Typically, licensed consumption accounts for only 35 per cent of surface water allocated for livestock use while losses account for 65 percent (Watrecon 2005). Since 60 percent of livestock water consumption comes from groundwater (no losses) and the balance comes from surface water with 65 percent losses, a total allocation of about 2,214 dam^3 would be required to support the animal populations in Table 10-8. This water requirement is about 200 dam^3 more than the water allocation in the Beaver Basin. Consequently, it is assumed that actual water use is more than the amount of water allocated for livestock.

Table 10-10 Estimated Livestock Water Requirements for 2001

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chicken	56,621	0.045	4.23
Turkey	773	0.15	0.19
Bulls	3,366	9	50.24
Milk cows	437	30	21.74
Beef cows	64,523	9	963.01
Heifers	21,722	6	216.14
Steers	8,677	6	86.33
Calves	61,178	3	304.36
Boars	114	6.5	1.22
Sows & Gilts - Breeding	1,722	6.5	18.56
Nursing and Weaner Pigs	4,745	0.5	3.93
Grower & Finishing Pigs	5,618	1.5	13.97
Sheep & Lamb	5,376	2	17.83
Horses & Ponies	5,367	10	89.00
Bison	4,509	2	14.96
Deer	1,019	10	16.90
Elk	1,197	3.5	6.95
Total			**1,829.56**

10.2.2.4 Forecasts of Future Stockwatering Water Use

The key factor affecting future livestock water demand is changes in cattle populations in the basin. As noted above, cattle account for about 90 percent of livestock water demands in the Beaver River Basin, so changes in the populations of other livestock species will have a minimal overall impact on future water demand. Although the historical trend analysis in Figure 10-8 shows that the amount of water allocated for livestock has remained relatively unchanged since the 1990s, suggesting a stable livestock population over time, data from the Census of Agriculture shows that the cattle population in the Beaver Basin increased by about four percent between 1996 and 2001. It is expected that cattle populations and associated water use will continue to increase over time.

Some indication of the potential for expansion of cattle populations in the Beaver River Basin can be determined by examining applications for new and expanded confined feeding operations, which must be approved by the NRCB in accordance with *AOPA*. Information from the NRCB indicates that, as of December 31, 2005, there had been no applications from farmers throughout the basin for major new or expanded cattle or dairy operations.

A study undertaken by Alberta Agriculture in the late 1990s also provides some insights regarding the potential for expansion of the beef industry in the province. That study identified several criteria - manure, odour and population densities, local silage supplies, water supply, landscape characteristics and land for manure spreading - to be considered in evaluating the capability of supporting a 5,000-head back grounding operation and a 20,000-head finishing operation. Townships suitable for livestock expansion are shown in Figures 2-2 and 2-9 in Section 2.3. These townships are located mostly in the south-eastern parts of the Basin, towards the Saskatchewan border. The figures show that there are more townships that meet all of the criteria for the back grounding operations than for finishing operations. For those townships that meet some of the criteria, landscape and silage are the limiting factors for back grounding operations. Limiting factors for finishing operations include silage and groundwater.

Based on Alberta Agriculture's assessment, it would appear that livestock expansion in the Beaver Basin could occur and would most likely consist of 5,000-head operations rather than the 20,000-head operations. While this assessment shows that there is potential for future expansion of livestock operations, the information from the NRCB suggests that this expansion has not yet occurred, probably due to the fact that the cattle industry is still adjusting to changes in markets associated with the effects of BSE. Future expansion in the Beaver River Basin may also be limited by the costs of transporting livestock to processing facilities, most of which are located in southern Alberta, and ability to grow forage to feed livestock. These factors can potentially constraint livestock expansion in the Basin.

Projections are based on the expectations that cattle populations will increase at annual rates somewhere between 0.5 percent (Low Growth) and 2.2 percent (High Growth) which reflects average annual growth rate in cattle population in Alberta during 1958-2005. The Medium Growth scenario assumes an annual growth rate of 1.2 percent, reflecting the constraint imposed by transportation costs and forage production. This forecast also assumes that the

current mix of livestock water use (90 percent cattle) and balance of surface and groundwater use will remain unchanged over the forecast period. The resulting projections, based on actual use are shown in Table 10-11. The forecasts are based on the actual water use and, in light of water that is actually required for livestock, it is assumed that farmers may pursue water licences in order to ensure sufficient water for their livestock.

Table 10-11 Water Use for Livestock in the Beaver River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,098	1,126	1,154	1,183	1,213
	Groundwater	1,116	1,145	1,173	1,203	1,233
	Total	**2,214**	**2,270**	**2,328**	**2,386**	**2,447**
Medium Growth	Surface	1,098	1,166	1,237	1,313	1,394
	Groundwater	1,116	1,185	1,258	1,335	1,417
	Total	**2,214**	**2,350**	**2,495**	**2,648**	**2,811**
High Growth	Surface	1,098	1,224	1,365	1,522	1,697
	Groundwater	1,116	1,245	1,388	1,547	1,725
	Total	**2,214**	**2,469**	**2,753**	**3,069**	**3,422**

Under the Low Scenario, water demand is projected to increase to 2,447 dam^3 by 2025; this represents a 10 percent increase over current use and exceeds current allocations. Under the High Scenario, livestock water use would increase to 3,422 dam^3 by 2025. This increase is 1.5 times higher than current livestock use and exceeds current allocations by about 1,400 dam^3.

10.2.3 Irrigation

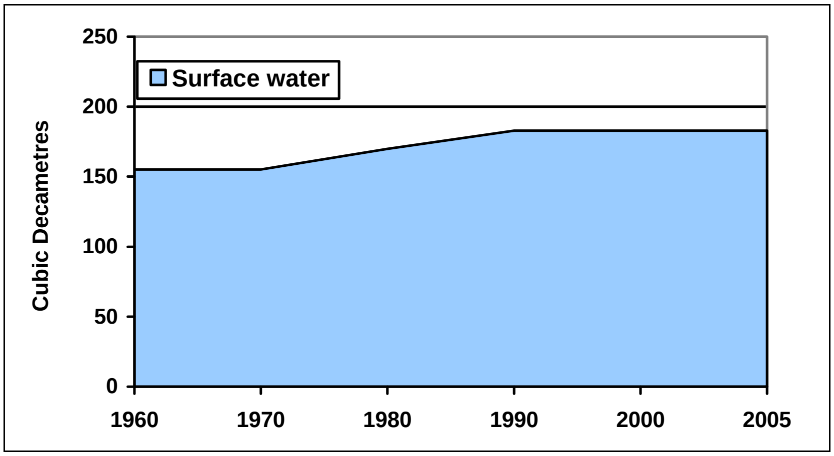
The other major use of water for agricultural purposes is irrigation or crop watering. There are no licences for district irrigation in the Beaver Basin. The farmers in this basin are private irrigators who have their own water licences and divert water using their own pumps and water distribution equipment.

When aggregate information from the 2001 Census of Agriculture for individual counties and municipal districts is modified to reflect river basin boundaries, the resulting estimates suggest that 998 acres of land in the Beaver River basin were irrigated in 2001. This number is incorrect however, because irrigation acres are not evenly distributed throughout each county that make up the Basin and because of likelihood of inaccuracy in the Census data. An estimate of the irrigated acres can be made based on water allocations and irrigation requirement of about 450 mm (18 inches). Based on this requirement it is estimated that water allocations are sufficient to support irrigation on 150 acres. There is no information on the mix of crops grown by private irrigators. However, AAFRD has indicated that most private irrigation in Alberta is used to raise supplemental forages to feed livestock.

10.2.3.1 Water Allocation

There are six private surface licences that allocate approximately 183 dam^3, which represents 100 percent of the total allocation. This basin accounts for less than one percent of total private allocation and less than one percent of the private licences issued in the province. A historical perspective on water allocated for irrigation is provided in Figure 10-9.

Figure 10-9 Historical Trends in Water Allocation for Irrigation in the Beaver Basin



The figure shows that the oldest licences for irrigation date back to the1960s and increased gradually between 1970 and 1990. The amount of water allocated to irrigation has remained the same since then.

10.2.3.2 Licensed Water Use

Table 10-12 summarizes the water licences issued for irrigation according to water source. The licences assume that about 16 percent of allocation (30 dam^3) will be returned to surface sources in the basin. However, the licence data also shows that only one single licence holder has an allowance for return flows.

10.2.3.3 Actual Water Use

Neither Alberta Agriculture nor Alberta Environment has any information on actual water use by private irrigators. For the purposes of this study it is assumed that actual use is equal to licensed water use. Thus, actual water use is estimated to be 153 dam^3. However, water use in any given year will depend on how much of the crop water demand can be satisfied by natural precipitation. It is noteworthy that the actual stockwatering water use in the Beaver Basin (2,214 dam^3) is nearly 14 times the irrigation water use.

Table 10-12 Irrigation Allocations and Use and Reported Actual Water Use, Beaver River Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
Private irrigation	Surface	6	182.5	152.9	29.6	0	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Total	**6**	**182.5**	**152.9**	**29.6**	**0**	**N/A**
Total	Surface	6	182.5	152.9	29.6	0	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Total	**6**	**182.5**	**152.9**	**29.6**	**0**	**N/A**

10.2.3.4 Forecasts of Future Irrigation Water Use

With expansion of livestock, additional demand for livestock forage is expected. However, demand for additional irrigation is not expected. The historical trend provided as Figure 10-9 shows that water allocation for irrigation has remained relatively unchanged since 1990s, suggesting that past increases in livestock have not led to increased water demand for expansion in the land area being irrigated for forage. Further, given climatic conditions and the limited land base in many parts of the Basin, additional expansion of irrigation acreage is not likely. Also, irrigation is a capital intensive operation but the net returns from forage production are not great (Watrecon 2005). These factors suggest that expansion of irrigation in the Beaver River Basin is not likely. It is assumed that available forage will be able to support modest increases in livestock populations. Irrigation water use is projected to remain at 153 dam^3 over the forecast period.

10.2.4 Summary

In summary, current agricultural water use in the Beaver Basin is estimated to be about 2,367 dam^3, of which eight percent is for irrigation and 92 percent is for livestock. In the future, agricultural water demand in the basin is expected to increase as a result of expansion of livestock populations. Demand for irrigation is expected to remain constant. A summary of future agricultural water demand is provided in Table 10-13. Agricultural water use in 2025 would be 2,600 dam^3 (an increase of 10 percent from 2005) under the Low Growth. Under High Growth water use would be 3,575 dam^3 which is an increase of 51 percent from 2005.

Table 10-13 Projected Water Use for Agriculture in the Beaver River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,251	1,279	1,307	1,336	1,366
	Groundwater	1,116	1,145	1,173	1,203	1,233
	Total	**2,367**	**2,423**	**2,481**	**2,539**	**2,600**
Medium Growth	Surface	1,251	1,318	1,390	1,466	1,547
	Groundwater	1,116	1,185	1,258	1,335	1,417
	Total	**2,367**	**2,503**	**2,648**	**2,801**	**2,964**
High Growth	Surface	1,251	1,377	1,518	1,675	1,850
	Groundwater	1,116	1,245	1,388	1,547	1,725
	Total	**2,367**	**2,622**	**2,906**	**3,222**	**3,575**

10.3 COMMERCIAL SECTOR

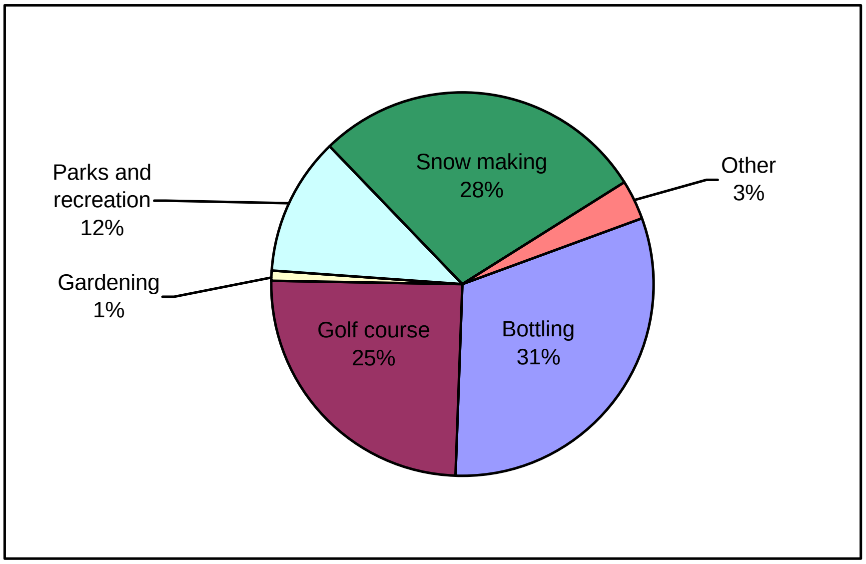
There are 14 licences that allow diversion of about 323 dam^3 of water in the Beaver River Basin. This allocation accounts for 0.7 percent of total allocations in the basin.

10.3.1 Water Allocations

As shown in Figure 10-10 the three largest allocations for commercial purposes are for bottling

(31 percent), snow making (28 percent) and golf courses (25 percent). These three uses account for 84 percent of the total commercial allocation.

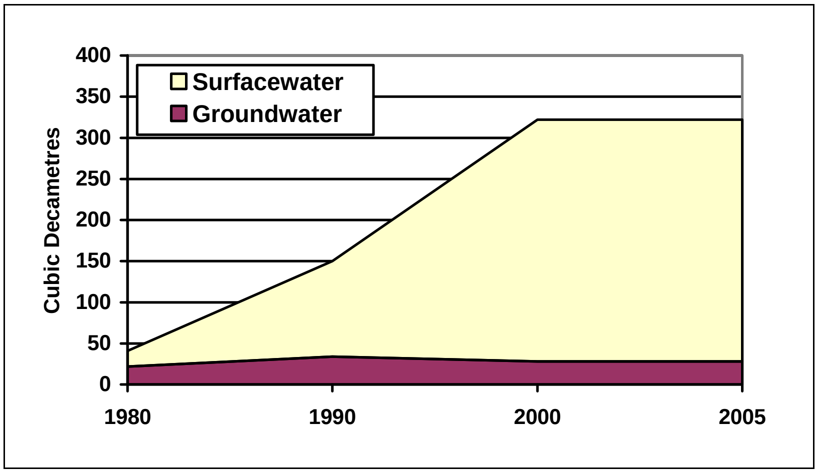
Figure 10-10 Water Allocation for Commercial Activities in the Beaver Basin



Licences issued for the commercial sector allow maximum withdrawals of 294 dam^3 of surface water; this represents 91 percent of total allocations for commercial purposes. The largest allocation is for bottling which accounts for about 30 percent of the total surface water allocation. Licences issued for the commercial sector allow maximum withdrawals of 28 dam^3 of groundwater (nine percent of allocations for commercial purposes). The largest allocation is for parks and recreation which accounts for about 90 percent of the total groundwater allocation.

A historical trend of commercial sector allocation in the Beaver Basin is provided in Figure 10-11. The earliest allocation began in the 1980s but steadily increased, mostly for surface water. Groundwater allocations have remained relatively static since the 1980s. The allocations have remained unchanged since 2000.

Figure 10-11 Historical Trend in Commercial Sector Water Allocations in the Beaver River Basin



10.3.2 Licensed Water Use

Table 10-14 provides a summary of licensed water allocations, use and return for various activities within the commercial sector in the Beaver Basin. There are no return flow allowances in any of the commercial sector allocations; it is expected that all of the allocations will be used.

10.3.3 Actual Water Use

Alberta Environment's Water Use Reporting System (WURS) contains no information on actual water use in 2005 by the any of the licensees in commercial sector in the Beaver River Basin. Therefore, it is assumed that all licensees are withdrawing and using the full amounts of water to which they are entitled. While this assumption may overstate actual water use in the basin, the commercial sector accounts for 0.7 percent of total allocations so it will not appreciably affect overall water use estimate for the Beaver River Basin.

Table 10-14 Licensed Commercial Allocations and Reported Actual Water Use, Beaver Basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Licensees Reporting	Reported Use	Percent of Allocation
Bottling	Surface	1	100.0	100.0	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**1**	**100.0**	**100.0**	**0.0**	**0**	**N/A**	**N/A**
Golf course	Surface	1	80.0	80.0	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**1**	**80.0**	**80.0**	**0.0**	**0**	**N/A**	**N/A**
Gardening	Surface	0	0.0	0.0	0.0	0	N/A	N/A
	Groundwater	2	2.5	2.5	0.0	0	N/A	N/A
	Subtotal	**2**	**2.5**	**2.5**	**0.0**	**0**	**N/A**	**N/A**
Parks and Recreation	Surface	2	12.3	12.3	**0.0**	0	N/A	N/A
	Groundwater	6	25.8	25.8	**0.0**	0	N/A	N/A
	Subtotal	**8**	**38.1**	**38.1**	**0.0**	**0**	**N/A**	**N/A**
Snowmaking	Surface	1	91.0	91.0	**0.0**	0	N/A	N/A
	Groundwater	0	0.0	0.0	**0.0**	0	N/A	N/A
	Subtotal	**1**	**91.0**	**91.0**	**0.0**	**0**	**N/A**	**N/A**
Other	Surface	1	11.1	11.1	**0.0**	0	N/A	N/A
	Groundwater	0	0.0	0.0	**0.0**	0	N/A	N/A
	Subtotal	**1**	**11.1**	**11.1**	**0.0**	**0**	**N/A**	**N/A**
Total	Surface	6	294.4	294.4	0.0	0	N/A	N/A
	Groundwater	8	28.2	28.2	0.0	0	N/A	N/A
	Total	**14**	**322.7**	**322.7**	**0.0**	**0**	**N/A**	**N/A**

10.3.4 Forecasts of Future Water Use

Since most of the allocation (84 percent) is for three activities, bottling, snow making and golf course, forecasts of future demand will focus on those activities.

10.3.4.1 Bottling

Although the bottling licence is set to expire by 2015, it is assumed that the licence will be renewed for the duration of the forecast period under similar terms and conditions as compared to currently. Annual water consumption to 2025 is expected to remain unchanged at 100 dam^3 over the forecast period.

10.3.4.2 Snowmaking

Water allocations for snowmaking are not expected to change in the near future. Although water demands for snowmaking are tied to participation in skiing and population growth in the Basin, there is not expected to be sufficient population growth in the next 20 years to warrant development of another ski facility.

10.3.4.3 Golf Courses

The water demand forecasts for golf courses employs the approach outlined in Watrecon (2005) which links water use to expansion of golf courses which is tied to population growth rates. The forecasts assume that the proportion of surface and groundwater use will not change over the forecast period. The resulting projections are shown in Table 10-15. Water use is expected to increase to 208 dam^3 by 2025 under Low Growth, which is a 2.6 times increase from current use. Using High Growth, water demand is projected to increase to 1,036 dam^3 by 2025 which is almost 12 times the current water use.

Table 10-15 Projected Water Use for Golf Courses, Beaver Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	80	114	146	178	208
	Groundwater	0	0	0	0	0
	Total	**80**	**114**	**146**	**178**	**208**
Medium Growth	Surface	80	174	275	381	484
	Groundwater	0	0	0	0	0
	Total	**80**	**174**	**275**	**381**	**484**
High Growth	Surface	80	288	527	782	1,036
	Groundwater	0	0	0	0	0
	Total	**80**	**288**	**527**	**782**	**1,036**

10.3.4.4 Summary

A summary of projected water demand for the commercial sector in the Beaver Basin is

provided in Table 10-16. This summary and projections are based water use estimates for the three activities listed above and assuming water use for the remaining activities remains constant over the forecast period. Under the Low Growth scenario, water demand is projected to rise to 451 dam^3, a 39 percent increase from current levels by 2025. Under the High Growth Scenario, water demand is projected to rise to 1,279 dam^3 by 2025; this amount is four times higher than current levels.

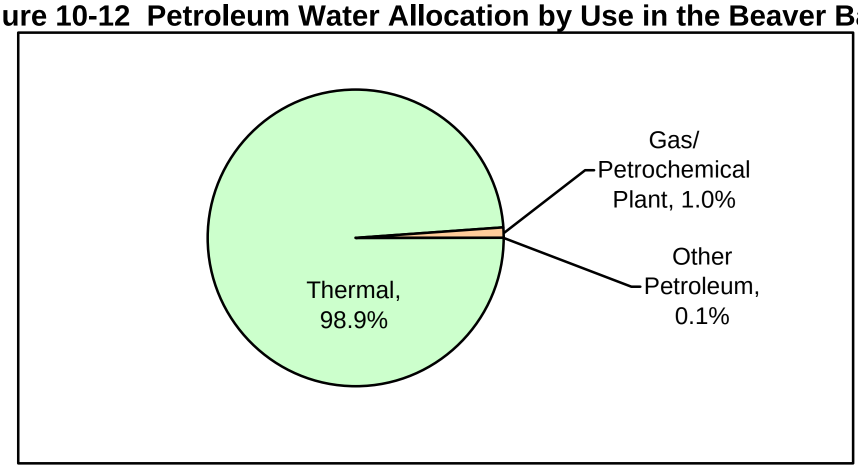
Table 10-16 Projected Water Use for Commercial Sector in the Beaver Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	294	328	360	392	422
	Groundwater	28	28	28	28	28
	Total	**323**	**357**	**389**	**421**	**451**
Medium Growth	Surface	294	388	489	595	698
	Groundwater	28	28	28	28	28
	Total	**323**	**417**	**518**	**624**	**727**
High Growth	Surface	294	502	741	996	1250
	Groundwater	28	28	28	28	28
	Total	**323**	**531**	**770**	**1,025**	**1,279**

10.4 PETROLEUM SECTOR

The Beaver River basin has 46 active licences which allocate 21,113 dam^3 of water to the petroleum sector. Petroleum allocations account for 44 percent of total allocations in the basin. As shown in Figure 10-12, the petroleum sector includes water allocations for thermal extraction, gas and petrochemical plants, and various other activities. About 99 percent of the allocations are for thermal extraction for enhanced oil and gas recovery (20,875 dam^3). Most of the water allocations are for groundwater (12,622 dam^3) which accounts for 60 percent of all allocations for the petroleum sector.

Figure 10-12 Petroleum Water Allocation by Use in the Beaver Basin



10.4.1 Thermal Extraction

10.4.1.1 Water Allocation

Thirty-six licences have been issued for thermal extraction activities in the Beaver basin with allocations totalling 20,875 dam^3. These include licences issued to Imperial Oil, Canadian Natural Resources Limited (CNRL), Talisman Energy, EnCana Corporation, Suncor Inc., Exxon Mobil and BlackRock Ventures (now Shell). Table 10-17 summarizes allocations for each of the major thermal extraction projects in the Beaver River basin. Operators for some of these projects have both surface and groundwater licences. In these situations, surface water licensees are used unless the level of Cold Lake declines for two consecutive days at which point they are required to switch to groundwater.

Table 10-17 Major Thermal Extraction Projects in the Beaver River Basin

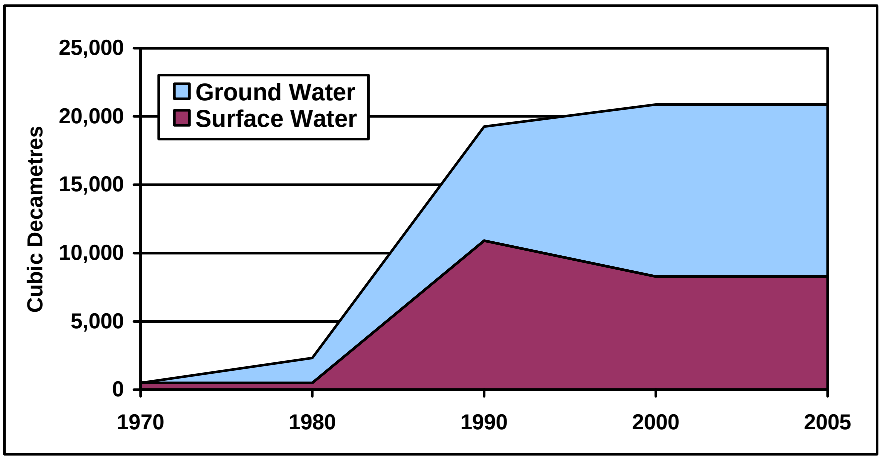
Groundwater		Surface Water	
Project	**Allocation (dam^3)**	**Project**	**Allocation (dam^3)**
CNRL –Wolf Lake	6,009.0	Imperial Oil	5,110.0
CNRL- Primrose	470.5	Imperial Oil	38.0
CNRL –Burnt lake	547.5	Imperial Oil	36.0
CNRL- Ft. Kent Project	183,9	CNRL –Burnt Lake	2,628.0
Imperial Oil –Cold Lake Operation (Contingency allocation to be used when Cold Lake water levels fall below the cutoff limits.)	2,920.0	CNRL	64.0
Imperial Oil –Cold Lake Operation (testing, sampling and repairs)	131.8	CNRL	25.9
BlackRock Ventures (now Shell) –Hilda Lake Project	219,0	Talisman Energy	499.6
Imperial Oil –remediation	2,100.0	Imperial Oil	25.0
CNRL –Kirby Lake Project	438.0	Imperial Oil	52.7
Suncor Inc, WR, 22079	6,170.0		
Exxon Mobil –La Corey Project	91.3		
EnCana –Foster Creek Pilot Project	2,203.6		
Groundwater Total	21,081.7*	**Surface Water Total**	8,479.2 *
Total Water Allocated	29,560.9 *		
Source: Cold Lake-Beaver River Basin State of the Basin Report (2006) * Note that this is more than is licensed in the EMS database.			

Details of the licences issued to the petroleum sector in the Beaver basin are provided in Table 10-18. The table shows that, based on a review of the water licence database, 36 licences have been issued for injection purposes, with surface water allocations (8,284 dam^3) accounting for nearly 40 percent. Groundwater allocations for thermal extraction total 12,591 dam^3. The allocations listed in Table 10-17 actually exceed the allocations listed for the

licences in the EMS database that were active in the 2005 (Table 10-18), especially for groundwater. This analysis is based on the licensed allocations listed in Table 10-18.

Water use for thermal commenced in the 1970s but grew rapidly in the 1980s. Figure 10-13 shows that there has actually been a slight decline in licensed allocations for surface water between 1990 and 2000, but this was offset by increased allocations of groundwater. Since 2000, total allocations have remained constant.

Figure 10-13 Historical Trends in Water Allocations for Thermal Extraction



10.4.1.2 Licensed Water Use

As shown in Table 10-18, the licences issued for thermal extraction purposes assume that 99.8 percent of allocations will be used. Return flow allowances in licences only amounted to 37 dam^3 of surface water withdrawals.

10.4.1.3 Actual Water Use

Detailed estimates of water used for thermal proposes have been prepared by Geowa based on EUB data. These estimates are also presented in Table 10-18. According to Geowa, an estimated 8,947 dam^3 of fresh water was diverted for thermal purposes in 2005. This volume includes 3,430 dam^3 of surface water and 5,516 dam^3 of groundwater. The activity also used 3,036 dam^3 of saline water. Based on these estimates, licensees actually used 41 percent of their surface water entitlements and 44 percent of their groundwater entitlements.

Table 10-18 Licensed Allocations and Estimated Water Use for the Petroleum Sector, Beaver River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Thermal	Surface	4	8,283.6	8,246.6	37.0	3,430.3	41.6%	41.6%
	Groundwater	32	12,591.2	12,591.2	0.0	5,516.2	43.8%	43.8%
	Subtotal	**36**	**20,874.8**	**20,837.8**	**37.0**	**8,946.5 ***	**42.9%**	**42.9%**
Gas/Petrochemical Plant	Surface	5	205.9	205.9	0.0	205.9	100.0%	100.0%
	Groundwater	2	15.8	15.8	0.0	15.8	100.0%	100.0%
	Subtotal	**7**	**221.7**	**221.7**	**0.0**	**221.7 ****	**100.0%**	**100.0%**
Other petroleum	Surface	0	0.0	0.0	0.0	0.0		
	Groundwater	3	15.2	15.2	0.0	15.2	100.0%	100.0%
	Subtotal	**3**	**15.2**	**15.2**	**0.0**	**15.2****	**100.0%**	**100.0%**
Total	Surface	9	8,489.5	8,452.5	37.0	3,636.2	42.8%	43.0%
	Groundwater	37	12,622.2	12,622.2	0.0	5,547.2	44.0%	44.0%
	Total	**46**	**21,111.6**	**21,074.6**	**37.0**	**9,183.4**	**43.5%**	**43.6%**

* EUB water use data provided by Geowa.
** Estimated actual use is assumed to be 100 percent of licensed consumption.

10.4.1.4 Forecasts of Future Water Use

The Cold Lake Clearwater (CLC) deposit, which is Alberta's second largest producer of crude bitumen production, is located within the Beaver Basin (EUB, 2006). The amount of fresh water used by the petroleum sector is expected to decline but the use of saline water is expected to increase. For the Beaver River Basin the sector is expected to be a net producer of water (dewatering), based on the water forecasts of EnCana, ESSO, CNRL, BlackRock, and Husky).

A big part of future petroleum projects and expansion in the Beaver Basin is water conservation planning. As a result, the petroleum sector's use of freshwater is not expected to increase relative to alternative water sources (AENV, 2006). Table 10-19 describes how AENV expects water used for thermal extraction to decline between 2005 and 2025. AENV's forecast has been adopted for this analysis.

Table 10-19 Forecast of Thermal Water Use in the Beaver Basin
(dam^3)

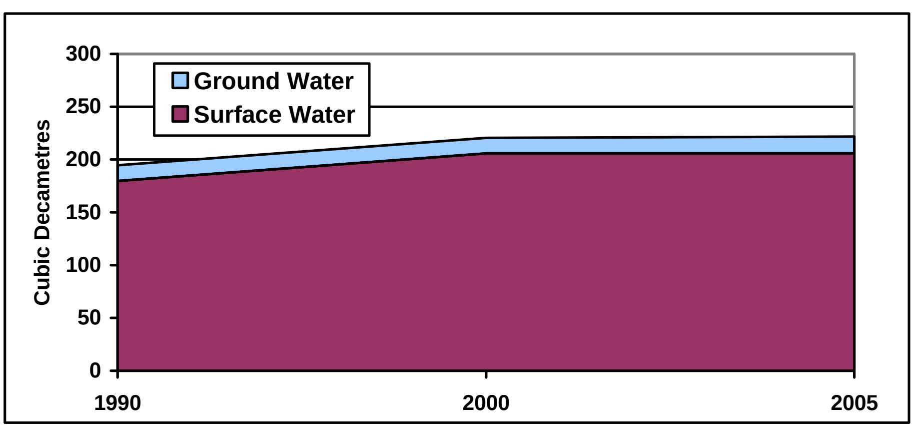
Scenario	Source	2005	2010	2015	2020	2025
AENV Forecast	Surface	3,430	3,635	3,663	2,494	2,494
	Groundwater	5,516	5,167	2,577	1,755	1,755
	Total	**8,947**	**8,802**	**6,241**	**4,248**	**4,248**

Under the scenario developed by AENV, water use for injection in 2025 will decline by 48 percent from current levels.

10.4.2 Gas and Petrochemical Plants

Seven licences with allocations totalling 222 dam^3 have been allocated to gas/petrochemical plants. Five of these licences allow up to 206 dam^3 to be diverted from surface water; this accounts for 93 percent of allocations to gas/petrochemical plants. As shown in Figure 10-15, these allocations of water for gas/petrochemical plants were issued in the 1990s, and have only increased slightly for both surface and groundwater since then.

Figure 10-14 Historical Trends in Water Allocations



Under the terms of the licences, it is expected that all of the water that can be withdrawn for use

by gas/petrochemical plants will be consumed. The actual water use for 2005 of gas/petrochemical plants in the Beaver basin was assumed to be 100 percent of licensed use. It is assumed that future water use by gas and petrochemical plants will remain relatively the same for the forecasts period.

10.4.3 Other Petroleum

Three groundwater licences have been issued for other petroleum activities amounting to a total of 15 dam^3. All of the licences were issued prior to 2000 and there are no allowances for return flow. No information on actual water use is available for other petroleum activities in the Beaver River basin. For this assessment it is assumed that all of the allocations contained in licences issued for other petroleum purposes are being withdrawn and used. It is assumed that future water use by other petroleum will remain relatively the same.

10.4.4 Summary

The petroleum sector in the Beaver basin is dominated by water allocated for thermal extraction. These plants accounted for 99 percent of allocations and 97 percent of actual water use in 2005. Water use data shows that although water licences expect that up to 20,838 dam^3 of water will be consumed for thermal extraction purposes, licensees are only using 41 percent of this amount.

In the future, there is expected to be slight decline in water requirements for petroleum activities as bitumen production from existing reserves declines. Future water demand for the gas and petrochemical plants and the other petroleum activities is expected to remain the same overtime. The overall water use projections for the petroleum sector are provided in Table 10-20. The forecasts assume that current ratio of surface to groundwater consumption remains the same.

Table 10-20 Forecast of Petrochemical Water Use in the Beaver Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Medium Decline	Surface	3,636	3,841	3,869	2,700	2,700
	Groundwater	5,547	5,198	2,608	1,786	1,786
	Total	**9,183**	**9,039**	**6,478**	**4,485**	**4,485**

Table 10-20 shows that, the overall demand for water in the Beaver basin is expected to decline by nearly 50 percent for the period to 2025.

10.5 INDUSTRIAL SECTOR

In the Beaver River basin only two active water licences have been issued for industrial purposes. Industrial water licences account for less than one percent of the allocations in the basin. These licences allow withdrawals of up to 2.5 dam^3 of groundwater for mining other than coal and were issued in the 1980s. The licences assume that all of the water diverted will be

consumed. There is no information regarding actual withdrawals of groundwater for industrial purposes. For purposes of this analysis it is assumed that they are using the full amount of their entitlement and will continue to do so for the duration of the forecast period.

10.6 OTHER SECTOR

In the Beaver River Basin there are 18 active water licences that allocate 12,114 dam^3 of water to the other sector. These other sector activities account for about 25 percent of licensed water use in the basin. Almost all water allocations are for surface water (12,110 dam^3); this accounts for 94 percent of the allocations for the other sector. Other water uses in this sector include water management for flood control and lake stabilization, and fish, wildlife and habitat enhancement (Figure 10-16).

Figure 10-15 Other Sector Water Allocation by Use in the Beaver Basin

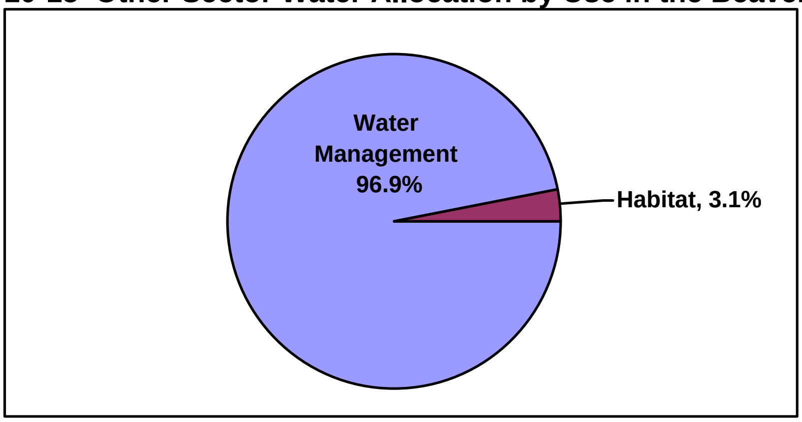


Table 10-21 summarizes the water allocation, use, and return associated with the licences for each activity in the Beaver Basin.

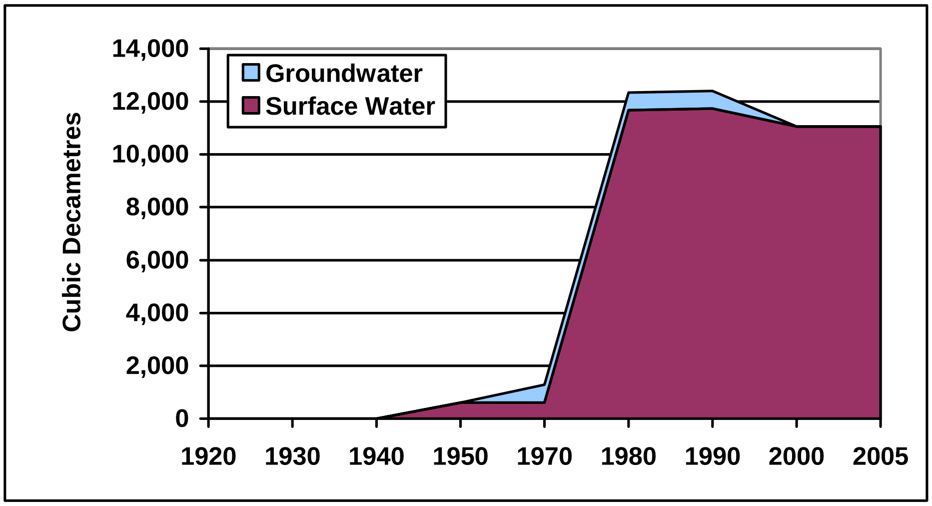
10.6.1 Water Management

About 97 percent of the allocations are for water management purposes such flood control and lake stabilization (11,734 dam^3). Table 10-21 shows that 15 licences have been issued for water management purposes, with all but one of these for surface water. The single groundwater licence is for only 3.7 dam^3 and is scheduled to expire in 2005. Surface water use for water management commenced in the 1920s but grew rapidly in the 1980s and 1990s but has declined since (Figure 10-17). Major licensees include AENV and Ducks Unlimited.

Table 10-21 Licensed Allocations and Estimated Water Use for the Other Sector, Beaver River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Water Management	Surface	14	11,730.7	4,632.3	7,098.4	4,632.3	100%	39.5%
	Groundwater	1	3.7	3.7	0.0	3.7	100%	100.0%
	Subtotal	**15**	**11,734.4**	**4,636.0**	**7,098.4**	**4,636.0**	**100%**	**39.5%**
Habitat	Surface	3	379.9	379.9	0.0	379.9	100%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**3**	**379.9**	**379.9**	**0.0**	**379.9**	**100%**	**100.0%**
Total	Surface	17	12,110.6	5,012.2	7,098.4	5,012.2	100%	41.4%
	Groundwater	1	3.7	3.7	0.0	3.7	100%	100.0%
	Total	**18**	**12,114.3**	**5,015.9**	**7,098.4**	**5,015.9**	**100%**	**41.4%**

Figure 10-16 Historical Trends in Water Allocations for Water Management



As shown in Table 10-20, the licences issued for water management purposes assume that about 40 percent of surface water allocations and 100 percent of groundwater allocations will be used. Return flow allowances in licences amounted to 7,098 dam^3 for surface water. There is no information on actual water diversions and consumption for water management activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement and will continue to do so for the duration of the forecast period.

10.6.2 Habitat Enhancement

Three surface licences have been issued to Ducks Unlimited for fish, wildlife and habitat enhancement (380 dam^3). Details of the licences issued to the other sector in the Beaver basin are provided in Table 10-21. The licences issued for habitat enhancement purposes assume that 100 percent of surface water allocations will be used. Surface water use for habitat commenced in the 1970s and grew slightly in the 1980s. There is no information on actual water diversions and consumption for habitat enhancement activities and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the other sector, it is assumed that water used for habitat enhancement in the Beaver basin will remain constant for the forecast period.

10.6.3 Summary of Other Uses

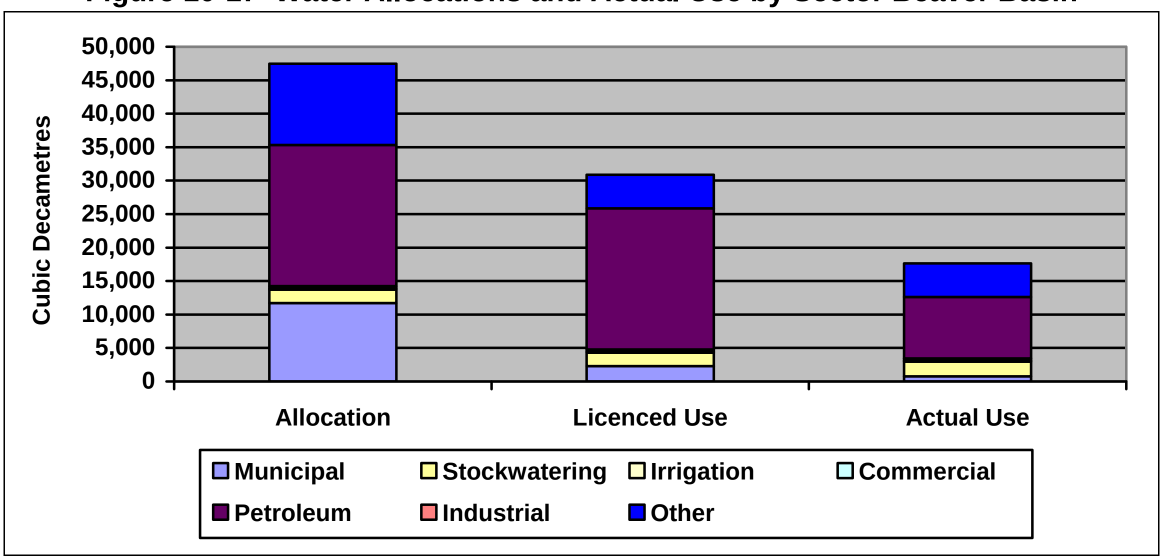
The other sector in the Beaver basin is dominated by water allocated for water management. These projects account for 97 percent of the water allocation and 92 percent of the licensed water use. In the absence of information about the other sector, it is assumed that these projects are using 100 percent of their licensed consumption and will continue to do so for the duration of the forecast period.

10.7 SUMMARY

Table 10-28 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the Beaver basin. In total, existing licences and registrations allow a maximum of 47,457 dam^3 of water to be withdrawn for use. Of this, up to 30,865 dam^3 expected to be used and 16,592 dam^3 will be returned to surface water. As noted previously, the largest amounts of water (45 percent) have been allocated to the petroleum sector, particularly thermal, and this sector accounts for 68 percent of licensed use.

With respect to actual use, the exact volumes withdrawn and used in 2005 are not known because very few water use reports have been filed with AENV. However, based on the assumptions used in the previous sections, it is estimated that 17,642 dam^3 were actually used in 2005. This represents 57 percent of water use allowed in existing licences and registrations. Based on estimated use, the petroleum sector accounted for 52 percent of total water use in the Beaver basin in 2005. Figure 10-18 shows how actual use compares to licensed allocations and use for each of the water use sectors.

Figure 10-17 Water Allocations and Actual Use by Sector Beaver Basin



Forecasts of future water use in the Beaver basin are provided in Tables 10-23 to 10-25 for the low, medium and high growth scenarios. Predicted water use under the medium growth scenario is shown in Figure 10-19. This figure shows that, for the period to 2010, water use will increased slightly due to increased use by the municipal, agricultural and petroleum sectors. However, after 2010, significant reductions in water use by the petroleum sector will result in total water use in the basin declining and then stabilizing in 2020. Under the Medium Growth Scenario, water demand in 2025 will be about 19 percent lower than at present. For the other scenarios, the water demand over 20 years will decrease by as much as 24 percent for Low Growth scenario to 12 percent for the High Growth scenario. For all scenarios, actual water use will be less than the amount that can be consumed under the terms of existing licences.

Figure 10-18 Forecast Water Use in the Beaver Basin: Medium Scenario

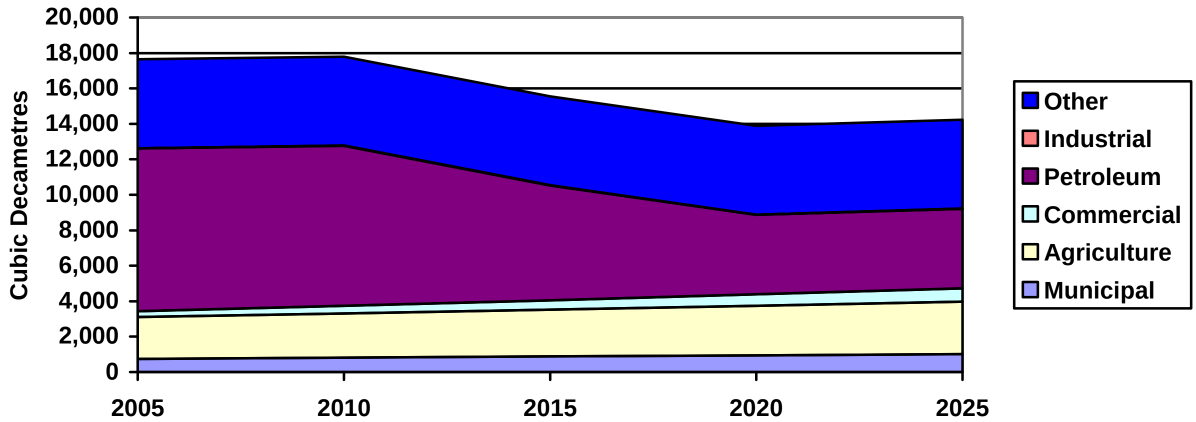


Table 10-22 Summary of Allocations and Estimated Water Use, Beaver Basin

Sector		Licensed Allocation and Use (dam^3)				Estimated Water Use (dam^3)		
		Allocation	Water Use	Return	Percent of Total Use	Use	Percent of Licensed use	Percent of Total Use
Municipal		11,708	2,281	9,427	7%	750	33%	4%
Agricultural	Stockwatering	2,016	2,016	0	7%	2,214	110%	13%
	Irrigation	183	153	30	0%	153	100%	1%
Commercial		323	323	0	1%	323	100%	2%
Petroleum		21,112	21,075	37	68%	9,183	44%	52%
Industrial		3	3	0	0%	3	100%	0%
Other		12,114	5,016	7,098	16%	5,016	100%	28%
Total		**47,459**	**30,867**	**16,592**	**100%**	**17,642**	**57%**	**100%**

Table 10-23 Forecast Water Use, By Sector, Beaver Basin: Low Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	663	703	740	778	813
	Agricultural	1,251	1,279	1,307	1,336	1,366
	Commercial	294	329	361	393	422
	Petroleum	3,636	3,841	3,869	2,700	2,700
	Industrial	0	0	0	0	0
	Other	5,012	5,012	5,012	5,012	5,012
	Total	10,857	11,164	11,289	10,219	10,313
Groundwater	Municipal	87	92	97	102	107
	Agricultural	1,116	1,145	1,173	1,203	1,233
	Commercial	28	28	28	28	28
	Petroleum	5,547	5,198	2,608	1,786	1,786
	Industrial	3	3	3	3	3
	Other	4	4	4	4	4
	Total	6,785	6,469	3,912	3,125	3,160
Total	Municipal	750	795	837	880	920
	Agricultural	2,367	2,424	2,480	2,539	2,599
	Commercial	323	357	389	421	450
	Petroleum	9,183	9,039	6,477	4,486	4,486
	Industrial	3	3	3	3	3
	Other	5,016	5,016	5,016	5,016	5,016
	Total	17,641	17,633	15,201	13,344	13,474

Table 10-24 Forecast Water Use, By Sector, Beaver Basin: Medium Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	663	717	777	839	898
	Agricultural	1,251	1,318	1,390	1,466	1,547
	Commercial	294	393	499	610	718
	Petroleum	3,636	3,841	3,869	2,700	2,700
	Industrial	0	0	0	0	0
	Other	5,012	5,012	5,012	5,012	5,012
	Total	10,857	11,281	11,547	10,627	10,875
Groundwater	Municipal	87	94	102	110	118
	Agricultural	1,116	1,185	1,258	1,335	1,417
	Commercial	28	28	28	28	28
	Petroleum	5,547	5,198	2,608	1,786	1,786
	Industrial	3	3	3	3	3
	Other	4	4	4	4	4
	Total	6,785	6,511	4,002	3,265	3,355
Total	Municipal	750	811	879	949	1,016
	Agricultural	2,367	2,503	2,648	2,801	2,964
	Commercial	323	421	528	639	746
	Petroleum	9,183	9,039	6,477	4,486	4,486
	Industrial	3	3	3	3	3
	Other	5,016	5,016	5,016	5,016	5,016
	Total	17,641	17,792	15,550	13,893	14,230

Table 10-25 Forecast Water Use, By Sector, Beaver Basin: High Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	663	743	835	933	1,031
	Agricultural	1,251	1,377	1,518	1,675	1,850
	Commercial	294	510	756	1,019	1,282
	Petroleum	3,636	3,841	3,869	2,700	2,700
	Industrial	0	0	0	0	0
	Other	5,012	5,012	5,012	5,012	5,012
	Total	10,857	11,483	11,991	11,339	11,875
Groundwater	Municipal	87	98	110	122	135
	Agricultural	1,116	1,245	1,388	1,547	1,725
	Commercial	28	28	28	28	28
	Petroleum	5,547	5,198	2,608	1,786	1,786
	Industrial	3	3	3	3	3
	Other	4	4	4	4	4
	Total	6,785	6,575	4,140	3,489	3,680
Total	Municipal	750	841	945	1,055	1,166
	Agricultural	2,367	2,622	2,906	3,222	3,575
	Commercial	323	538	785	1,047	1,310
	Petroleum	9,183	9,039	6,477	4,486	4,486
	Industrial	3	3	3	3	3
	Other	5,016	5,016	5,016	5,016	5,016
	Total	17,641	18,058	16,131	14,828	15,555

Athabasca River Basin

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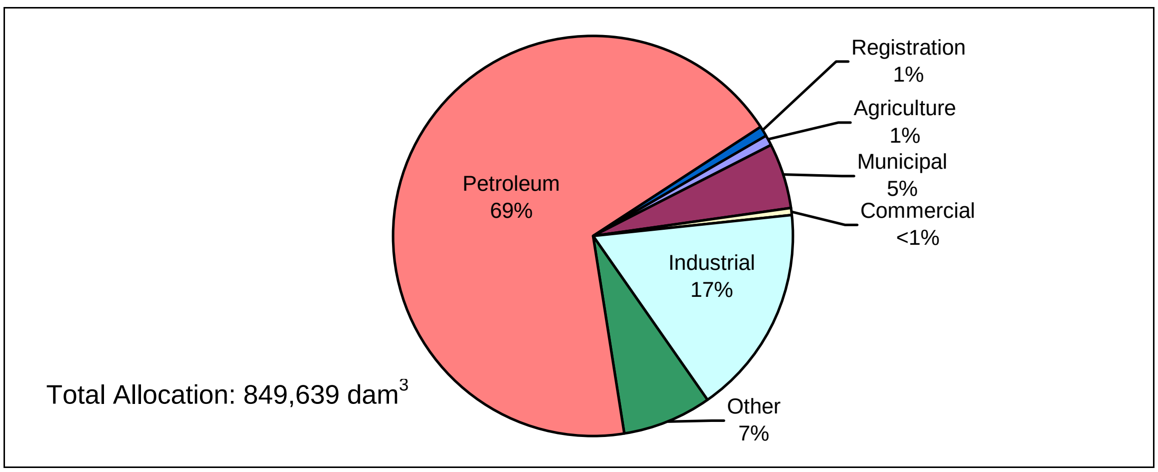
11.0 ATHABASCA RIVER BASIN

The Athabasca Basin is about 140,000 km^2 in area and occupies approximately 23 percent of Alberta. The mean annual natural river discharge of the Athabasca River is 24,000,000 dam^3. The Athabasca River is part of the Mackenzie River system, which drains eventually into the Arctic Ocean. In 2001, the basin had a population of 154,097 people, or five percent of the provincial population. The population density of the basins was just over one person per square kilometre. The Athabasca River Basin includes all or parts of 22 rural or regional municipalities and includes of 2d3 urban municipalities and 14 Aboriginal settlements.

An overview of current surface and groundwater allocations is provided in Figure 11-1. It shows that in 2005 the petroleum sector accounted for 68 percent of allocations (581,792 dam^3) and the industrial sector accounts for another 17 percent of total allocations (145,368 dam^3). The other and municipal sectors accounted for most of the remaining allocations, accounting for 59,988 dam^3 (seven percent) and 46,097 dam^3 (five percent), respectively. Total allocations in the basin in 2005 were 849,639 dam^3.

Figure 11-1 Distribution of Active Water Allocations in the Athabasca Basin



Figures 11-2 and 11-3 show the location, allocation and sector of all active water licences in Athabasca River Basin. Figure 11-4 shows the location of registrations issued for the basin.

11.1 MUNICIPAL AND RESIDENTIAL SECTOR

11.1.1 Population

In 2001, the Athabasca River Basin had a population of 154,097 people. Only 35 percent of the population lives in an urban municipality. The majority of the population (62 percent) lived in rural parts of the basin, specifically the Regional Municipality of Wood Buffalo, which includes the community of Fort McMurray. Another three percent of the population lived on one of the 14 Aboriginal reserves.

Table 11-1 shows that the population of the basin increased by about 4.6 percent between 1996 and 2001. While the population of the rural or regional municipalities increased at a faster rate (6.8 percent), the urban population grew very little. The highest population growth occurred in the Aboriginal settlements, which reported a 17 percent increase in population over five years.

Table 11-1 Population Distribution and Growth in Athabasca River Basin, 2001

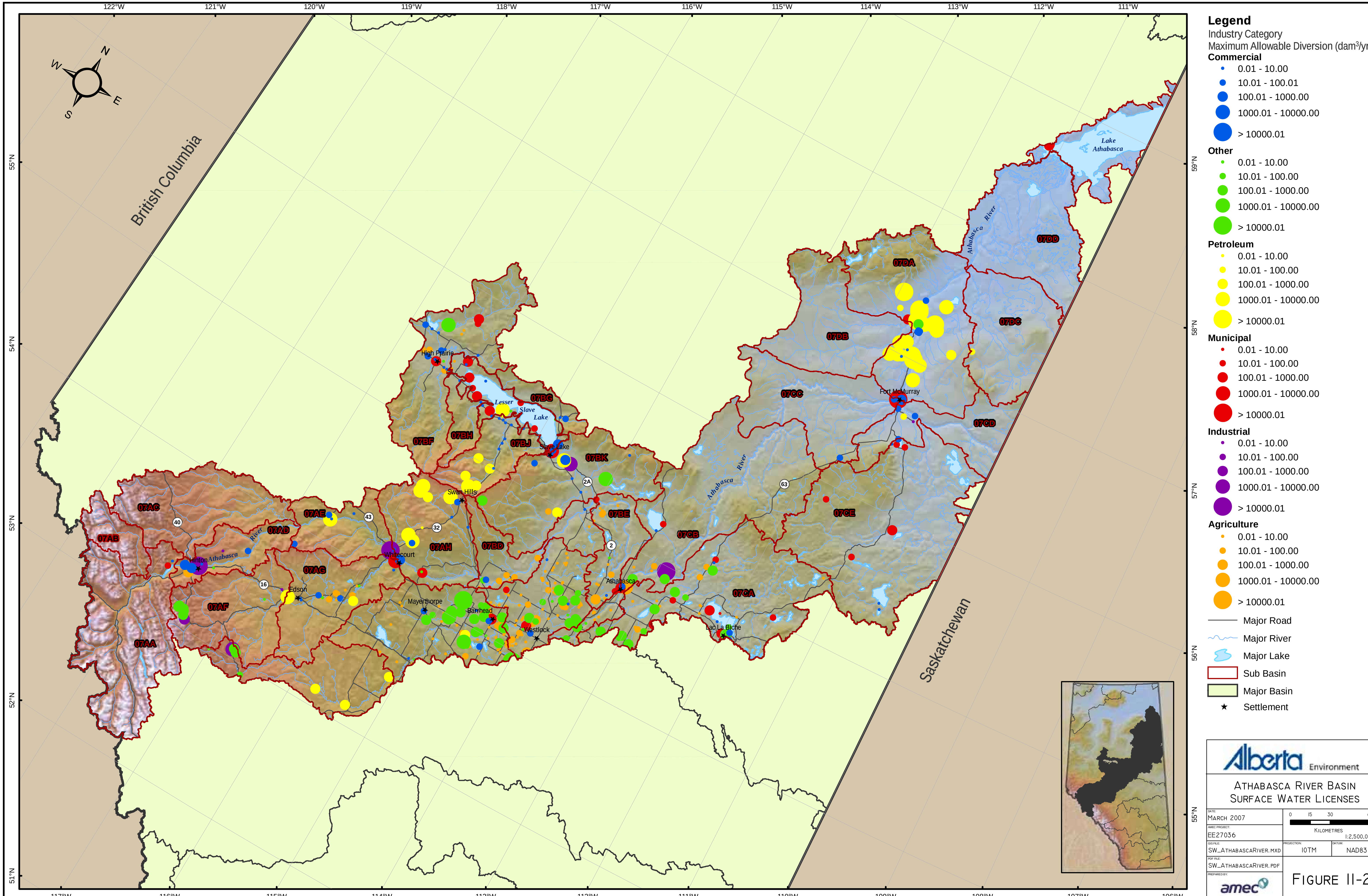
	2001		1996	1996 to 2001 Population Change
	Population	**Percent**	**Population**	**Percent**
Urban Municipality	54,212	35.2%	54,164	0.1%
Rural or Regional Municipality	96,041	62.3%	89,887	6.8%
First Nations and Métis Settlements	3,844	2.5%	3,295	16.7%
Total	**154,097**	**100%**	**147,346**	**4.6%**

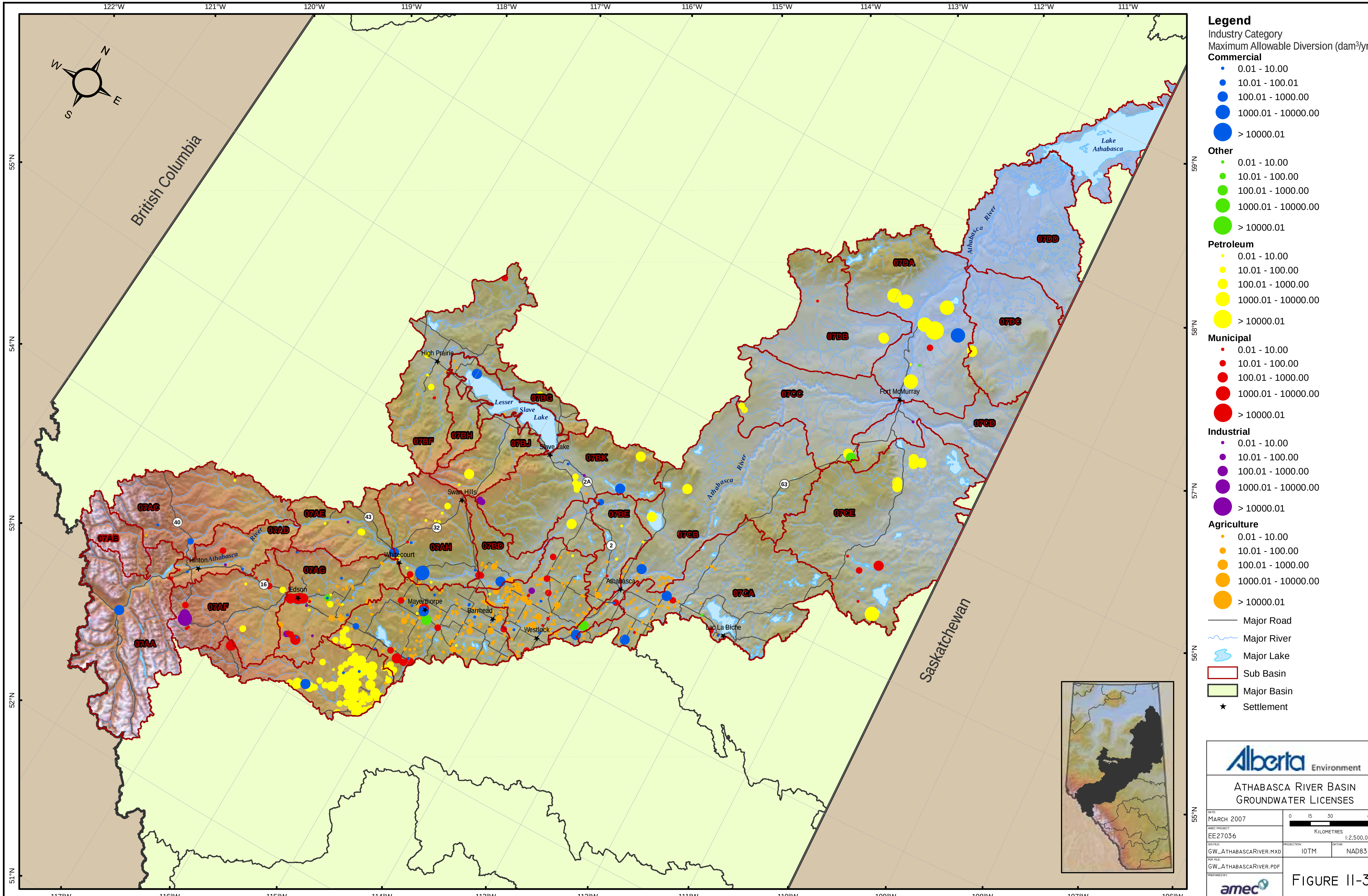
Table 11-2 lists all the urban and rural municipalities that are situated in the Athabasca River Basin, the estimated 2001 population of each municipality within the basin, and the water allocations for those municipalities with licences of 100 dam^3 or more. The major urban population centres include the towns of Hinton (9,405 residents), Whitecourt (8,334), Edson (7,585), Slave Lake (6,600), Westlock (4,819) and Barrhead (4,213). The most populous rural or regional municipality is the Regional Municipality of Wood Buffalo (39,068), followed by Yellowhead County (9,232), and the County of Athabasca No. 12 (7,052).

Table 11-3 identifies all of the major Aboriginal communities in the Athabasca River Basin, their 2001 population, and water allocations for those municipalities with licensees of 100 dam^3 or more include. The three largest Aboriginal communities are the Driftpile River Band (693 people), the Peavine Métis Settlement (608) and the Sucker Creek Band (588).

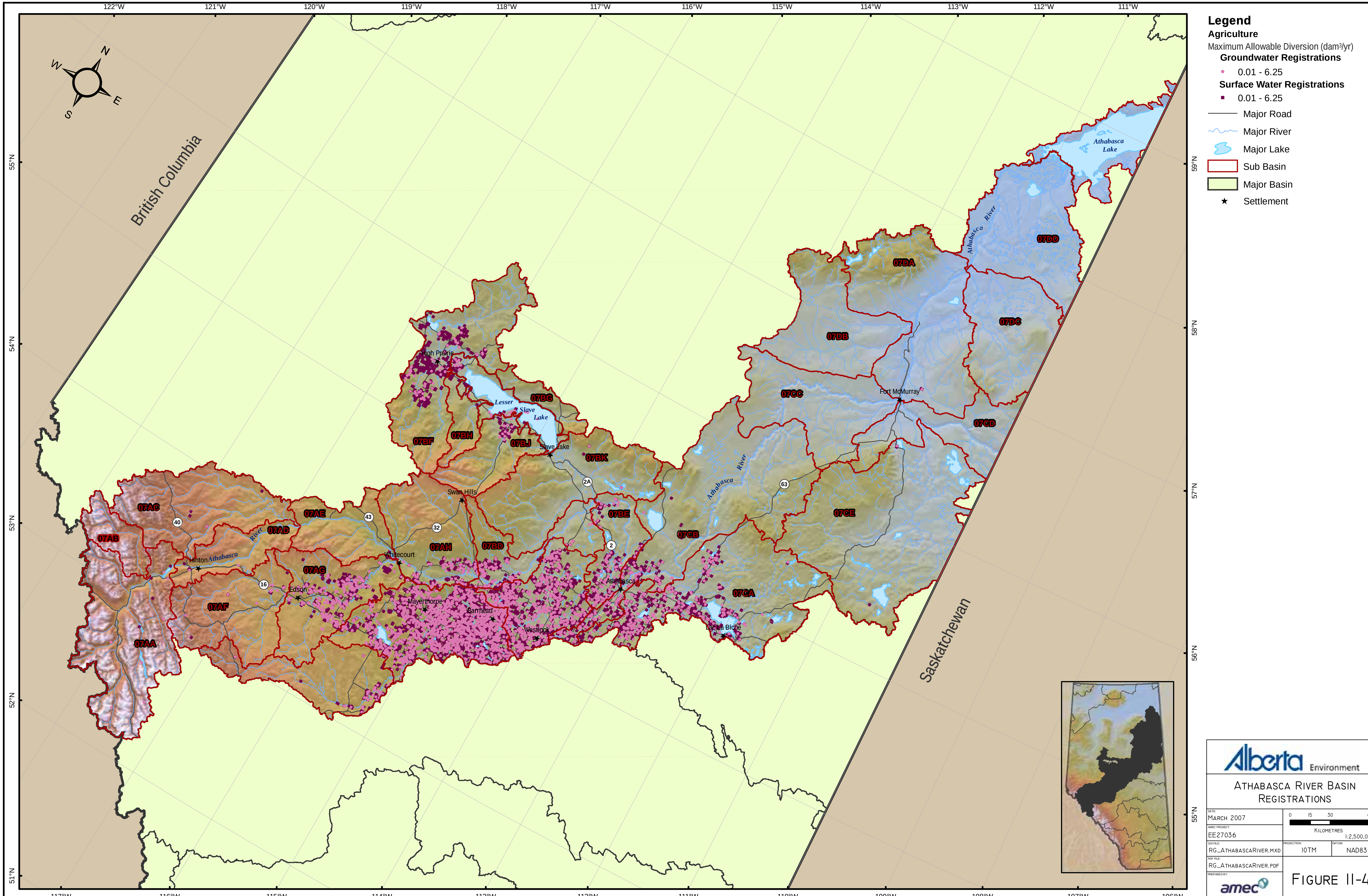
11.1.2 Water Allocations

As of 2005, 177 active municipal water licences had been issued to 70 licensees in Athabasca River Basin. These licences allow a maximum diversion of up to 46,097 dam^3 per year. Municipal water uses account for six percent of all licensed water allocations in the Athabasca River Basin. Urban users account for 94 percent of total municipal allocations. Rural users and other municipal users each account for three percent of total allocations.


Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
0.01 - 10.00
10.01 - 100.01
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Petroleum
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Municipal
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Industrial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Agriculture
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
British Columbia
Saskatchewan
Lake Athabasca
Lesser Slave Lake
Athabasca River
High Prairie
Slave Lake
Swan Hills
Whitecourt
Hinton
Edson
Mayerthorpe
Barrhead
Westlock
Athabasca
Lac La Biche
Fort McMurray
07AA
07AB
07AC
07AD
07AE
07AF
07AG
07AH
07BC
07BD
07BE
07BF
07BG
07BH
07BJ
07BK
07CA
07CB
07CC
07CD
07CE
07DA
07DB
07DC
07DD
Alberta Environment
Athabasca River Basin
Surface Water Licenses
Date: March 2007
AMEC Project: EE27036
GIS File: SW_AthabascaRiver.mxd
PDF File: SW_AthabascaRiver.pdf
Projection: 10TM
Datum: NAD83
Kilometres 1:2,500,000
0 15 30 60
Prepared by: amec
Figure 11-2



Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
0.01 - 10.00
10.01 - 100.01
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Petroleum
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Municipal
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Industrial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Agriculture
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
British Columbia
Saskatchewan
Lake Athabasca
Lesser Slave Lake
Athabasca River
High Prairie
Swan Hills
Slave Lake
Whitecourt
Hinton
Edson
Mayerthorpe
Barrhead
Westlock
Athabasca
Lac La Biche
Fort McMurray
07AA
07AB
07AC
07AD
07AE
07AF
07AG
07AH
07BB
07BC
07BD
07BE
07BF
07BH
07BJ
07BK
07CA
07CB
07CC
07CD
07CE
07DA
07DB
07DC
07DD
Alberta Environment
Athabasca River Basin
Groundwater Licenses
Date: March 2007
AMEC Project: EE27036
GIS File: GW_AthabascaRiver.mxd
PDF File: GW_AthabascaRiver.pdf
Projection: 10TM
Datum: NAD83
0 15 30 60
Kilometres
1:2,500,000
Prepared by: amec
Figure 11-3



Legend
Agriculture
Maximum Allowable Diversion (dam³/yr)
Groundwater Registrations
0.01 - 6.25
Surface Water Registrations
0.01 - 6.25
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
British Columbia
Saskatchewan
Athabasca Lake
Lesser Slave Lake
Athabasca River
High Prairie
Slave Lake
Swan Hills
Whitecourt
Hinton
Edson
Mayerthorpe
Barrhead
Westlock
Athabasca
Lac La Biche
Fort McMurray
07AA
07AB
07AC
07AD
07AE
07AF
07AG
07AH
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07BH
07BJ
07BK
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07DA
07DB
07DC
07DD
Alberta Environment
Athabasca River Basin Registrations
March 2007
EE27036
RG_AthabascaRiver.mxd
RG_AthabascaRiver.pdf
Kilometres
1:2,500,000
10TM
NAD83
amec
Figure 11-4

Table 11-2 2001 Urban and Rural Municipal Populations and Water Allocations within Athabasca River

Urban Municipal Name		2001 Population Within Basin	Water Source	Allocation (dam^3)
Towns	HINTON	9,405		
	WHITECOURT	8,334	Surface	4,811
	EDSON	7,585	Groundwater	2,207
	SLAVE LAKE	6,600	Surface	1,850
	WESTLOCK	4,819	Surface	1,480
	BARRHEAD	4,213	Surface	1,310
	LAC LA BICHE	2,776	Surface	777
	HIGH PRAIRIE	2,737	Surface	863
	ATHABASCA	2,415	Surface	808
	SWAN HILLS	1,807	Surface	660
	MAYERTHORPE	1,570	Groundwater	283
Villages	BOYLE	836		
	SANGUDO	377		
	KINUSO	231		
Summer Villages	WHISPERING HILLS	118		
	ISLAND LAKE SOUTH	76		
	ISLAND LAKE	71		
	BIRCH COVE	50		
	SUNSET BEACH	50		
	WEST BAPTISTE	46		
	SOUTH BAPTISTE	44		
	NAKAMUN PARK	31		
	LARKSPUR	21		
Total		**54,212**		**15,049**

Rural Municipal Name	2001 Population Within Basin	Water Source	Allocation (dam^3)
REGIONAL MUNICIPALITY OF WOOD BUFFALO	39,068	Surface	26,632
YELLOWHEAD COUNTY	9,232	Groundwater	139
COUNTY OF ATHABASCA No. 12	7,052		
LAC STE. ANNE COUNTY	5,922		
COUNTY OF BARRHEAD No. 11	5,730		
M, D.OF BIG LAKES	5,249	Surface	189
WESTLOCK COUNTY	5,009		
MUNICIPALITY OF JASPER	4,180		
WOODLANDS COUNTY	3,818	Groundwater	164
LAKELAND COUNTY	2,800	Surface	185
M.D.OF LESSER SLAVE RIVER No. 124	2,748	Surface	187
BRAZEAU COUNTY	2,502		
PARKLAND COUNTY	1,110	Groundwater	120
M.D. OF OPPORTUNITY No. 17	816		
M. D. OF GREENVIEW No. 16	460		
COUNTY OF THORHILD NO. 7	112		
NORTHERN SUNRISE COUNTY	96		
M.D. OF SMOKY RIVER No. 130	76		
IMPROVEMENT DISTRICT NO. 12	49		
IMPROVEMENT DISTRICT NO. 24	9		
IMPROVEMENT DISTRICT NO. 9	1		
IMPROVEMENT DISTRICT NO. 25	0		
Total	**96,041**		**120**

Table 11-3 2001 Populations and Water Allocations for Aboriginal Settlements in Athabasca River

Aboriginal Settlements/ Reserves	2001 Population Within Basin	Water Source	Allocation (dam^3)
DRIFTPILE RIVER BAND	693	Surface	160
PEAVINE MÉTIS SETTLEMENT	608	Surface	138
SUCKER CREEK BAND	588	Surface	133
EAST PRAIRIE MÉTIS SETTLEMENT	420		
SWAN RIVER FIRST NATION	305		
CHIPEWYAN PRAIRIE FIRST NATION	296		
FORT MCKAY FIRST NATION	264		
FORT MCMURRAY FIRST NATION	240		
HEART LAKE FIRST NATION	175		
BIGSTONE CREE NATION	88		
KAPAWE'NO FIRST NATION	79		
GIFT LAKE MÉTIS SETTLEMENT	54		
SAWRIDGE BAND	33		
ALEXIS BAND	1		
Total	**3,844**		**431**

Municipal licences allow up to 41,735 dam^3 of surface water to withdrawn and they account for 90 percent of total municipal water allocations. Urban users hold 53 licences that allow withdrawals of 39,922 dam^3 of surface water (96 percent). Seven licences allow rural users to withdraw 1,312 dam^3 of surface water.

Groundwater licences account for 10 percent of total municipal water allocations. A total of 4,362 dam^3 of groundwater has been allocated for municipal purposes with urban users holding 44 licences that allow withdrawals of up to 3,270 dam^3. Another 25 licences allow other municipal users, primarily camps, to withdraw up to with 902 dam^3 of groundwater.

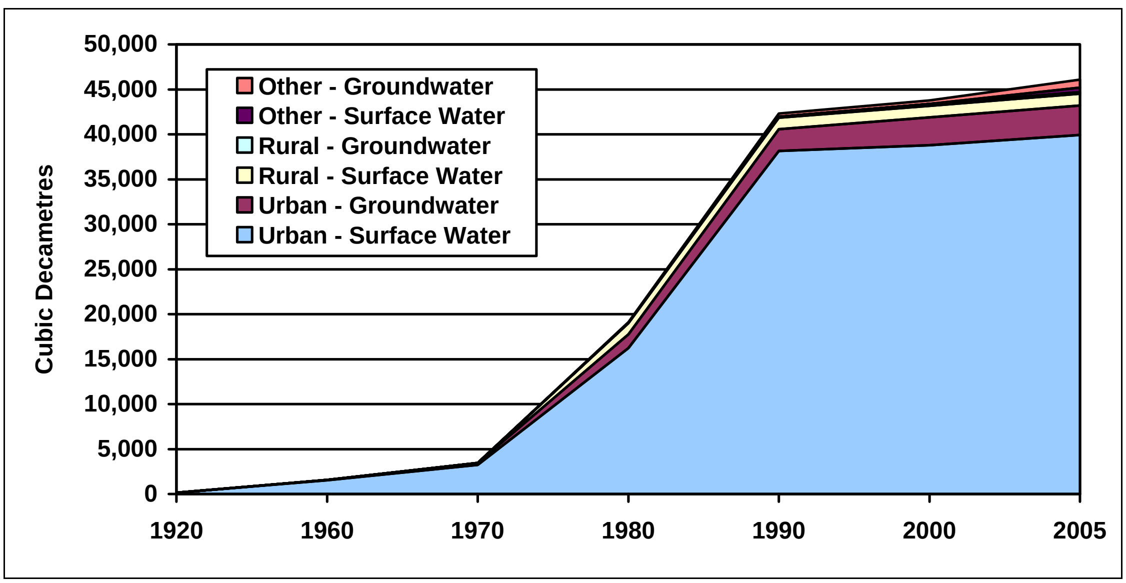
Tables 11-2 and 11-3 identify the urban and rural communities situated in the Athabasca River Basin that have large municipal water licences with allocations of 100 dam^3 or more. Although the Town of Hinton does not have its own water license, it is served under a licence held by the local West Fraser Timber Company which announced in early 2007 that it would end the agreement to provide the municipality with water within ten years. Large municipal water licences have also been issued to a number of other organizations and these are listed in Table 11-4. Theses include licence issued to the towns of Falher and McLennan and the Village of Donnelly, which are located within Peace/Slave Basin but draw their water from the Athabasca Basin. The licence database includes a current groundwater licence issued to the Village of Evansburg which has existed as a separate municipality since 1998 when it reverted to unincorporated hamlet status within the jurisdiction of Yellowhead County.

Table 11-4 Other Large Athabasca Basin Municipal Water Licences and Sources

Approval Holder	Water Source	Allocation (dam^3)
SYNCRUDE CANADA LTD	Surface	1,233
RANGER BOARD INC.	Surface	500
SUNCOR ENERGY INC.	Groundwater	438
TOWN OF FALHER	Surface	331
PRAIRIE MINES AND ROYALTY LTD.	Groundwater	292
TOWN OF MCLENNAN	Surface	216
VILLAGE OF EVANSBURG	Groundwater	213
VILLAGE OF DONNELLY	Surface	146

Figure 11-5 shows historical cumulative municipal water allocations in Athabasca Basin up to 2005. Municipal uses accounting for less than 0.1 percent of total allocations are not shown. Although urban surface water allocations predominate in Peace/Slave Basin, strong growth in all types of municipal allocations occurred from 1970 to 1990.

Figure 11-5 Athabasca Basin Historical Municipal Water Allocations



11.1.3 Licensed Water Use

Table 11-5 summarizes water licence information for the municipal sector in Athabasca River Basin. These licences assume that 8,907 dam^3 will be used, and the balance (37,190 dam^3) will be returned. This means that 19 percent of municipal allocations are expected to be consumed and/or lost. Return flow allowances in licences for urban municipalities range from 87 percent for surface water licences to 67 percent for groundwater. For rural users, there are no return flow allowances for surface water allocations, but 15 percent of maximum groundwater withdrawals are expected to be returned. There are also no return flow allowances in licences issued to other municipal users for surface water, but they are expected to return 28 percent of

groundwater allocations.

11.1.4 Actual Water Use

In 2005, 14 municipal licences reported their water diversions to the provincial government through the WURS. These licences had a total allocation of 34,427 dam^3, which represents 73 percent of municipal allocations in the basin. For 2005, these licences reported diverting 5,516 dam^3 or 16 percent of their allocations. The towns of Whitecourt and Westlock reported water return flows in 2005 totalling 2,365 dam^3. This represents 52 percent of the 4,954 dam^3 of water they actually diverted. Environment Canada's Municipal Water Use database (MUD) has water withdrawal information for 2001 for 13 municipalities that accounted for 64 percent of basin's population. However, only two of these (Jasper and Whitecourt) reported return flow.

Given the limited information available, estimates of actual use in 2005 were determined by combining data from both provincial and national databases. Estimates of diversions and return flows were determined by examining information for those licensees for whom there was information in both databases. Average estimates were calculated by combining the 2005 information from WURS with a 2005 population-adjusted estimate from MUD. Based on available information it appears that surface water users were withdrawing about 34 percent of their allocations and actually using 56 percent of withdrawals. Municipal groundwater users are estimated to have withdrawn 74 percent of their allocations and used 85 percent of withdrawals.

The resulting estimates of water use are shown in Table 11-6. It shows that municipal users are estimated to have withdrawn 17,341 dam^3 of water, used 5,580 dam^3 and returned the balance (11,833 dam^3). Under these assumptions, municipal groundwater users accounted for nine percent of total municipal allocations, 19 percent of actual withdrawals, and 29 percent of estimated consumption.

11.1.5 Future Water Use Forecasts

Figure 11-6 shows low, medium and high population projection scenarios for Athabasca Basin based on Alberta Finance Census Division projections. These population forecasts have been used to predict future municipal surface and groundwater use. The resulting forecasts of water use are provided in Table 11-7, and are based on the estimated per capita water use in 2005.

Table 11-5 Licensed and WURS Reported Diversions, Water Use and Returns by Type of Municipal Use for Athabasca Basin

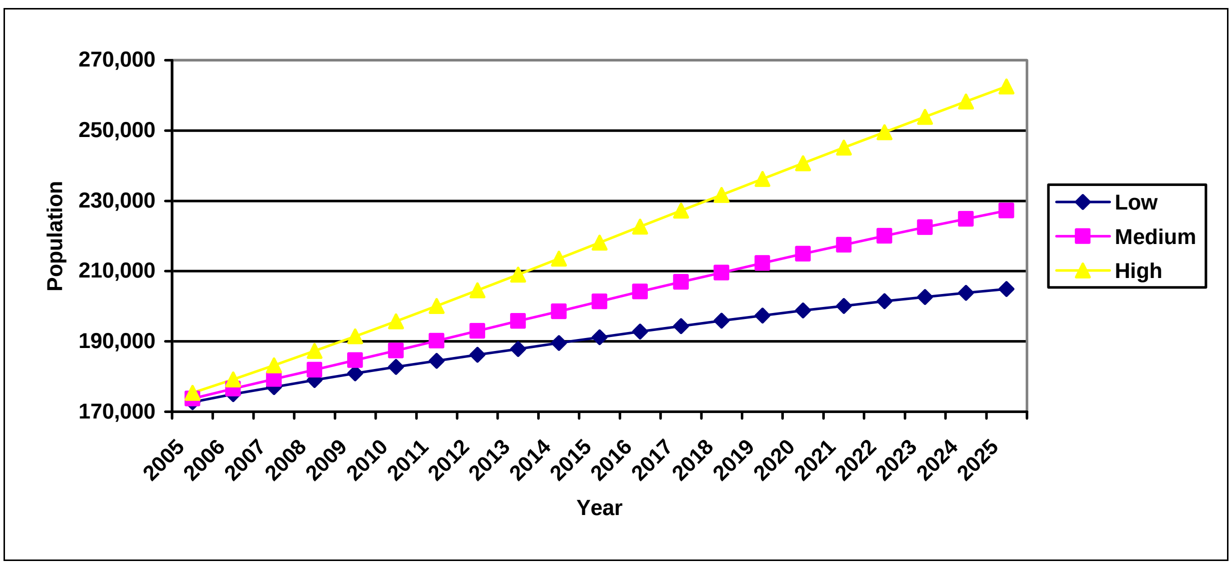
Water Use	Source	Number of Licenses	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Diversion	Reported Use	Return
Urban*	Surface	53	39,922	5,210	34,712	4,470	2,105	2,365
	Groundwater	44	3,270	1,073	2,197	307	N/A	N/A
	Subtotal	**97**	**43,192**	**6,283**	**36,910**	**4,777**	**2,105**	**2,365**
Rural**	Surface	7	1,312	1,312	0	50	N/A	N/A
	Groundwater	47	190	161	28	N/A	N/A	N/A
	Subtotal	**54**	**1,503**	**1,474**	**28**	**50**	**N/A**	**N/A**
Other***	Surface	1	500	500	0	N/A	N/A	N/A
	Groundwater	25	902	650	252	689	N/A	N/A
	Subtotal	**26**	**1,402**	**1,150**	**252**	**689**	**N/A**	**N/A**
Total	Surface	61	41,735	7,023	34,712	4,520	2,105	2,365
	Groundwater	116	4,362	1,885	2,477	996	N/A	N/A
	Total	**177**	**46,097**	**8,907**	**37,190**	**5,516**	**2,105**	**2,365**

* Urban includes villages, summer villages, towns, cities, hamlets;
** Rural includes condominiums / townhouses / mobile homes / complexes, hotels / motels, cooperatives, farmsteads, single-multi homes, colonies and subdivisions
*** Other includes camps, institutions, senior/correctional centres, nursing/children's homes, hospitals

Table 11-6 Estimated Municipal Water Use in the Athabasca River Basin

Municipal Use	Source	Withdrawals (dam^3)	Use (dam^3)	Return Flow (dam^3)
Urban	Surface	10,701	489	10,213
	Groundwater	1,970	646	1,324
	Subtotal	**12,671**	**1,135**	**11,536**
Rural	Surface	2,956	2,956	0
	Groundwater	428	363	65
	Subtotal	**3,384**	**3,319**	**65**
Other	Surface	458	458	0
	Groundwater	827	596	231
	Subtotal	**1,285**	**1,054**	**231**
Total Use	Surface	14,116	3,903	10,213
	Groundwater	3,225	1,605	1,620
	Total	**17,341**	**5,508**	**11,833**
Licensed Use	Surface	41,735	7,023	34,712
	Groundwater	4,362	1,885	2,477
	Total	**46,097**	**8,907**	**37,190**
Percent of Licensed Use	Surface	33.8%	55.6%	29.4%
	Groundwater	73.9%	85.1%	65.4%
	Total	**37.6%**	**61.8%**	**31.8%**

Figure 11-6 Athabasca Basin Population Growth Forecast



Under the low population growth scenario, municipal water use in 2025 is expected to be 19 percent greater than at present and diversions will be 45 percent of current MAD in 2025. Water use is expected to be 73 percent of current licensed use under the low population growth scenario in 2025. Under the high population growth scenario, water use will increase by 50 percent over current levels and total diversions (GW and SW) are expected to be 56 percent of current municipal MAD. Water use is expected to be 93 percent of current licensed use under

the high population growth scenario in 2025.

Table 11-7 Projected Water Use for the Municipal Sector in the Athabasca Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Population Growth	Surface	3,903	4,129	4,320	4,493	4,631
	Groundwater	1,605	1,698	1,777	1,847	1,904
	Total	**5,508**	**5,827**	**6,097**	**6,340**	**6,535**
Medium Population Growth	Surface	3,903	4,210	4,524	4,828	5,104
	Groundwater	1,605	1,731	1,860	1,985	2,099
	Total	**5,508**	**5,941**	**6,384**	**6,814**	**7,203**
High Population Growth	Surface	3,903	4,356	4,854	5,357	5,842
	Groundwater	1,605	1,791	1,996	2,203	2,403
	Total	**5,508**	**6,148**	**6,851**	**7,560**	**8,245**

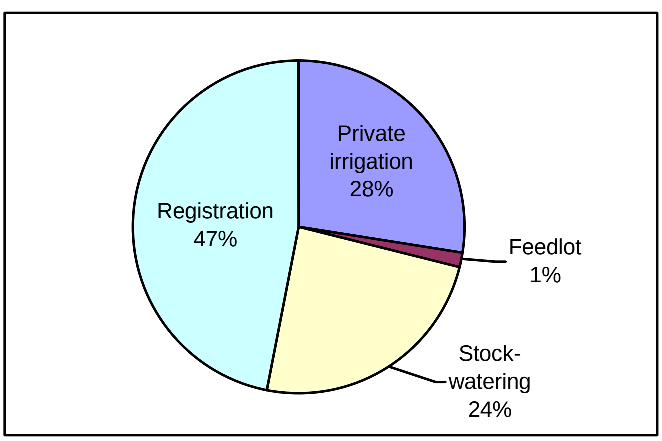
11.2 AGRICULTURAL SECTOR

As of December 2005 a total of 12,597 dam^3 had been allocated to the agricultural sector in the Athabasca River Basin. This includes 9,049 registrations representing 5,921 dam^3 and 932 licences representing 6,675 dam^3 of water. Water allocated to agriculture accounts for 1.6 percent of all allocations in the Athabasca River Basin.

Figure 11-7 shows how water allocations are distributed among the different agricultural uses in the basin. The largest allocation is for registrations (47 percent). Private irrigation accounts for 28 percent, stockwatering accounts for 24 percent, and feedlots accounts for one percent of the total allocation.

A total of 5,517 registrations and 216 licences allow withdrawals of up to 6,525 dam^3 of surface water; this accounts for 52 percent of all water allocations to the agricultural sector. There are 716 licences and 3,532 registrations that allow up to 6,073 dam^3 of groundwater diversion (48 percent of total allocation).

Figure 11-7 Water Allocations for Agricultural Activities in the Athabasca Basin



11.2.1 Overview of Agriculture in the Athabasca Basin

Based on information from the 2001 Census of Agriculture, there were about 5,822 farms in the Athabasca Basin. These farms accounted for 11 percent of all farms in Alberta. Farms in the Athabasca Basin cover an area of nearly 3.9 million acres; this is equivalent to about 16,000 km^2 or about 11 percent of the basin. Table 11-8 shows about 46 percent of the land in the basin is used to raise crops. About 40 per cent of the agricultural land is pasture. The rest of the lands are in summerfallow or other uses.

Table 11-8 Agricultural Land Use in the Athabasca River Basin, 2001

Land Use	Acres	Percent
Crop Land	1,812,556	45.5%
Summerfallow	105,359	2.6%
Tame/Seeded Pasture	675,963	17.0%
Natural Pasture	930,175	23.3%
Other	461,341	11.6%
Total	**3,985,393**	**100.0%**

Table 11-8 shows the classification of farms based on the commodity groups that accounted for 51 per cent or more of total gross farm receipts. The table shows that about 57 percent of the farms in the basin raise beef cattle and about 13 percent of the farms are field crop farms. Specialty farms make up about 12 percent of farms. The average size of the farms in the Athabasca Basin is smaller (684 acres) than the provincial average (970 acres). Like Alberta, the single largest farm type in the Athabasca Basin is cattle (beef) farm although its relative share is much higher than in Alberta. The relative distributions of other types of farms are similar for both Alberta and the Athabasca Basin except for wheat and grain and oilseed farms which the basin contains relatively lower proportion than Alberta.

Table 11-9 Classifications of Farms in the Athabasca Basin and Alberta, 2001

Farm Type (Farms with Gross Receipts >$2,500)	Percent of Farms in the Athabasca Basin	Percent Share of Alberta	Percent Alberta Farm Type
Dairy Farms	1.4%	9.4%	1.5%
Cattle (beef) Farms	56.0%	13.2%	45.4%
Hog Farms	2.0%	13.0%	1.7%
Poultry & Egg Farms	0.6%	6.8%	0.9%
Wheat Farms	2.2%	3.2%	7.4%
Grain & Oilseed Farms	10.1%	5.9%	18.4%
Field Crop Farms	12.5%	14.2%	9.3%
Fruit Farms	0.1%	6.7%	0.1%
Misc.Speciality Farms	11.4%	11.2%	10.9%
Sum of Livestock Comb. Farms	1.9%	9.0%	2.3%
Sum of Vegetable Farms	0.1%	9.5%	0.1%
Sum of Other Comb Farms	1.6%	8.9%	2.0%
Total	**100.0%**	**10.7%**	**100.0%**

11.2.2 Stockwatering

As noted in Table 11-9 about 60 percent of the farms in the Athabasca Basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species in 2001 are provided in Table 11-10. The table shows that there about 800,000 cattle and calves, which together, accounted for about 87 percent of livestock population in the basin. This is about 5.2 times the human population of the Athabasca River Basin. Other livestock in the Athabasca Basin included pigs, sheep and lamb, horses and ponies, bison, deer and elk.

Table 11-10 Estimated Livestock Populations in the Athabasca Basin and Alberta, 2001

Livestock Species	Basin Total	Alberta	Percent of Alberta
Hens and Chicken	788,329	12,175,246	6.5%
Turkey	4,756	864,438	0.6%
Cattle	571,914	6,615,201	8.6%
Calves	212,950	2,169,607	9.8%
Pigs	135,755	2,027,533	6.7%
Sheep and Lamb	32,608	307,302	10.6%
Horse and Ponies	16,672	159,962	10.4%
Bison	8,000	79,731	10.0%
Deer	1,069	8,331	12.8%
Elk	4,132	31,304	13.2%

11.2.2.1 <u>Water Allocation</u>

Overall, 9,933 licences and registrations have been issued for livestock watering, with total allocation amounting to 9,122 dam^3. Registrations account for 47 percent of total allocation. In addition to these allocations, farmers are able to obtain up to 1,250 m^3 of water for household purposes. The numbers of such households in the basin is not known. Furthermore, the numbers of “exempted agricultural” users are also not known in the Athabasca Basin.

A historical perspective on water used for livestock is provided in Figure 11-8. The figure shows that some registrations were issued with priority dates in the 1890s while licences for stockwatering began to be issued from the early 1900s. Allocations for stockwatering have risen steadily since the 1920s with groundwater registrations accounting for about half of the increase. The majority of licensed allocations for livestock were issued during the 1970s and 1980s, and there has been very little change since about 1990. As of 2005, around 10,000 dam^3 had been allocated. In Alberta there has been a trend toward livestock intensification, and the development of feedlots. In the Athabasca Basin, the first allocations for feedlots were issued in the 1990s but only account for about one percent of total livestock water allocation.

Figure 11-8 Historical Trends in Water Allocation for Livestock in the Athabasca Basin

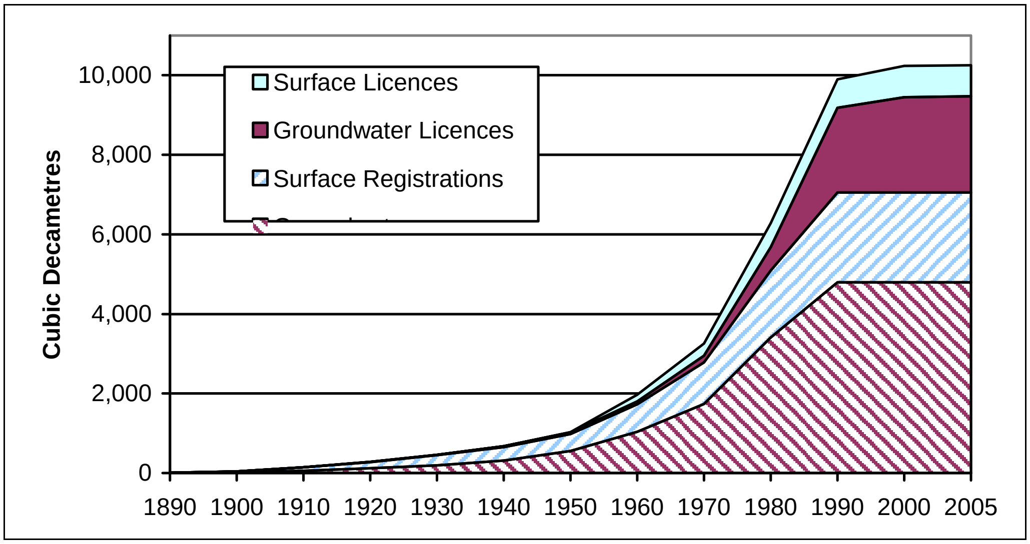


Table 11-11 summarizes the water licences and registrations issued for livestock according to the water source. The table shows that surface water accounts for about 60 percent of water allocations for livestock.

11.2.2.2 <u>Licensed Water Use</u>

Table 11-11 shows that none of the licences or registrations issued for livestock watering have any return flow allowances. Thus, all water withdrawals are expected to be used (i.e. consumed or lost).

Table 11-11 Summary of Water Licences and Registrations Issued for Livestock Watering in the Athabasca Basin

Activity	Source	Number of Licenses/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensee Reporting	Reported Use
Feedlot	Surface	1	30.8	30.8	0.0	0	N/A
	Groundwater	11	118.8	118.8	0.0	0	N/A
	Subtotal	**12**	**149.6**	**149.6**	**0.0**		
Stockwatering	Surface	168	753.9	753.9	0.0	0	N/A
	Groundwater	704	2,296.4	2,296.4	0.0	0	N/A
	Subtotal	**872**	**3,050.3**	**3,050.3**	**0.0**		
Registration	Surface	5,517	2,265.8	2,265.8	0.0	0	N/A
	Groundwater	3,532	3,656.0	3,656.0	0.0	0	N/A
	Subtotal	**9,049**	**5,921.9**	**5,921.9**	**0.0**		
Total	Surface	5,686	3,050.5	3,050.5	0.0	0	N/A
	Groundwater	4,247	6,071.3	6,071.3	0.0	0	N/A
	Total	**9,933**	**9,121.8**	**9,121.8**	**0.0**	0	N/A

11.2.2.3 Actual Water Use

There is no information in Alberta Environment's WURS that indicates the extent to which water allocations are actually used in the Athabasca Basin. However, a reasonable estimate of water use can be derived using the actual animal population in the basin as shown in Table 11-10. Based on livestock populations for the Athabasca Basin in 2001, the total water required for livestock was estimated to be 6,900 dam^3, or about 70 per cent of the licensed allocation. The calculations for this estimate are provided also in Table 11-12 which shows livestock populations in the basin and the daily water requirements for various livestock species as provided by Alberta Environment in its "Guide to Calculate Quantities for Water for Raising Animals". In terms of water requirements by species, cattle accounts for about 86 per cent of the total, about six percent is required by pigs, one percent is required by poultry and all other species accounted for the remaining seven per cent.

Table 11-12 Estimated Livestock Water Use Based on 2001 Animal Populations

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chickens	788,329	0.045	58.8
Turkey	4,756	0.15	1.2
Bulls	10,418	9.0	155.5
Milk Cows	6,547	30.0	325.7
Beef Cows	215,473	9.0	3,215.9
Heifers	77,342	6.0	769.5
Steers	46,475	6.0	462.4
Calves	212,950	3.0	1,059.4
Boars	877	6.5	9.5
Sows and Gilts - Breeding	14,680	6.5	158.2
Nursing and Weaner Pigs	41,432	0.5	34.4
Grower and Finishing Pigs	78,187	1.5	194.5
Sheep and Lambs	32,608	2.0	108.2
Horse and Ponies	16,672	10.0	276.5
Bison	8,000	2.0	26.5
Deer	1,069	10.0	17.7
Elk	4,132	3.5	24.0
Total			**6,898.0**

While the estimated actual consumption based on livestock populations (6,898 dam^3**)** appears to be less than the amount of water allocated (9,122 dam^3), the data in Table 11-12 do not include an allowance for the evaporative and seepage losses associated with storing water for livestock use. Typically, consumption accounts for only 35 per cent of surface water allocated for livestock use while losses account for 65 percent (Watrecon 2005). Since 66 percent of livestock water consumption comes from groundwater (no losses) and the balance comes from surface water with 65 per cent losses, a total allocation of about 8,055 dam^3 would be required to support the animal populations in Table 11-10. This water requirement is about 88 percent of licensed allocations and registration. Consequently, it is assumed that actual water use is

equivalent to the amount of water allocated for livestock.

11.2.2.4 Forecasts of Future Stockwatering Water Use

The key factor affecting future livestock water demand is the extent to which cattle populations in the basin will change over time. As noted above, cattle account for about 87 percent of livestock water demand in the Athabasca Basin, so changes in the populations of other livestock species will have a minimal overall impact on future water demand. Although the historical trend analysis in Figure 11-8 shows that the amount of water allocated for livestock has remained relatively unchanged since the 1990s, suggesting a stable livestock population over time, data from the Census of Agriculture shows that the cattle population increased by about 11 percent between 1996 and 2001. Thus, continued expansion of cattle populations and associated water use is expected.

Some indication of the potential for expansion of cattle populations in the Athabasca River basin can be determined by examining applications for new and expanded confined feeding operations, which must be approved by the NRCB in accordance with *AOPA*. Information from the NRCB indicates that, as of December 31, 2005, there had been 16 applications from farmers throughout the basin for cattle and dairy operations. A majority of these applications have been approved (Table 11-13).

Table 11-13 Status of Applications under *AOPA*

Type of Application	Number	Withdrawn	Approved	Denied
Approval	4	1	3	0
Registrations	4	0	2	2
Authorizations	8	1	6	1
Total	**16**	**2**	**11**	**3**

A study undertaken by Alberta Agriculture in the late 1990s also provides some insights regarding the potential for expansion of the beef industry in the province. That study identified several criteria - manure odour and population densities, local silage supplies, water supply, landscape characteristics and land for manure spreading – to be considered in evaluating the capability of supporting a 5,000-head backgrounding operation and a 20,000-head finishing operation.. Townships suitable for livestock expansions are shown in Figures 2-2 and 2-3 in Section 2.3. The townships that meet all of the criteria for backgrounding operations are mostly located in the Peace Region in northwest Alberta and along the southern edge of the cetrnal portion of the basin, north of Edmonton. For townships that meet some of the criteria for backgrounding operations, the limiting factors include silage, landscape and groundwater. Very few townships meet all of the criteria for finishing operations; these are mostly located in the Peace Region in northwest Alberta. The limiting factors for finishing operations are similar as backgrounding operations. Generally, there are relatively few townships that meet all the criteria and that more townships are capable of meeting all the criteria for a 5,000-head backgrounding operation than a 20,000-head operation. Based on AAFRD's assessment, it would appear that livestock expansion in the Athabasca River Basin could occur and would most likely consist of 5,000-head operations. The potential for future expansion of livestock

operations is also corroborated by the information from the NRCB.

For this analysis it is assumed that livestock populations and stockwatering requirements will increase over time. Given the relatively few townships identified by AAFRD that appear suitable for intensive livestock development, the projections are based on the expectations that cattle populations will increase at annual rates somewhere between 0.5 percent (Low Case) and 2.2 percent (High Case) which reflects average annual growth rate in cattle population in Alberta during 1958-2005. The Base Growth scenario assumes 1.2 percent annual growth. This forecast also assumes that the current mix of livestock (86 percent cattle) and balance of surface and groundwater use will remain unchanged over the forecast period. The resulting projections are shown in Table 11-14.

Table 11-14 Projected Water Use for Livestock in the Athabasca River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	3,502	3,591	3,681	3,774	3,869
	Groundwater	4,553	4,668	4,786	4,906	5,030
	Total	**8,055**	**8,258**	**8,467**	**8,681**	**8,900**
Medium Growth	Surface	3,502	3,717	3,946	4,188	4,446
	Groundwater	4,553	4,833	5,130	5,445	5,779
	Total	**8,055**	**8,550**	**9,075**	**9,633**	**10,225**
High Growth	Surface	3,502	3,905	4,353	4,854	5,412
	Groundwater	4,553	5,076	5,660	6,310	7,035
	Total	**8,055**	**8,981**	**10,013**	**11,164**	**12,447**

Under the Low Growth scenario, water demand is projected to increase to 8,900 dam^3 by 2025; this represents a 11 percent increase over current use, but is still less than current allocations contained in licences and registrations. Under the High Growth scenario, livestock water use would increase to 12,447 dam^3 by 2025; this represents a 55 percent increase over current livestock use and would exceed current allocations by about 2,500 dam^3. Current allocations are sufficient for water use until 2015 for the Low and Base Growth scenarios.

11.2.3 Irrigation

The other major use of water for agricultural purposes is irrigation or crop watering. There are no licences for district irrigation in the Athabasca Basin. The farmers in this basin are private irrigators who have their own water licences and divert water using their own pumps and water distribution equipment.

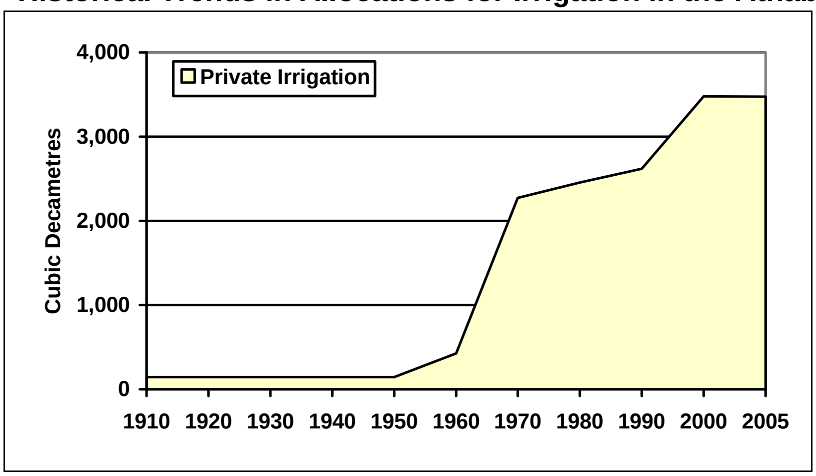
When aggregate information from the 2001 Census of Agriculture for individual counties and municipal districts is modified to reflect river basin boundaries, the resulting estimates suggest that 2,858 acres of land in the Athabasca River basin were irrigated in 2001. This number is not necessarily correct however, because irrigation acres are not evenly distributed throughout each county that makes up the Basin. Although the exact number of irrigated acres in the Athabasca River basin is not known, the acres can be estimated based on water allocations to private

irrigators and irrigation requirements of about 450 mm (18 inches). Based on the water allocation it is estimated that there are 2,858 acres. This number is very similar to the number derived from the Census. Although there is no information on the mix of crops grown by private irrigators, AAFRD has indicated that most private irrigation in Alberta is used to raise supplemental forages to feed livestock.

11.2.3.1 Water Allocation

There are 48 private licences that allow withdrawals of up to approximately 3,475 dam^3 for irrigation. Of this, more than 99 percent is from surface water sources. The Athabasca River Basin accounts for less than one percent of total private allocation in Alberta and about two percent of the private licences issued in the province. A historical perspective on water used for irrigation is provided in Figure 11-9. Allocations for irrigation date from 1910 and increased sharply during the 1960s and then again in the 1990s. Since 2000, allocations for irrigation have remained virtually unchanged at about 3,400 dam^3.

Figure 11-9 Historical Trends in Allocations for Irrigation in the Athabasca Basin



11.2.3.2 Licensed Water Use

Table 11-15 summarizes the water licences issued for crop watering and irrigation according to water source. It shows that up to 60 percent of the total allocation of surface water is expected be used and that 40 percent (1,382 dam^3) will be returned to surface sources.

Table 11-15 Irrigation Allocations and Use and Reported Actual Water Use, Athabasca River Basin

Activity	Source	Number of Licenses	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Water Use	Return	Water Use	Return	Water Use
Private irrigation	Surface	47	3,474.0	2,092.6	1,381.5	0	N/A
	Groundwater	1	1.2	1.2	0.0	0	N/A
	Subtotal	**48**	**3,475.3**	2,093.8	**1,381.5**	**0**	**N/A**
Total	Surface	47	3,474.0	2,092.6	1,381.5	0	N/A
	Groundwater	1	1.2	1.2	0.0	0	N/A
	Total	**48**	**3,475.3**	**2,093.8**	**1,381.5**	**0**	**N/A**

11.2.3.3 Actual Water Use

Neither AAFRD nor AENV has any information on actual water use by private irrigators. For the purposes of this study it is assumed that actual use is equal to licensed water use shown in Table 11-15. However, actual water use in any given year will depend on how much of the crop water demand can be satisfied by natural precipitation. It is noteworthy that stockwater use (8,055 dam^3) is nearly four times the amount of water that can be used for irrigation (2,094 dam^3).

11.2.3.4 Forecasts of Future Irrigation Water Use

With expansion of livestock, additional demand for livestock forage is expected. The historical trend provided as Figure 11-9 shows that water allocation for irrigation has increased over time, suggesting that past increases in livestock have led to increased water demand for expansion in irrigated crop areas. However, continued increases in the area used to raise crops are likely to be limited by combination of geography (northern location with limited growing season), and landscape (forested areas). Also, irrigation is a capital intensive operation but the net returns from forage production are not great (Watrecon 2005). These factors suggest that expansion of irrigation is not likely. It is assumed that available forage will be able to support modest increases in livestock populations. Irrigation water use is projected to remain at 2,094 dam^3 over the forecast period.

11.2.4 Summary

In summary, current agricultural water use in the Athabasca Basin is estimated to be about 10,149 dam^3, of which 80 percent is for livestock and 20 percent is for irrigation. In the future, agricultural water demand in the basin is expected to increase as a result of expansion of livestock populations. Irrigation water use is expected to remain constant. A summary of future agricultural water demand is provided in Table 11-16. Agricultural water use in 2025 under the Low Growth scenario would be about 10,993 dam^3, an increase of eight percent from 2005. Under the High Growth scenario, water use is projected to be 14,541 dam^3 by 2025 and this represents an increase of 43 percent from 2005).

Table 11-16 Projected Water Use for Agriculture in the Athabasca River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	5,595	5,683	5,774	5,867	5,962
	Groundwater	4,554	4,669	4,787	4,908	5,032
	Total	**10,149**	**10,352**	**10,561**	**10,774**	**10,993**
Medium Growth	Surface	5,595	5,810	6,038	6,281	6,538
	Groundwater	4,554	4,834	5,131	5,446	5,781
	Total	**10,149**	**10,644**	**11,169**	**11,727**	**12,319**
High Growth	Surface	5,595	5,997	6,446	6,946	7,504
	Groundwater	4,554	5,077	5,661	6,311	7,037
	Total	**10,149**	**11,074**	**12,107**	**13,258**	**14,541**

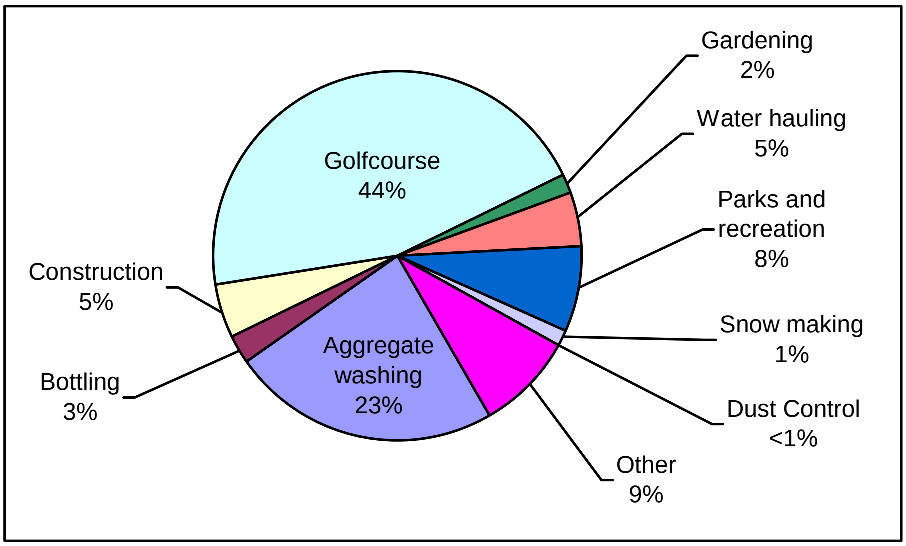
11.3 COMMERCIAL SECTOR

There are 161 licences that allow diversion of 3,801 dam^3 of water in the Athabasca Basin. Allocations for the commercial sector account for only 0.5 percent of total allocations in the Athabasca River Basin.

11.3.1 Water Allocations

As shown in Figure 11-10 the three largest allocations, golf course (44 percent), aggregate washing (23 percent) and other (nine percent) together account for 76 percent of the total allocation.

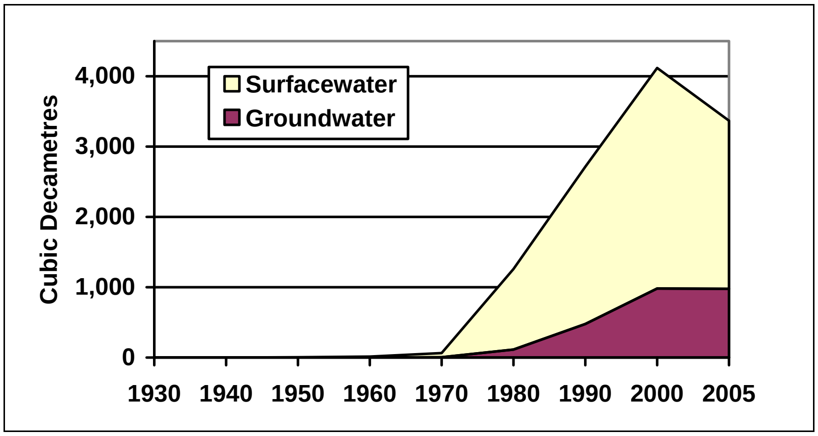
Figure 11-10 Water Allocation for Commercial Activities in the Athabasca Basin



Licences issued for the commercial sector allow maximum withdrawals of about 2,771 dam^3 of surface water (73 percent of allocation). The largest allocation is for golf courses which account for about 60 percent of the total surface water allocation. Licences issued for the commercial sector allow maximum withdrawals of 1,014 dam^3 of groundwater (27 percent of allocation). The largest allocation is for aggregate washing which accounts for about 40 percent of the total groundwater allocation.

A historical trend of commercial sector allocation in the Athabasca Basin is provided in Figure 11-10. The earliest allocation were issued in the 1930s but remained relatively small (less than 10 dam^3) until the 1970s. In the 1970s allocations of surface water increased rapidly and this continued until 2000, when allocations decreased by 24 percent. Groundwater allocations increased in the 1980s, continued to rise until 2000, and have remained constant since then.

Figure 11-11 Historical Trend in Commercial Sector Allocations in the Athabasca Basin



11.3.2 Licensed Water Use

Table 11-17 provides a summary of licensed water allocations, use and return for various activities within the commercial sector in the Athabasca Basin. The table shows that only 52 dam^3, which represents 1.4 percent of allocations mostly for surface water sources, is expected to be returned.

11.3.3 Actual Water Use

At the present time Alberta Environment's Water Use Reporting System (WURS) contains no information on actual water use in 2005 by the any of the licensees in the commercial sector in the Athabasca Basin (Table 11-17). Consequently, it is assumed that all licensees are withdrawing and using the full amounts of water to which they are entitled. While this assumption may overstate actual water use in the basin, the commercial sector accounts for 0.5 percent of total allocations so it will not appreciably affect overall water use estimate for the Athabasca Basin.

11.3.4 Forecasts of Future Water Use

Forecasts of future water use will focus on three activities: golf courses, aggregate washing and other commercial uses. Together these activities account for 76 percent of commercial allocations. Future water use for the other activities is assumed to remain at current levels.

Table 11-17 Licensed Commercial Allocations and Reported Actual Water Use, Athabasca Basin

Activity	Source	Number of Licenses	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Licensees Reporting	Reported Use	Percent of Allocation
Aggregate washing	Surface	15	512.0	478.7	33.3	0	N/A	N/A
	Groundwater	7	383.6	366.6	17.1	0	N/A	N/A
	Subtotal	**22**	**895.6**	**845.2**	**50.4**	**0**	**N/A**	**N/A**
Bottling	Surface	5	83.2	83.2	0.0	0	N/A	N/A
	Groundwater	5	20.2	20.2	0.0	0	N/A	N/A
	Subtotal	**10**	**103.4**	**103.4**	**0.0**	**0**	**N/A**	**N/A**
Construction	Surface	1	8.6	8.6	0.0	0	N/A	N/A
	Groundwater	2	163.8	163.8	0.0	0	N/A	N/A
	Subtotal	**3**	**172.5**	**172.5**	**0.0**	**0**	**N/A**	**N/A**
Golf course	Surface	22	1,699.6	1,699.6	0.0	0	N/A	N/A
	Groundwater	6	32.5	32.5	0.0	0	N/A	N/A
	Subtotal	**28**	**1,732.1**	**1,732.1**	**0.0**	**0**	**N/A**	**N/A**
Gardening	Surface	6	53.2	53.2	0.0	0	N/A	N/A
	Groundwater	7	8.7	8.7	0.0	0	N/A	N/A
	Subtotal	**13**	**61.8**	**61.8**	**0.0**	**0**	**N/A**	**N/A**
Water hauling	Surface	0	0.0	0.0	0.0	0	N/A	N/A
	Groundwater	3	165.4	165.4	0.0	0	N/A	N/A
	Subtotal	**3**	**165.4**	**165.4**	**0.0**	**0**	**N/A**	**N/A**
Parks and Recreation	Surface	10	82.4	80.7	**b**	0	N/A	N/A
	Groundwater	18	208.0	208.0	**0.0**	0	N/A	N/A
	Subtotal	**28**	**290.5**	**288.8**	**1.7**	**0**	**N/A**	**N/A**

Table 11-17 Licensed Commercial Allocations and Reported Actual Water Use, Athabasca Basin (continued)

Activity	Source	Number of Licenses	Licensed Allocation and Use (dam³)			Reported Actual Water Use (dam³)		
			Allocation	Water Use	Return	Licensees Reporting	Reported Use	Percent of Allocation
Snowmaking	Surface	2	54.3	54.3	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**2**	**54.3**	**54.3**	**0.0**	**0**	**N/A**	**N/A**
Dust control	Surface	39	1.0	1.0	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**39**	**1.0**	**1.0**	**0.0**	**0**	**N/A**	**N/A**
Food processing	Surface	0	0.0	0.0	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**0**	**0.0**	**0.0**	**0.0**	**0**	**N/A**	**N/A**
Other	Surface	7	276.3	276.3	0.0	0	N/A	N/A
	Groundwater	5	48.5	48.5	0.0	0	N/A	N/A
	Subtotal	**12**	**324.7**	**324.7**	**0.0**	**0**	**N/A**	**N/A**
Total	Surface	107	2,770.5	2,735.5	35.0	0	N/A	N/A
	Groundwater	53	1,030.7	1,013.6	17.1	0	N/A	N/A
	Total	**160**	**3,801.2**	**3,749.2**	**52.0**	**0**	**N/A**	**N/A**

11.3.4.1 Golf Courses

The water demand forecasts for golf courses employs the approach outlined in Watrecon (2005) which links water use to expansion of golf courses which is tied to population growth rates. The forecasts assume that the proportion of surface and groundwater use will not change over the forecast period. The resulting projections are shown in Table 11-18. Water use is expected to increase to 2,058 dam^3 by 2025 under the Low Growth scenario; this is a 19 percent increase from current use. Using the High Growth scenario, water demand is projected to increase to 4,377 dam^3 by 2025, and this is about 2.5 times higher than current water use.

Table 11-18 Projected Water Use for Golf Course, Athabasca Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,700	1,799	1,883	1,959	2,019
	Groundwater	33	34	36	38	39
	Total	**1,732**	**1,833**	**1,919**	**1,996**	**2,058**
Medium Growth	Surface	1,700	1,971	2,248	2,517	2,761
	Groundwater	33	38	43	48	53
	Total	**1,732**	**2,008**	**2,291**	**2,566**	**2,814**
High Growth	Surface	1,700	2,306	2,973	3,645	4,295
	Groundwater	33	44	57	70	82
	Total	**1,732**	**2,350**	**3,030**	**3,715**	**4,377**

11.3.4.2 Aggregate Washing

Projections are based on licensed allocations and use, as described in Table 11-17. Future demands for aggregate material (and water use) are assumed to reflect changes in the level of economic activity, particularly construction, so the projections are related to change in economic activity (GDP growth rate). Although Alberta is experiencing higher than average rate of GDP growth compared to historic levels, the water use forecasts use long term annual growth rates of 1.2 percent (Low Growth scenario), 2.2 percent (Medium Growth scenario) and 3.2 percent (High Growth scenario).

The resulting water use projections are shown in Table 11-19. Water use is expected to increase to 1,073 dam^3 by 2025 under the Low Growth scenario and this is 27 percent higher than current use. Using the High Growth scenario, water use is projected to increase to 1,587 dam^3 by 2025, almost double the current water use.

Table 11-19 Projected Water Use for Aggregate Washing, Athabasca Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	479	508	539	573	608
	Groundwater	367	389	413	438	465
	Total	**845**	**897**	**952**	**1011**	**1073**
Medium Growth	Surface	479	534	595	663	740
	Groundwater	367	409	456	508	567
	Total	**845**	**942**	**1051**	**1172**	**1306**
High Growth	Surface	479	560	656	768	899
	Groundwater	367	429	502	588	688
	Total	**845**	**989**	**1158**	**1356**	**1587**

11.3.4.3 Other Commercial Use

Water use for other commercial purposes is also assumed to be related to economic growth, so annual growth rates of 1.2, 2.2 and 3.2 percent have been used for the for Low, Medium and High Growth scenarios, respectively. Projections using these assumptions are shown in Table 11-20. Water use is expected to increase to 412 dam^3 by 2025 under the Low Growth scenario; this is a 27 percent increase from current use. For the High Growth scenario, water use is projected to increase to 610 dam^3 by 2025 which is almost double the current water use.

Table 11-20 Projected Water Use for Other, Athabasca Basin
(dam^3)

Source	Scenario	2005	2010	2015	2020	2025
Low Growth	Surface	276	293	311	330	351
	Groundwater	49	51	55	58	62
	Total	**325**	**345**	**366**	**388**	**412**
Medium Growth	Surface	276	308	343	383	427
	Groundwater	49	54	60	67	75
	Total	**325**	**362**	**404**	**450**	**502**
High Growth	Surface	276	323	379	443	519
	Groundwater	49	57	66	78	91
	Total	**325**	**380**	**445**	**521**	**610**

11.3.4.4 Summary

A summary of projected water demand for the commercial sector in the Athabasca Basin is provided in Table 11-21. This summary and projections are based on the water use estimates for the three activities listed above and assuming water use for the other activities remains constant over the forecast period. Under the Low Growth scenario, water use is projected to rise to 4,390 dam^3, a 17 percent increase from current levels by 2025. Under the High Growth scenario, water use is projected to rise to 7,421 dam^3 in 2025 and this is double current levels of use by the commercial sector.

Table 11-21 Projected Water Use for Commercial Sector in the Athabasca Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	2,736	2,881	3,014	3,143	3,258
	Groundwater	1,014	1,041	1,070	1,100	1,131
	Total	**3,749**	**3,922**	**4,084**	**4,242**	**4,390**
Medium Growth	Surface	2,736	3,093	3,468	3,845	4,208
	Groundwater	1,014	1,066	1,125	1,189	1,260
	Total	**3,749**	**4,160**	**4,593**	**5,034**	**5,469**
High Growth	Surface	2,736	3,471	4,288	5,137	5,993
	Groundwater	1,014	1,096	1,192	1,301	1,427
	Total	**3,749**	**4,567**	**5,480**	**6,439**	**7,421**

11.4 PETROLEUM SECTOR

In the Athabasca Basin, there are 333 active licences which allocate 561,685 dam^3 of water to the petroleum sector. These licences account for nearly 68 percent of total allocations in the Athabasca River Basin. The majority (88 percent) of all petroleum water allocations are for surface water. As shown in Figure 11-12, the petroleum sector includes water allocations for oilsands mining, thermal and gas and petrochemical plants. A small amount of water (less than 0.001 percent) is also allocated to other petroleum activities. Water allocated for oilsands mining accounts for almost 90 percent of licenced allocations issued to the petroleum sector.

Figure 11-12 Petroleum Water Allocation by Use in the Athabasca Basin

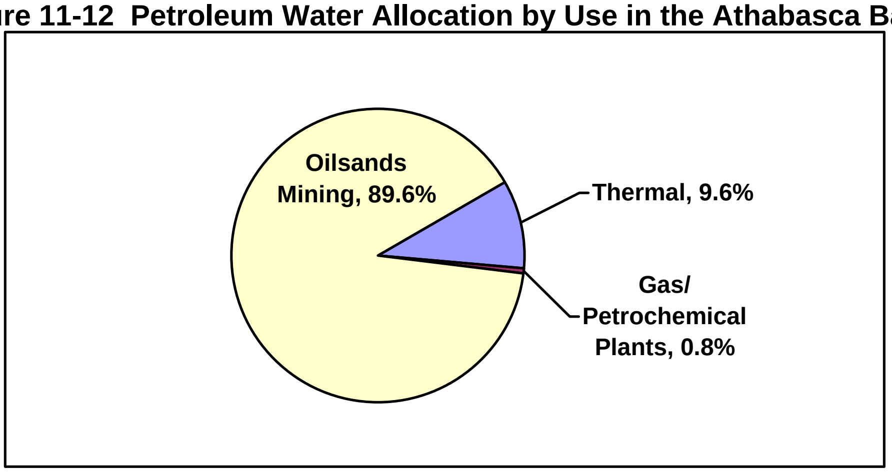


Table 11-22 summarizes the water allocation, use, and return associated with the licences for each activity in the Athabasca Basin. This table is based largely on information from the EMS database but, in reviewing the licence information, AENV determined that the database was inconsistent with the contents of the actual licences issued to some oilsands operators. Thus, the information in Table 11-22 is different from the EMS database but provides a more reliable description of licensed allocations.

Table 11-22 Licensed Allocations and Estimated Water Use by the Petroleum Sector, Athabasca Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Thermal *	Surface	35	38,211.6	35,394.2	2,817.4	8,108	22.9%	21.2%
	Groundwater	204	15,583.2	15,583.2	0.0	3,430	22.0%	22.0%
	Subtotal	**239**	**53,794.8**	**50,977.3**	**2,817.4**	**11,538**	**22.6%**	**21.4%**
Oilsands Mining **	Surface	22	471,272.8	433,064.6	38,208.2	158,077	36.5%	33.5%
	Groundwater	27	52,418.4	52,418.4	0.0	12,224	23.3%	23.3%
	Subtotal	**49**	**523,691.2**	**485,483.0**	**38,208.2**	**170,302**	**35.1%**	**32.5%**
Gas/Petrochemical Plant ***	Surface	3	1,609.0	1,609.0	0.0	546	34.0%	34.0%
	Groundwater	33	2,689.6	2,492.4	197.2	1,272	51.0%	47.3%
	Subtotal	**36**	**4,298.6**	**4,101.4**	**197.2**	**1,818**	**44.3%**	**42.3%**
Other Petroleum***	Surface	0	0.0	0.0	0.0	0		
	Groundwater	4	7.1	7.1	0.0	7	100.0%	100.0%
	Subtotal	**4**	**7.1**	**7.1**	**0.0**	**7**	**100.0%**	**100.0%**
Total	Surface	60	511,093.4	470,067.8	40,025.6	166,732	35.5%	32.6%
	Groundwater	268	70,698.3	70,501.1	197.2	16,933	24.0%	24.0%
	Total	**328**	**581,791.7**	**540,568.8**	**41,222.8**	**183,664**	**34.0%**	**31.6%**

* Estimated water use based on Geowa.
** Estimated water use based on Alberta Environment for withdrawals from the Athabasca River and 100% from other sources.
*** Estimated water use is based on WURS data.
*** Estimated water use assumes 100% use.

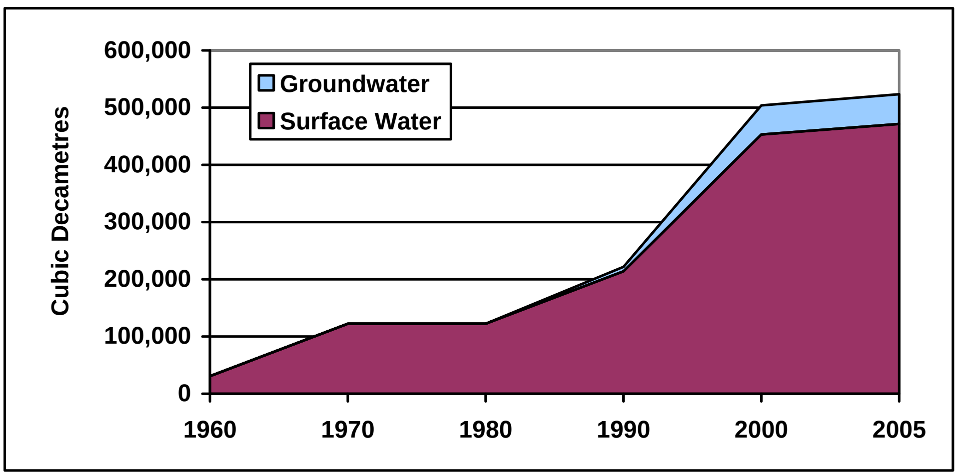
11.4.1 Oilsands Mining

11.4.1.1 Water Allocations

Table 11-22 shows that 49 licences have been issued for oilsands mining and total allocations amounted to 523,691 dam^3. Although the majority of these licences (57 percent) have been issued for groundwater, groundwater allocations only account for 52,418 dam^3, or 10 percent of total allocations. Surface water licences account for the other 90 percent of water allocated to oilsands mining.

The first allocations of surface water for oilsands activities in the Athabasca River Basin commenced in the 1960s, grew rapidly until 2000, and remained relatively constant to 2005. Figure 11-13 shows that there has also been an increase in groundwater allocations between 1990 and 2000 and between 2000 and 2005.

Figure 11-13 Historical Trends in Water Allocations for Oilsands Mining



The largest allocations are for six major oilsands projects. These include:

- Suncor, including the Voyageur projects
- Syncrude
- Albian Sands Project
- Fort Hills Project (Petro-Canada/UTS Energy/Teck Cominco)
- Horizon Project (Canadian Natural Resources Limited (CNRL))
- Jackpine Project (Shell Canada)

Current allocations of surface and groundwater for these projects and a number of minor projects that rely solely on groundwater are provided in Table 11-23. The table shows that the largest licences for surface water allocations have been issues to CNRL (25 percent) and Syncrude (21 percent). Licences issued for withdrawals from the Athabasca River account for 69 percent of surface allocations. Other surface water bodies, such as the Muskeg, North Steepbank and Tar rivers and Beaver and McLean creeks account for another 13 percent of allocations. The balance (eight percent) allows Syncrude to capture and use surface run-off.

Table 11-23 Licensed Allocations for Oilsands Projects

Licensee	Athabasca River (dam^3)	Other Surface (dam^3)	Surface Run-Off (dam^3)	Ground-water (dam^3)	Total (dam^3)
Albian Sands Energy Inc.	55,100	3,830	0	7,130	66,060
Canadian Natural Resources Limited	79,320	34,700	0	7,301	121,321
Fort Hills Energy Corporation	39,270	0	6,847	6,665	52,782
Shell Canada Limited	63,500	8,900	0	26,000	98,400
Suncor Energy Inc.	62,825	3,390	16,235	3,839	86,289
Syncrude Canada Ltd	61,675	15,557	20,124	1,255	98,611
Other	0	0	0	228	228
Total	**380,312**	**66,377**	**43,206**	**52,418**	**523,691**

11.4.1.2 Licensed Water Use

The licence information provided in Table 11-22 shows that 93 percent of allocations for oilsands mining are expected to be used. The balance (seven percent or 38,208 dam^3) is expected to be returned after use. There are no return flow allowances in licences issued for use of groundwater.

11.4.1.3 Actual Water Use

Of the six previously mentioned oilsands projects only Suncor, Syncrude and Albian Sands were operating in 2005. These projects are licensed to use water from a variety of sources including the Athabasca River and its tributaries, groundwater, and surface runoff. Actual water use information for these sources is not available. For the purposes of this report, actual water use was estimated based on reported withdrawal information for the Athabasca River licences and assuming licence holders are using the full capacity of their licences from other sources.

Most (80 percent) of Suncor, Syncrude and Albian Sands' water licences are for withdrawals from the Athabasca River. These licence holders reported withdrawing 98,942 dam^3 of fresh water from the Athabasca River for oilsands mining in 2005 (AENV). Assuming that they are using the full entitlement of their licences for the remaining water sources, it is estimated that oil sands mining in the Athabasca Basin used a maximum of 170,302 dam^3 of fresh water in 2005. This volume includes 128,081 dam^3 of surface water (98,942 dam^3 from the Athabasca, 22,777 dam^3 from other surface water sources and 36,359 dam^3 from surface run-off) and 12,224 dam^3 of groundwater. This estimate for water use other than Athabasca River likely overstates water use for the reason that operators are encouraged to use other surface and groundwater sources before using the Athabasca River and, under the recently released management framework for the Lower Athabasca River, operators may be required to use water from alternate sources if water flows in the Athabasca River drop below specified thresholds. Consequently, it is unlikely that the full extent of all allocations from all sources would be used in any given year.

Overall, the three operators are estimated to have used at least 98,942 dam^3 and at most

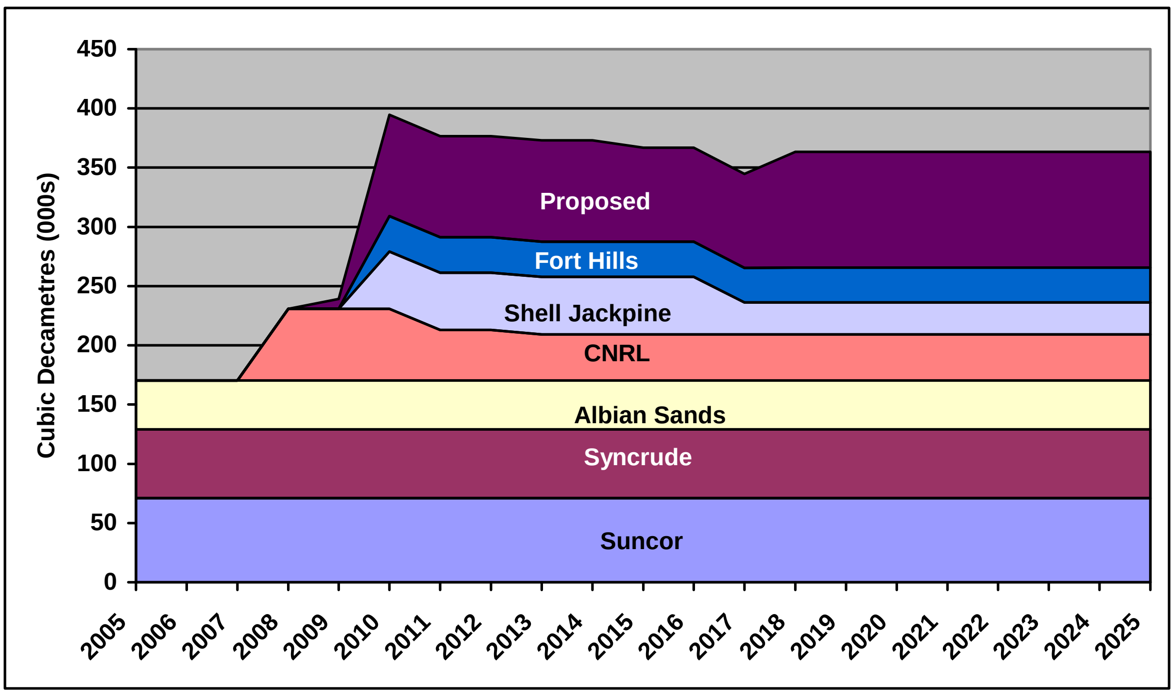
170,302 dam^3 in 2005, about 39 to 68 percent of the water that they were licensed to withdraw.

11.4.1.4 Forecasts of Future Water Use

Forecasts provided by AENV indicate that, based on current and proposed projects, water use for oilsands mining in the Athabasca River is expected to increase until at least 2015. These forecasts assume that water use by the three existing operations will remain constant and that water use will rise as the three additional major projects (Jackpine, Horizon, Fort Hills) come on line. AENV's forecasts also include water requirements for three proposed projects: Imperial Oil/Exxon Kearl mine, Deer Creek (Total E&P Canada) Joslyn North Mine Project, and Synenco Energy/SinoCanada Petroleum Northern Lights Mining and Extraction Project.

Figure 11-14 shows that, based on AENV's forecast, water use from the Athabasca River Basin will more than double by 2010 and then start to decline as new projects improve their operating efficiencies. Actual water use for the existing and currently-proposed major projects from the Athabasca River is expected to stabilize at about 363,300 dam^3 after 2017.

Figure 11-14 Estimated Water Use for Major Oilsands Mines from the Athabasca River Basin



This water will come from a combination of the Athabasca River, other surface water sources and groundwater, with the mix varying from year to year because each operator relies on a different mix of water sources. However, the general pattern consists of 63 percent from the Athabasca River, 26 percent from other surface water sources (including run-off), and 11 percent from groundwater.

The Medium Growth scenario for oilsands mining in the Athabasca basin in Table 11-24 is

based on the AENV forecasts for the major projects and assuming that smaller operations continue to operate as they currently do. This scenario is generally consistent with bitumen production forecasts from the EUB which suggest that volumes of mined bitumen will increase from 99,400 m^3 per day in 2005 to about 286,000 m^3 per day in 2015, an increase of 187 percent. Under AENV's forecast, water use is projected to more than double (an increase of 114 percent) by 2025.

Table 11-24 Forecast of Oilsands Mining Water Use in the Athabasca Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	158,077	265,240	262,201	295,225	328,028
	Groundwater	12,224	30,750	31,272	31,715	35,239
	Total	**170,301**	**295,991**	**293,473**	**326,940**	**363,266**
Medium Growth	Surface	158,077	353,654	327,751	328,028	328,028
	Groundwater	12,224	41,000	39,090	35,239	35,239
	Total	**170,301**	**394,654**	**366,841**	**363,266**	**363,266**
High Growth	Surface	158,077	353,654	327,751	354,372	380,716
	Groundwater	12,224	41,000	39,090	39,.057	42,874
	Total	**170,301**	**394,654**	**366,841**	**393,428**	**423,590**

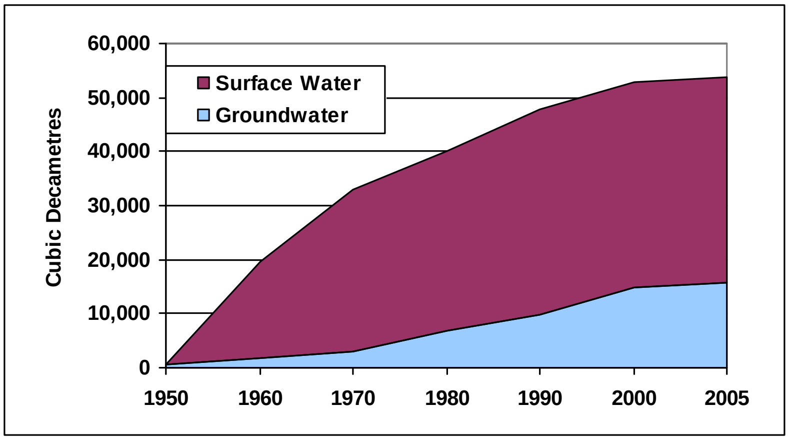
For the Low Growth scenario it is assumed that development of new projects will be delayed so that there is less water use in 2010 but, by 2020, the water use requirements will be the same. The High Growth scenario assumes that two new major oilsands mines each requiring 50,000 dam^3 will be constructed after 2015, with the result that water use in 2025 will be 17 percent higher than for the Medium Growth scenario.

11.4.2 Thermal Recovery

11.4.2.1 <u>Water Allocations</u>

Table 11-22 shows that licences issued for thermal recovery (53,795 dam^3) account for less than 10 percent of total allocations for the petroleum sector in the Athabasca River Basin. Surface water licences account for 71 percent of allocations for thermal recovery. The majority of licences (85 percent) are for groundwater, but they only account for 29 percent of total allocations. The first groundwater licences for thermal recovery were issued in the 1960s and allocations have increased steadily since then, although the rate of increase slowed after 1990. Figure 11-15 shows that allocations of surface water for thermal recovery increased significantly between 1980 and 1990, decreased slightly by 2000, and have remained constant since then.

Figure 11-15 Historical Trends in Water Allocations for Thermal



11.4.2.2 Licensed Water Use

As shown in Table 11-22, the licences issued for thermal recovery purposes assume that 95 percent of allocations will be used. There are no return flow allowances for groundwater used for thermal recovery and only seven percent of surface water diversions will be returned.

11.4.2.3 Actual Water Use

Detailed estimates of water used for thermal proposes have been prepared by Geowa based on EUB data and are presented in Table 11-22. The assessment determined that an estimated 11,538 dam^3 of fresh water was diverted for thermal purposes in 2005. This volume includes 8,108 dam^3 of surface water and 3,430 dam^3 of groundwater. Thermal recovery also used 156 dam^3 of saline water.

11.4.2.4 Forecasts of Future Water Use

According to recent forecasts from the EUB and CAPP, the general trend in Alberta is for bitumen production to increase as fields are developed. The EUB forecasts that in situ crude bitumen production (thermal) will increase from 69,700 m^3 per day in 2005 to 170,000 m^3 per day by 2015. CAPP forecasts that in situ crude oil production (thermal) will increase to 277,433 m^3 per day by 2015, and then decrease to 274,094 m^3 per day by 2020.

The Athabasca/Peace basin is expected to follow the overall Alberta production trend since the province's most important oilsands deposits, the Athabasca Wabiskaw-McMurray (AWM), are located within the basin (EUB, 2006). The forecast of future water use for thermal recovery in the Athabasca River Basin assumes that the amount of water required for thermal activities will follow the trend in bitumen production: water use will increase significantly to 2015 and then decline. The forecasts in Table 11-25 assume that the current ratio of surface to groundwater use remains constant during the forecast period and estimates for 2010 and 2020 assume no change from previous five years.

Table 11-25 Forecast of Water Use for Thermal Recovery in the Athabasca River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	8,109	8,109	30,661	30,661	29,928
	Groundwater	3,430	3,430	12,969	12,969	12,659
	Total	**11,538**	**11,538**	**43,630**	**43,630**	**42,586**
Medium Growth	Surface	8,109	8,109	32,275	32,275	31,503
	Groundwater	3,430	3,430	13,651	13,651	13,325
	Total	**11,538**	**11,538**	**45,926**	**45,926**	**44,828**
High Growth	Surface	8,109	8,109	54,183	54,183	52,879
	Groundwater	3,430	3,430	22,918	22,918	22,366
	Total	**11,538**	**11,538**	**77,101**	**77,101**	**75,246**

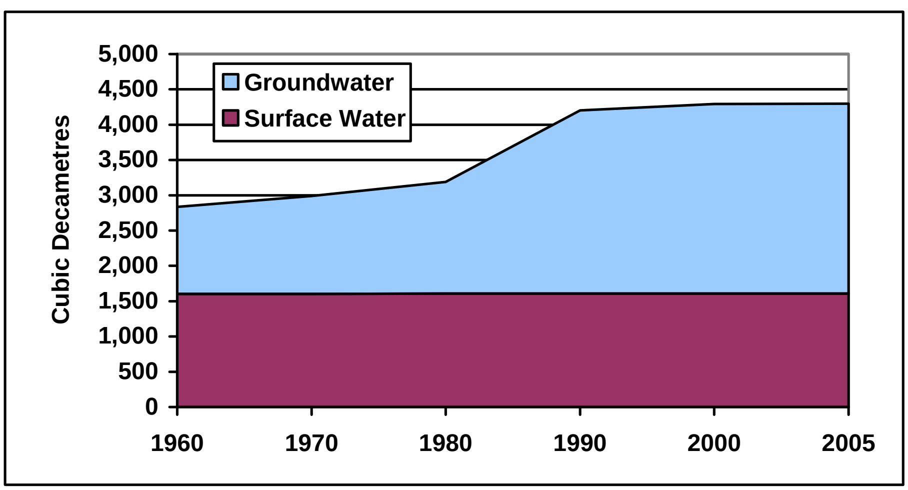
Under the Low Growth scenario, water use for thermal recovery will increase by 378 percent by 2015 and then decline by 2.5 percent by 2025. Under the High Growth scenario, the increase will be 668 percent by 2015 with a 2.5 percent decrease to 2025.

11.4.3 Gas/ Petrochemical Plants

11.4.3.1 Water Allocations

Less than one percent of the water allocations for the petroleum sector in the Athabasca basin are for gas/petrochemical plants (4,299 dam^3). This allocation consists of 37 percent surface water and 63 percent groundwater. The first surface water licences were issued in the 1960s and have slightly increased since then. Figure 11-16 shows that, in the 1960s, allocations of surface water and groundwater were nearly the same but, groundwater allocations have increased significantly in the 1980s and have remained constant since 1990.

Figure 11-16 Historical Trends in Water Allocations for Gas/ Petrochemical Plants



11.4.3.2 Licensed Water Use

Table 11-22 shows that the licences issued for gas and petrochemical plants assume that 95 percent of allocations will be used. There are no return flow allowances in licences for surface water but it is expected that up to seven percent of groundwater withdrawals will be returned.

11.4.3.3 Actual Water Use

The WURS database has use information for 17 of the 36 water licences for gas/petrochemical plants. The licensees who reported accounted for 98.5 percent of total allocations for gas/petrochemical plants. In 2005 they reported diverting approximately 44 percent of their licensed allocations and 42 percent of their total licensed water use. Reported use ranged from 34 percent of surface water withdrawals to 51 percent of groundwater withdrawals. These percentages have been used to estimate water use for all licensees. Thus, estimated water use by gas/petrochemical plants in the Athabasca River Basin is estimated to be 1,820 dam^3 for 2005 (1,270 dam^3 for surface water, 550 dam^3 for groundwater).

11.4.3.4 Forecasts of Future Water Use

Future water requirements for gas/petroleum plants will ultimately depend on whether raw bitumen is upgraded in Alberta or exported for upgrading elsewhere. For purposes of this assessment it is assumed that at least one upgrader will be developed in the Athabasca River Basin by 2015. Water requirements will depend on the capacity of the upgrade and the technology adopted. For purposes of this analysis, it is assumed that the upgrader would have a production capacity of 250,000 bbl per day and would require approximately 8,000 dam^3 of surface water. Upgraders typically have a seasonal water demand that is higher in May to October and lower in November to April. Due to uncertainty about the future requirements for upgrading, the forecast assumes that no additional upgraders will be developed in the basin after 2015. Forecast use of groundwater is expected to remain constant over the 20-year forecast period.

Table 11-26 Forecast of Gas/Petrochemical Plant Water Use in the Athabasca Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Medium Growth	Surface	546	546	8,546	8,546	8,546
	Groundwate	1,272	1,272	1,272	1,272	1,272
	Total	**1,818**	**1,818**	**9,818**	**9,818**	**9,818**

11.4.4 Other Petroleum

Only 7.1 dam^3 of groundwater have been allocated for other petroleum uses; this accounts for less than 0.001 percent of the allocations for the petroleum sector in the Athabasca basin. These licences were issued in the 1960s and have increased slightly since then. The licensees are not expected to return any of the water they divert. In the absence of actual water use for

these activities, it is assumed that in 2005 they used all the water they were licensed to use and that water use will remain constant over the forecast period.

11.4.5 Summary

The petroleum sector in the Athabasca River Basin is dominated by water allocations for oilsands mining. Oilsands mining accounted for almost 90 percent of allocations and 95 percent of actual water use in 2005. Water use data shows that although water licences are allowed to consume up to 518,609 dam^3 of water for petroleum purposes, licensees are only using 29 percent of this amount; this reflects the fact that only three of six licensed oilsands mines were actually operating in 2005.

In the future, there is expected to be an increase in the amount of water used for oilsands activities as bitumen production increases. The overall water use projections for the petroleum sector are provided in Table 11-27 and are based on the forecasts presented in Tables 11-24 to 11-26 for the individual activities within the sector. Forecasts assume that the amount of water used by other petroleum activities remains the same over time.

Table 11-27 Forecast of Petroleum Water Use in the Athabasca Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	166,732	273,895	301,408	334,432	366,502
	Groundwater	16,933	35,459	45,520	45,963	49,177
	Total	**183,665**	**309,355**	**346,928**	**380,395**	**415,678**
Medium Growth	Surface	166,732	362,309	368,572	368,849	368,077
	Groundwater	16,933	45,709	54,020	50,169	49,843
	Total	**183,665**	**408,018**	**422,592**	**419,017**	**417,919**
High Growth	Surface	166,732	362,309	390,480	417,101	442,141
	Groundwater	16,933	45,709	63,287	63,254	66,519
	Total	**183,665**	**408,018**	**453,767**	**480,354**	**508,660**

Table 11-27 shows that, for all three scenarios, the overall demand for water in the Athabasca River Basin is expected to increase significantly until 2015. After 2015, significant increases are predicted under the High Growth scenario which assumes that two new oilsands mines will be built. For all scenarios, water use in 2025 will be more than double current use. For the High Growth scenario water use in 2025 is forecast to be 2.8 times than estimated use in 2005. Both the Low and Medium Growth scenarios have water demand in 2025 being about 2.3 times higher than in 2005.

11.5 INDUSTRIAL SECTOR

In the Athabasca River Basin, 44 licences have been issued to the industrial sector and allow up to 145,367 dam^3 of water to be withdrawn. These industrial allocations account for over 17 percent of total allocations in the basin. The majority (96 percent) of industrial water allocations are for surface water. As shown in Figure 11-17, the industrial sector in the

Athabasca River Basin includes water allocations for cooling, forestry, coal mining, and other industrial activities.

Figure 11-17 Industrial Water Allocation by use in the Athabasca Basin

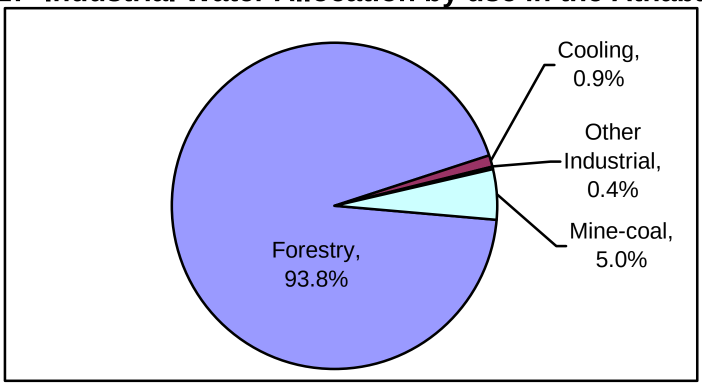


Table 11-28 summarizes the water allocation, use, and return associated with the licences for each activity in the Athabasca River Basin.

11.5.1 Cooling

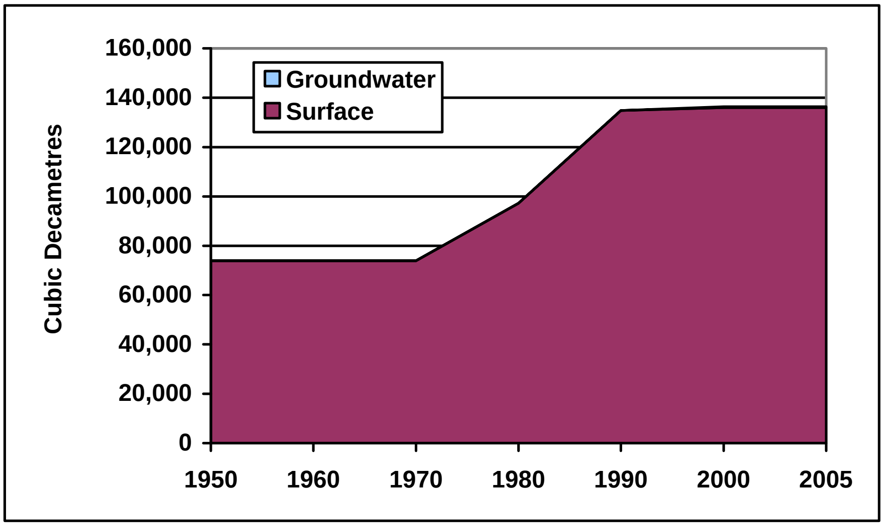
Two licences have been issued for cooling purposes accounting for less than one percent of the total industrial allocations in the Athabasca River Basin. The licences allow withdrawals of up to 1,232 dam^3 of surface water and 16 dam^3 of groundwater. Cooling water allocations commenced in the 1920s and increased in the 1940s and have remained constant since then for surface and groundwater. Licensees are expected to consume 100 percent of the water they are allocated. There is no information on actual water diversions and consumption for cooling purposes and, for purposes of this analysis, it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by cooling activities in the Athabasca Basin will remain constant for the forecast period.

11.5.2 Forestry

11.5.2.1 <u>Water Allocations</u>

Nearly 94 percent of the allocations for the industrial sector in the Athabasca River Basin are for forestry activities (136,288 dam^3). This includes six groundwater licences for 356 dam^3 and six surface water licences with a total allocation of 135,932 dam^3. As shown in Figure 11-18, the first surface water licences for forestry purposes were issued in the 1950s, and allocations have increased since the 1980s. Licences allowing groundwater use for forestry allocations were issued in the 1990s and, although the allocations have increased since then, groundwater allocations only account for six percent of total allocations for the forest industry.

Figure 11-18 Historical Trends in Water Allocations for Forestry Activities



The six major surface water licences have been issued to five pulp mills located throughout the basin. As noted in Table 11-29, the largest of the mills is located in Hinton; there are two mills in Whitecourt; the smallest of the pulp mills is at Slave Lake; and the second largest mill is located near Athabasca.

Table 11-28 Water Surface Water Allocations for Pulp Mills, Athabasca River Basin

Name	Location	Licensed Diversion and Use (dam^3)		
		Allocation	Use	Return
Alberta Newsprint Company	Whitecourt	14,802	1,480	13,322
Alberta Pacific Forest Industries Inc.	Athabasca	36,388	8,610	27,778
Millar Western Forest	Whitecourt	9,500	936	8,564
Slave Lake Pulp	Slave Lake	1,233	56	1,178
West Fraser	Hinton	74,009	6,439	67,570
Total		**135,932**	**17,521**	**11,8412**

11.5.2.2 Licensed Water Use

Table 11-28 shows that the licences issued to forestry expect that 87 percent of surface water withdrawals will be returned but 100 percent of diversions of groundwater will be consumed. Total return flow allowances in licences amount to 118,411 dam^3.

11.5.2.3 Actual Water Use

The Alberta Forest Products Association (AFPA) provided actual 2004 water use data for pulp mills in the basin. The five pulp companies are entitled to withdraw up to 135,932 dam^3 of surface water and are licensed to use 17,521 dam^3. According to the AFPA, water use by these pulp mills amounted to 12 percent of their allocations and 92 percent of licensed water use.

Table 11-29 Licensed Allocations and Estimated Water Use by the Industrial Sector, Athabasca River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Cooling	Surface	1	1,232.0	1,232.0	0.0	1,232.0	100.0%	100.0%
	Groundwater	1	16.4	16.4	0.0	16.4	100.0%	100.0%
	Subtotal	**2**	**1,248.4**	**1,248.4**	**0.0**	**1,248.4 ** **	**100.0%**	**100.0%**
Forestry	Surface	6	135,931.7	17,520.5	118,411.3	16,070.5	91.7%	11.8%
	Groundwater	6	356.3	356.3	0.0	356.3	100.0%	100.0%
	Subtotal	**12**	**136,288.1**	**17,876.8**	**118,411.3**	**16,426.8 ***	**91.9%**	**12.1%**
Chemical Plants	Surface	2	14.8	14.8	0.0	14.8	100.0%	100.0%
	Groundwater	2	2.5	2.5	0.0	2.5	100.0%	100.0%
	Subtotal	**4**	**17.3**	**17.3**	**0.0**	**17.3 *****	**100.0%**	**100.0%**
Mine-coal	Surface	10	3,221.6	3,221.6	0.0	3,221.6	100.0%	100.0%
	Groundwater	7	3,976.5	1,040.0	2,936.6	1,040.0	100.0%	26.2%
	Subtotal	**17**	**7,198.2**	**4,261.6**	**2,936.6**	**4,261.6 *****	**100.0%**	**59.2%**
Other Industrial	Surface	2	298.6	298.6	0.0	298.6	100.0%	100.0%
	Groundwater	6	313.4	313.4	0.0	313.4	100.0%	100.0%
	Subtotal	**8**	**612.0**	**612.0**	**0.0**	**612.0 *****	**100.0%**	**100.0%**
Total	Surface	21	140,698.8	22,287.5	118,411.3	20,837.5	93.5%	14.8%
	Groundwater	22	4,665.1	1,728.5	2,936.6	1,728.6	100.0%	37.1%
	Total	43	**145,363.9**	**24,016.0**	**121,347.8**	**22,566.1**	**94.0%**	**15.5%**

* Actual water use based on data provided by AFPA.
** Estimates of water use are based on information provided to AMEC by licence holders.
*** Actual water use is assumed to be 100 percent of licensed consumption.

Actual water use in 2005 for these pulp mills was assumed to be the same as in 2004. In the absence of water use information for the other forestry uses, it assumed that the six groundwater licensees consumed 100 percent of their entitlements. Based on these assumptions, total water use by forestry in 2005 is estimated to be 16,427 dam^3, consisting of 16,071 dam^3 of surface water and 356 dam^3 of groundwater.

11.5.2.4 Forecasts of Future Water Use

The general trend in Alberta is for forestry operations to decrease their water use as a result of using new technology that requires less water. The AFPA anticipates that pulp mills, which hold most of the forestry water licences, will decrease their demand for water by between two percent (Medium Growth scenario) and five percent (Low Growth scenario) over the forecast period. The High Growth scenario includes the possibility of the sector continuing to use the current amount of water surface water over the entire forecast period. Forecasts assume that the amount of groundwater remains the same over the forecast period. A decrease in water use of 1,137 dam^3 is expected by 2015 due to the expiration of one surface water licence. The resulting water use forecasts for forestry are provided in Table 11-30.

Table 11-30 Forecast of Forestry Water Use in the Athabasca Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	16,071	16,071	14,934	14,187	14,187
	Groundwater	356	356	356	356	356
	Total	**16,427**	16,427	**15,290**	**14,543**	**14,543**
Medium Growth	Surface	16,071	16,071	14,934	14,635	14,635
	Groundwater	356	356	356	356	356
	Total	**16,427**	**16,427**	**15,290**	**14,991**	**14,991**
High Growth	Surface	16,071	16,071	14,934	14,934	14,934
	Groundwater	356	356	356	356	356
	Total	**16,427**	**16,427**	**15,290**	**15,290**	**15,290**

Under the Low Growth scenario, water use for forestry in 2025 will decline 11 percent from current levels. Under the High Growth scenario, water use for the forestry sector in the Athabasca River Basin is predicted to decrease by seven percent from current levels.

11.5.3 Chemical Plants

Four licences have been issued for chemical plants and they allow withdrawals of up to 17 dam^3; this represents less than 0.5 percent of the total industrial allocations in the Athabasca Rive Basin. The licences allow withdrawals of up to 15 dam^3 of surface water and two dam^3 of groundwater. Chemical plant water allocations commenced in the 1980s and have remained the same since. Licensees are expected to consume 100 percent of the water they are allocated. There is no information on actual water diversions and consumption for chemical plants and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is

assumed that water used by chemical plants in the Athabasca Basin will remain constant for the forecast period.

11.5.4 Coal Mining

Water allocations for coal mining (7,198 dam^3) account for less than five percent of the allocations for the industrial sector in the Athabasca River Basin. These allocations include seven groundwater licences for 3,977 dam^3 and 10 surface water licences for 3,222 dam^3. Surface water licences for coal mining were first issued in the 1960s and allocations have increased since then, especially in the 1980s and 1990s. Groundwater licences were issued in the 1980s and allocations have also increased. Table 11-28 shows that licences issued to coal mining assume that there will be no return flow for surface water licences (100 percent consumption) and that 26 percent of diversions of groundwater will be consumed. Return flow allowances in licences amounted to 2,937 dam^3. There is no information on actual water diversions and consumption for coal mining and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by coal mining in the Athabasca Basin will remain constant for the forecast period.

11.5.5 Other Industrial Activities

Eight licences have been issued for other industrial activities and allow withdrawal of up to 612 dam^3, when represents less than 0.5 percent of total industrial allocations. These licences allow withdrawals of up to 299 dam^3 of surface water and 313 dam^3 of groundwater. Surface water licences for other industrial water purposes were issued in the 1990s and have remained constant since then. Groundwater licences were issued in the 1980s; groundwater allocations increased slightly in the 1990s and have remained the same since then. Licensees are expected to consume 100 percent of the water they are allocated. There is no information on actual water diversions and consumption for chemical plants and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by other industrial activities in the Athabasca Basin will remain constant for the forecast period.

11.5.6 Summary

The industrial sector in the Athabasca basin is dominated by water allocations to the forestry sector. The forest industry accounts for 94 percent of industrial allocations and 74 percent of licensed water use in 2005. Based on actual water use data for the pulp mills for 2004 and assuming that all other industrial water users used all of their entitlements, it is estimated that industrial users in the basin actual used 91 percent of the 24,016 dam^3 that it expected to be used under then terms of their licences.

In the future, there is expected to be a slight decline in water requirements for forestry activities as existing mills implement new technology to reduce their water consumption. The forecasts in

Table 11-30 assume that future water use by all industrial activities except for forestry will remain the same over the forecast period.

Table 11-31 Forecast of Industrial Water Use in the Athabasca Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	20,838	20,838	19,701	18,954	18,954
	Groundwater	1,729	1,729	1,729	1,729	1,729
	Total	**22,566**	**22,566**	**21,429**	**20,683**	**20,683**
Medium Growth	Surface	20,838	20,838	19,701	19,402	19,402
	Groundwater	1,729	1,729	1,729	1,729	1,729
	Total	**22,566**	**22,566**	**21,429**	**21,131**	**21,131**
High Growth	Surface	20,838	20,838	19,701	19,701	19,701
	Groundwater	1,729	1,729	1,729	1,729	1,729
	Total	**22,566**	**22,566**	**21,429**	**21,429**	**21,429**

Table 11-31 shows that all of the three forecast scenarios indicate that industrial water use in the Athabasca River Basin will decrease during the period to 2025. This decrease ranges from 8.3 percent for the Low Growth scenario to 5.0 percent for High Growth scenario.

11.6 OTHER SECTOR

Other sector uses in the Athabasca River Basin include licences issued for water management (flood control and lake stabilization), fish, wildlife and habitat enhancement, water conservation, and uses specified by a director with AENV. In 2005 there were 112 such licences which allocated 59,988 dam^3 of water for these purposes. These allocations account for about seven percent of all licensed water use in the Athabasca River Basin. As shown in Figure 11-19, the allocations for water management accounted for more than 96 percent of allocations to the other sector. Allocations for habitat enhancement accounted for just over three percent.

Figure 11-19 Other Sector Water Allocation by Use in the Athabasca Basin

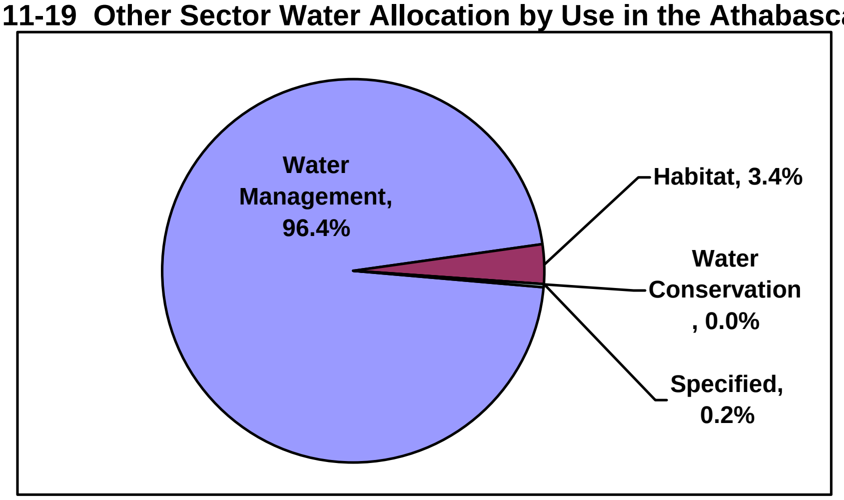


Table 11-32 summarizes the water allocation, use, and return associated with the licences for each activity in the Athabasca Basin.

11.6.1 Water Management

Slightly more than 96 percent of the allocations are for water management purposes such flood control and lake stabilization. Total allocations amounted to 57,844 dam^3. Table 11-30 shows that 77 licences have been issued for water management purposes, with nearly 86 percent of these for surface water. Eleven licences have been issued for groundwater and allow withdrawals of up to 2,341 dam^3. Licences for surface water were first issued in the 1930s. Figure 11-20 shows that surface water allocations increased through the 1930s, levelled off in the 1940s and 1950s, then increased rapidly in the 1970s and 1980s. There has been a slight decrease in surface water allocations since 2000. Although the first groundwater licences for water management were issued in the 1900s and there was a significant increase in groundwater allocations since the 1980s, groundwater allocations only account 14 percent of current allocations for water management purposes.

Figure 11-20 Historical Trends in Water Allocations for Water Management

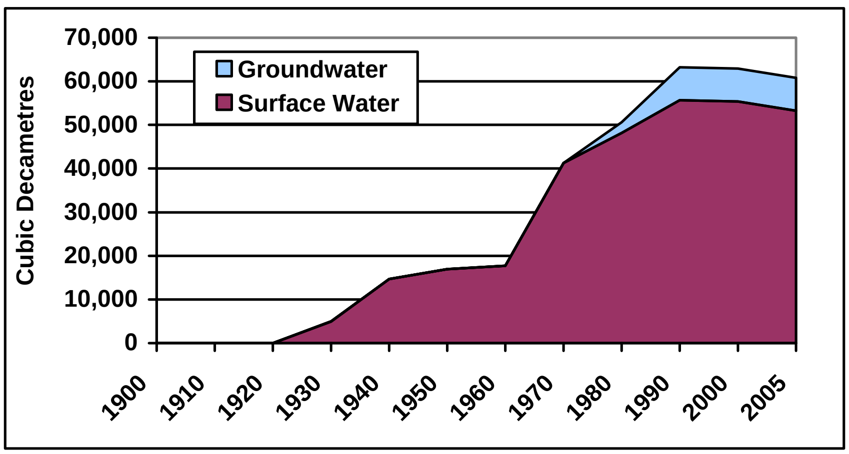


Table 11-32 shows that licences issued for water management purposes assume that about 82 percent of surface water allocations and less than one percent of groundwater allocations will be used. Return flow allowances in licences amount to 9,985 dam^3 for surface water and 2,322 dam^3 for groundwater. There is no information on actual water diversions and consumption for water management activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement. In the absence of information about this component of the other sector, it is assumed that water used for water management in Athabasca basin will remain constant for the forecast period.

Table 11-32 Licensed Allocations and Estimated Water Use by the Other Sector, Athabasca River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Water Management	Surface	66	55,502.8	45,517.6	9,985.2	45,517.6	100%	82.0%
	Groundwater	11	2,341.1	19.2	2,322.0	19.2	100%	0.8%
	Subtotal	**77**	**57,843.9**	**45,536.8**	**12,307.2**	**45,536.8**	**100%**	**78.7%**
Habitat	Surface	33	1,969.8	1,821.8	148.0	1,821.8	100%	92.5%
	Groundwater	1	49.3	24.7	24.7	24.7	100%	50.0%
	Subtotal	**34**	**2,019.1**	**1,846.4**	**172.7**	**1,846.4**	**100%**	**91.4%**
Specified	Surface	0	0.0	0.0	0.0	0.0		
	Groundwater	1	125.0	125.0	0.0	125.0	100%	100.0%
	Subtotal	**1**	**125.0**	**125.0**	**0.0**	**125.0**	**100%**	**100.0%**
Total	Surface	99	57,472.6	47,339.3	10,133.2	47,339.3	100%	82.4%
	Groundwater	13	2,515.5	168.9	2,346.6	168.9	100%	6.7%
	Total	**112**	**59,988.1**	**47,508.2**	**12,479.9**	**47,508.2**	**100%**	**79.2%**

11.6.2 Habitat Enhancement

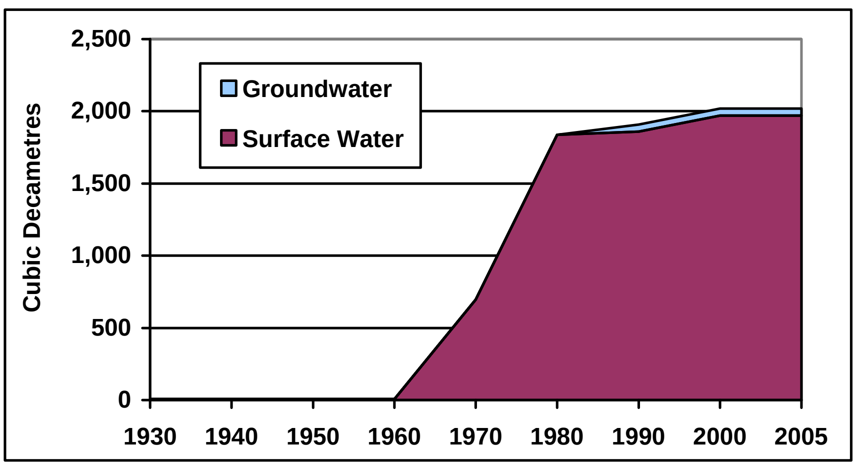
11.6.2.1 Water Allocations

Less than four percent of other sector allocations are for fish, wildlife and habitat enhancement. Table 11-32 shows that 33 licences have been issued for habitat enhancement projects and allow withdrawals of up to 2,019 dam^3. All but one of these licences are for surface water. The single groundwater licence allows withdrawals of up to 49 dam^3. Surface water licences for habitat enhancement were first issued in the 1930s but, as shown in Figure 11-21, most allocations occurred in the 1960s and 1970s. Allocations for habitat enhancement have remained constant since about 1980. The licence for groundwater for habitat enhancement was issued in the 1990s

11.6.2.2 Licensed Water Use

Table 11-32 shows that the licences issued for habitat enhancement purposes assume that about 92 percent of surface water allocations and 50 percent of groundwater allocations will be used. Return flow allowances in licences amounted to 148 dam^3 for surface water and 25 dam^3 for groundwater.

Figure 11-21 Historical Trends in Water Allocations for Habitat Enhancement



11.6.2.3 Actual Water Use

There is no information on actual water diversions or consumption for habitat enhancement activities. For purposes of this analysis, it is assumed that licensees are using their full entitlement.

11.6.2.4 Forecasts of Future Water Use

Forecasts of future water use by the other sector are based on consultation with large licence holders: Ducks Unlimited and AENV. Neither of these organizations has formal forecasts of

their future water needs. The number of projects that Ducks Unlimited implements depend on a number of factors such as their budget, the state of the economy, and environment objectives. It is anticipated that there will be an increased emphasis on restoring drained wetlands to pre-drainage or natural conditions. These types of projects will not require new water licences. At most, Ducks Unlimited foresees development of new projects at the rate of one per year, with each requiring 300 dam^3 of water. Water use by Alberta Environment is not expected to change in the period forecasted. Forecasts assume that new projects are for surface water use, and this reflects the current distribution of surface to groundwater licences.

The High Growth scenario assumes that Ducks Unlimited will acquire new surface water licences at the rate of 300 dam^3 per year over the forecast period. As shown in Table 11-33, this would result in water allocations for habitat enhancement in 2025 being more than 20 times current levels. A Low Growth scenario has been developed that assumes that water use would increase by two percent every five years. The Medium Growth scenario assumes that water use would increase by five percent every 5 years. Under the Low Growth scenario, water use for water management projects in 2025 would increase by just over eight percent from current levels. Under the Medium Growth scenario, water use would increase by 22 percent.

Table 11-33 Forecast of Water Use by Habitat Enhancement Projects in Athabasca Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,822	1,859	1,896	1,935	1,974
	Groundwater	25	25	25	25	25
	Total	**1,846**	**1,883**	**1,921**	**1,959**	**1,999**
Medium Growth	Surface	1,822	1,914	2,011	2,113	2,220
	Groundwater	25	25	25	25	25
	Total	**1,846**	**1,939**	**2,036**	**2,137**	**2,244**
High Growth	Surface	1,822	10,822	19,822	28,822	37,822
	Groundwater	25	25	25	25	25
	Total	**1,846**	**10,846**	**19,846**	**28,846**	**37,846**

11.6.3 Specified Activities

One groundwater licence has been issued for specified use by a director with AENV. This licence allows withdrawals of up to 125 dam^3 and all of this allocation is to be used. There is no information on actual water diversions and consumption for specified activities and, for purposes of this analysis; it is assumed that the licensee is using their full entitlement. In the absence of information about this component of the other sector, it is assumed that water used by activities specified by the director in the Athabasca Basin will remain constant for the forecast period.

11.6.4 Summary

The other sector in the Athabasca basin is dominated by water allocated for water management. These projects account for more than 96 percent of the water allocation and licensed water use. In the future, the amount of water used for other sector activities is expected to increase due to

additional allocations for habitat enhancement. The overall water use projections for the other sector are provided in Table 11-34.

Table 11-34 Forecast of Other Water Use in the Athabasca Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	47,339	47,376	47,414	47,452	47,492
	Groundwater	169	169	169	169	169
	Total	**47,508**	**47,545**	**47,583**	**47,621**	**47,660**
Medium Growth	Surface	47,339	47,432	47,529	47,630	47,737
	Groundwater	169	169	169	169	169
	Total	**47,508**	**47,601**	**47,697**	**47,799**	**47,906**
High Growth	Surface	47,339	56,339	65,339	74,339	83,339
	Groundwater	169	169	169	169	169
	Total	**47,508**	**56,508**	**65,508**	**74,508**	**83,508**

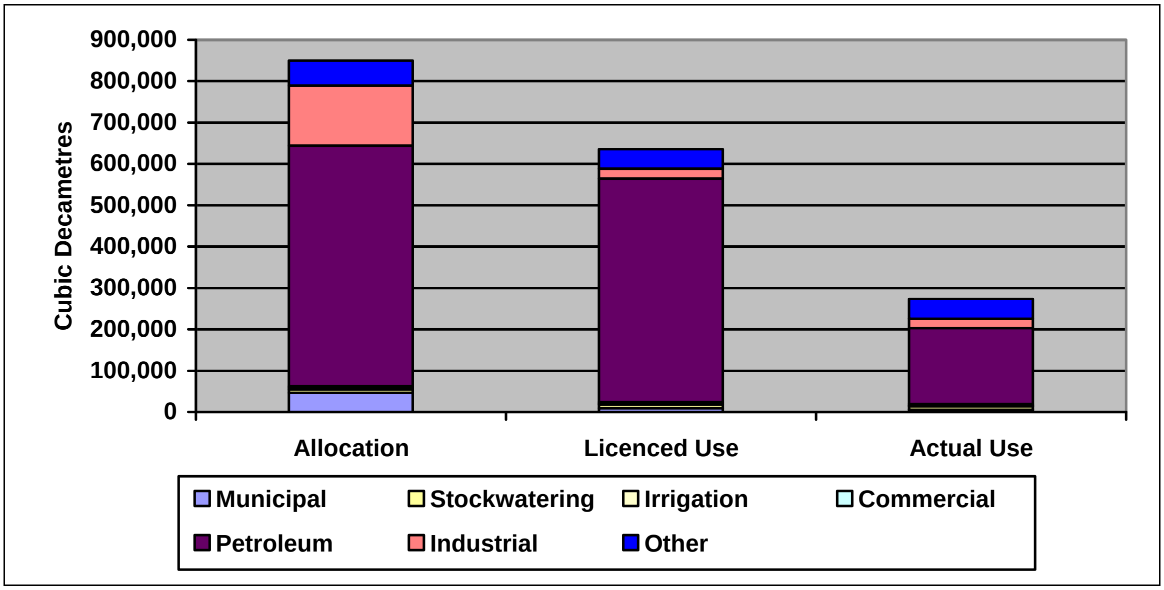
These forecasts assume that allocations for water management, water conservation and activities specified by the director will remain the same for the forecasted period. Forecasts assume that new projects are for surface water use, this is appropriate given the current distribution of surface to groundwater licences. Table 11-34 shows that, for all three scenarios, the overall demand for water in the Athabasca basin is expected to increase over the forecast period.

11.7 SUMMARY

Table 11-35 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the Athabasca River Basin. In total, existing licences and registrations allow a maximum of 849,639 dam^3 of water to be withdrawn for use. Of this, up to 635,965 dam^3 is expected to be used and 213,674 dam^3 will be returned to surface water. As noted previously, the largest amounts of water have been allocated to the petroleum sector (68 percent) and the industrial sector (17 percent). Figure 11-22 shows licensed allocations and use for each of the water use sectors.

With respect to actual use, the exact volumes withdrawn and used in 2005 are not known because very few water use reports have been filed with Alberta Environment. However, based on the assumptions used in the previous sections, it is estimated that 273,144 dam^3 were actually used in 2005. This represents 43 percent of water use allowed in licences and registrations that existed in 2005. However, the water licence data includes allocations for three oilsands mines that are currently under construction. When the licence information is corrected to exclude these three plants, actual water use accounts for 74 percent of licensed use and 47 percent of allocations. Based on estimated use, the petroleum sector accounted for 67 percent of total water use in the Athabasca River Basin in 2005. Figure 11-22 shows how actual use compares to licensed allocations and use for each of the water use sectors

Figure 11-22 Water Allocations and Actual Use, by Sector, Athabasca River Basin



Forecasts of future water use in the Athabasca River Basin are provided in Tables 11-36 to 11-38 for the Low, Medium and High Growth scenarios. Predicted water use under the Medium Growth scenario is shown in Figure 11-23. This figure shows that nearly all of the growth in water use will occur in the petroleum sector, with water used for oilsands plant accounting 82 percent of total water use by 2025. Under the Medium Growth scenario, water demand in 2025 will be about 117 percent higher than at present. For the other scenarios, the increase in water demand over 20 years will range from 85 percent for the Low Growth Scenario and 135 percent for the High Growth scenario. For all scenarios, actual water use will exceed the amount that can be consumed under the terms of existing licences.

Figure 11-23 Forecast Water Use in the Athabasca River Basin: Medium Scenario

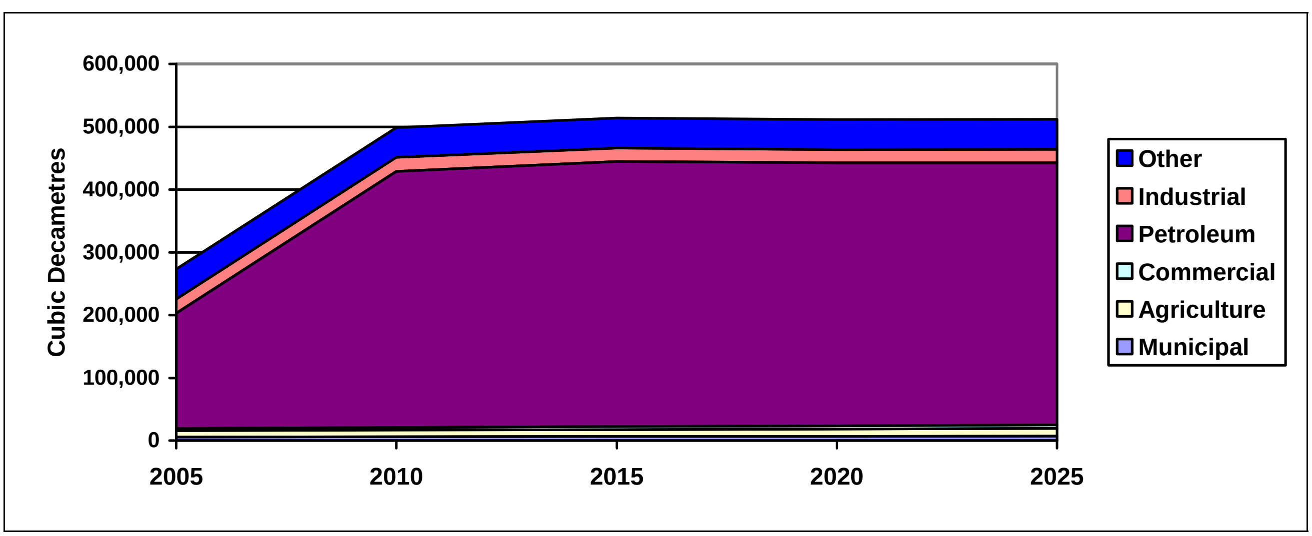


Table 11-35 Summary of Allocations and Estimated Water Use, Athabasca River Basin

Sector		Licensed Allocation and Use (dam^3)				Estimated Water Use (dam^3)		
		Allocation	Water Use	Return	Percent of Total Use	Use	Percent of Licensed Use	Percent of Total Use
Municipal		46,097	8,907	37,190	1%	5,508	62%	2%
Agricultural	Stockwatering	9,122	9,122	1	1%	8,055	88%	3%
	Irrigation	3,475	2,094	0	0%	2,094	100%	1%
Commercial		3,801	3,749	52	1%	3,749	100%	1%
Petroleum		581,792	540,569	41,223	85%	183,664	34%	67%
Industrial		145,364	24,016	121,348	4%	22,566	94%	8%
Other		59,988	47,508	12,480	7%	47,508	100%	17%
Total		**849,639**	**635,965**	**213,674**	**100%**	**273,144**	**43%**	**100%**

Table 11-36 Forecast Water Use, By Sector, Athabasca River Basin: Low Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	3,903	4,129	4,320	4,493	4,631
	Agricultural	5,595	5,683	5,774	5,867	5,962
	Commercial	2,736	2,881	3,014	3,143	3,258
	Petroleum	166,732	273,895	301,408	334,432	366,502
	Industrial	20,838	20,838	19,701	18,954	18,954
	Other	47,339	47,376	47,414	47,452	47,492
	Total	247,143	354,802	381,631	414,341	446,799
Groundwater	Municipal	1,605	1,698	1,777	1,847	1,904
	Agricultural	4,554	4,669	4,787	4,908	5,032
	Commercial	1,014	1,041	1,070	1,100	1,131
	Petroleum	16,933	35,459	45,520	45,963	49,177
	Industrial	1,729	1,729	1,729	1,729	1,729
	Other	169	169	169	169	169
	Total	26,004	44,765	55,052	55,716	59,142
Total	Municipal	5,508	5,827	6,097	6,340	6,535
	Agricultural	10,149	10,352	10,561	10,775	10,994
	Commercial	3,750	3,922	4,084	4,243	4,389
	Petroleum	183,665	309,355	346,928	380,395	415,678
	Industrial	22,567	22,567	21,430	20,683	20,683
	Other	47,508	47,545	47,583	47,621	47,661
	Total	273,147	399,568	436,683	470,057	505,940

Table 11-37 Forecast Water Use, By Sector, Athabasca River Basin: Medium Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Wate	Municipal	3,903	4,210	4,524	4,828	5,104
	Agricultural	5,595	5,810	6,038	6,281	6,538
	Commercial	2,736	3,093	3,468	3,845	4,208
	Petroleum	166,732	362,309	368,572	368,849	368,077
	Industrial	20,838	20,838	19,701	19,402	19,402
	Other	47,339	47,432	47,529	47,630	47,737
	Total	247,143	443,692	449,832	450,835	451,066
Groundwater	Municipal	1,605	1,731	1,860	1,985	2,099
	Agricultural	4,554	4,834	5,131	5,446	5,781
	Commercial	1,014	1,066	1,125	1,189	1,260
	Petroleum	16,933	45,709	54,020	50,169	49,843
	Industrial	1,729	1,729	1,729	1,729	1,729
	Other	169	169	169	169	169
	Total	26,004	55,238	64,034	60,687	60,881
Total	Municipal	5,508	5,941	6,384	6,813	7,203
	Agricultural	10,149	10,644	11,169	11,727	12,319
	Commercial	3,750	4,159	4,593	5,034	5,468
	Petroleum	183,665	408,018	422,592	419,017	417,919
	Industrial	22,567	22,567	21,430	21,131	21,131
	Other	47,508	47,601	47,698	47,799	47,906
	Total	273,147	498,930	513,866	511,521	511,946

Table 11-38 Forecast Water Use, By Sector, Athabasca River Basin: High Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	3,903	4,356	4,854	5,357	5,842
	Agricultural	5,595	5,997	6,446	6,946	7,504
	Commercial	2,736	3,471	4,288	5,137	5,993
	Petroleum	166,732	362,309	390,480	417,101	442,141
	Industrial	20,838	20,838	19,701	18,954	18,954
	Other	47,339	56,339	65,339	74,339	83,339
	Total	247,143	453,310	491,108	527,834	563,773
Groundwater	Municipal	1,605	1,791	1,996	2,203	2,403
	Agricultural	4,554	5,077	5,661	6,311	7,037
	Commercial	1,014	1,096	1,192	1,301	1,427
	Petroleum	16,933	45,709	63,287	63,254	66,519
	Industrial	1,729	1,729	1,729	1,729	1,729
	Other	169	169	169	169	169
	Total	26,004	55,571	74,034	74,967	79,284
Total	Municipal	5,508	6,147	6,850	7,560	8,245
	Agricultural	10,149	11,074	12,107	13,257	14,541
	Commercial	3,750	4,567	5,480	6,438	7,420
	Petroleum	183,665	408,018	453,767	480,354	508,660
	Industrial	22,567	22,567	21,430	20,683	20,683
	Other	47,508	56,508	65,508	74,508	83,508
	Total	273,147	508,881	565,142	602,800	643,057

Peace/Slave River Basin

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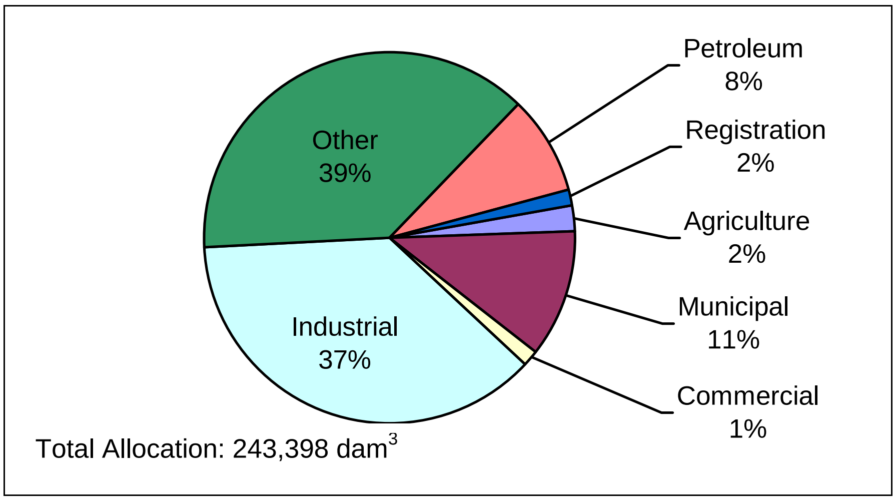
12.0 PEACE/SLAVE RIVER BASIN

The Peace/Slave River Basin covers an area of about 180,000 km^2, is the largest river basin in Alberta, occupying approximately 30 percent of the province. The mean annual natural river discharge of the Peace/Slave River is 108,000,000 dam^3. It is part of the Mackenzie River system, which drains eventually into the Arctic Ocean. In 2001, the basin had a population of 133,973 people, which represents five percent of the provincial population. The basin had a population density of less than one person per square kilometre. The Peace/Slave Basin covers all or parts of 17 rural or regional municipalities and includes 15 Aboriginal settlements and 22 urban municipalities.

Figure 12-1 provides an overview of surface and groundwater allocations in 2005. Allocations to the other sector account for 39 percent of allocations (92,436 dam^3) and the industrial sector accounts for another 37 percent (691,866 dam^3). The municipal sector accounts for 11 percent (27,141 dam^3) and the petroleum sector accounts for another eight percent (20,547 dam^3). Total allocations in the Peace/Slave Basin in 2005 were 243,398 dam^3.

Figure 12-1 Distribution of Active Water Allocations in the Peace/Slave Basin



Figures 12-2 and 12-3 show the location, allocation and sector of all active surface and groundwater licences in Peace/Slave Basin. Figure 12-4 shows the location of all registrations issued in the Peace/Slave Basin.

12.1 MUNICIPAL AND RESIDENTIAL SECTOR

12.1.1 Population

About 133,970 people lived in the Peace/Slave Basins in 2001. Just over half of these (55 percent) lived in one of the urban municipalities. Another 38 percent lived in the rural parts of the basin, and about eight percent lived in Aboriginal communities.

Between 1996 and 2001, the population of the basin increased by 6.3 percent or about

1.2 percent per year. The highest growth rates were in the Aboriginal communities, where the population increased by nearly 16 percent. In comparison, the urban population increased by 6.6 percent but the rural population only increased by 4.1 percent.

Table 12-1 Population Distribution and Growth in Peace/Slave River Basin, 2001

	2001		1996	1996 to 2001 Population Change
	Population	Percent	Population	Percent
Urban Municipality	73,068	54.5%	68,525	6.6%
Rural or Regional Municipality	50,465	37.7%	48,477	4.1%
First Nations and Métis Settlements	10,440	7.8%	9,029	15.6%
Total	**133,973**	**100%**	**126,031**	**6.3%**

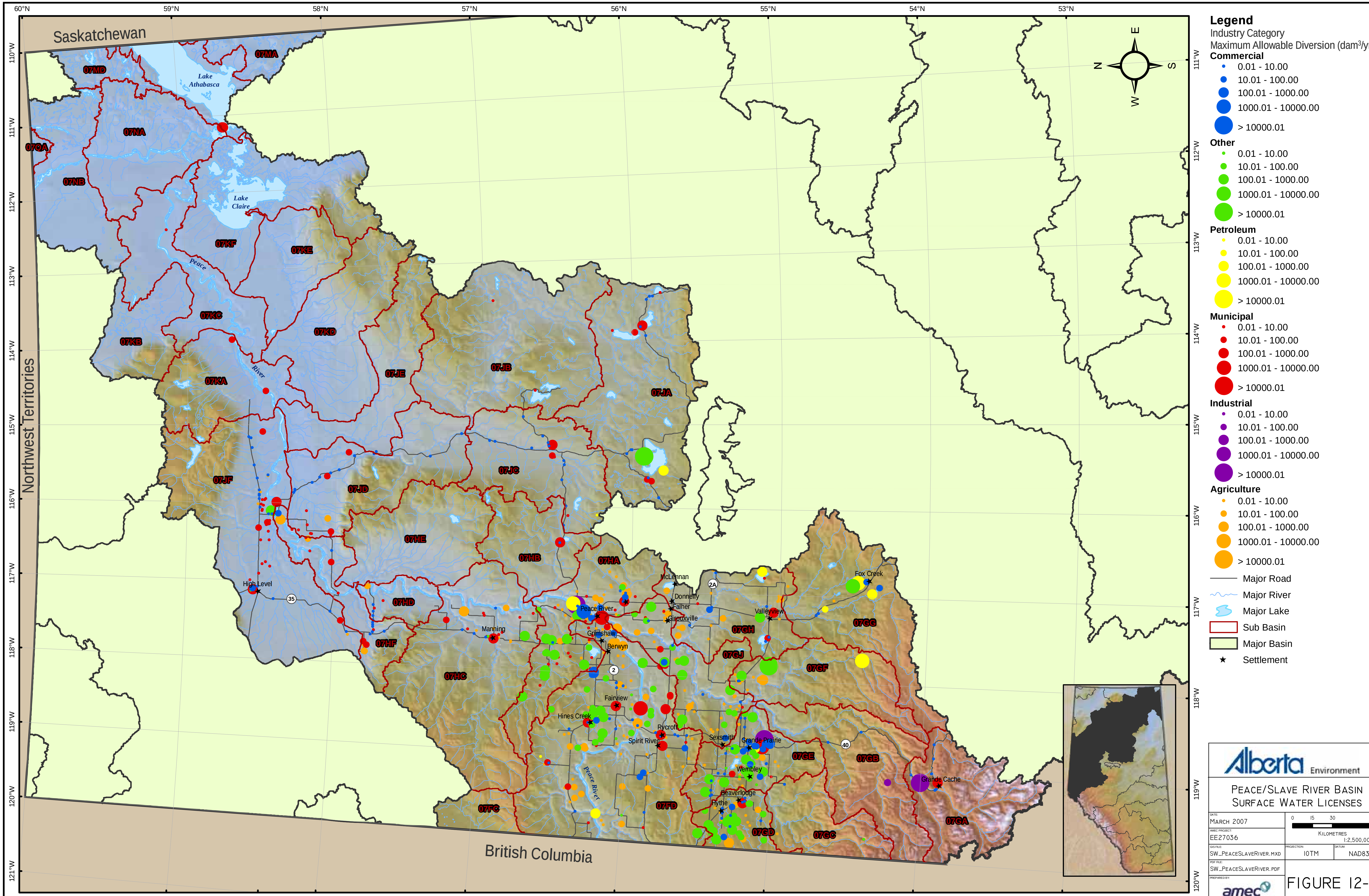
Table 12-2 lists all municipalities in the Peace/Slave Basin, their estimated 2001 populations, and municipal water allocations for those communities with allocations of 100 dam^3 or more. The largest population centres include the City of Grande Prairie (36,983 residents) and the Town of Peace River (6,240). The most populous rural or regional municipality is the County of Grande Prairie No. 1 (15,638). The Little Red River Cree Nation has the largest population among Aboriginal communities (2,731).

12.1.2 Water Allocations

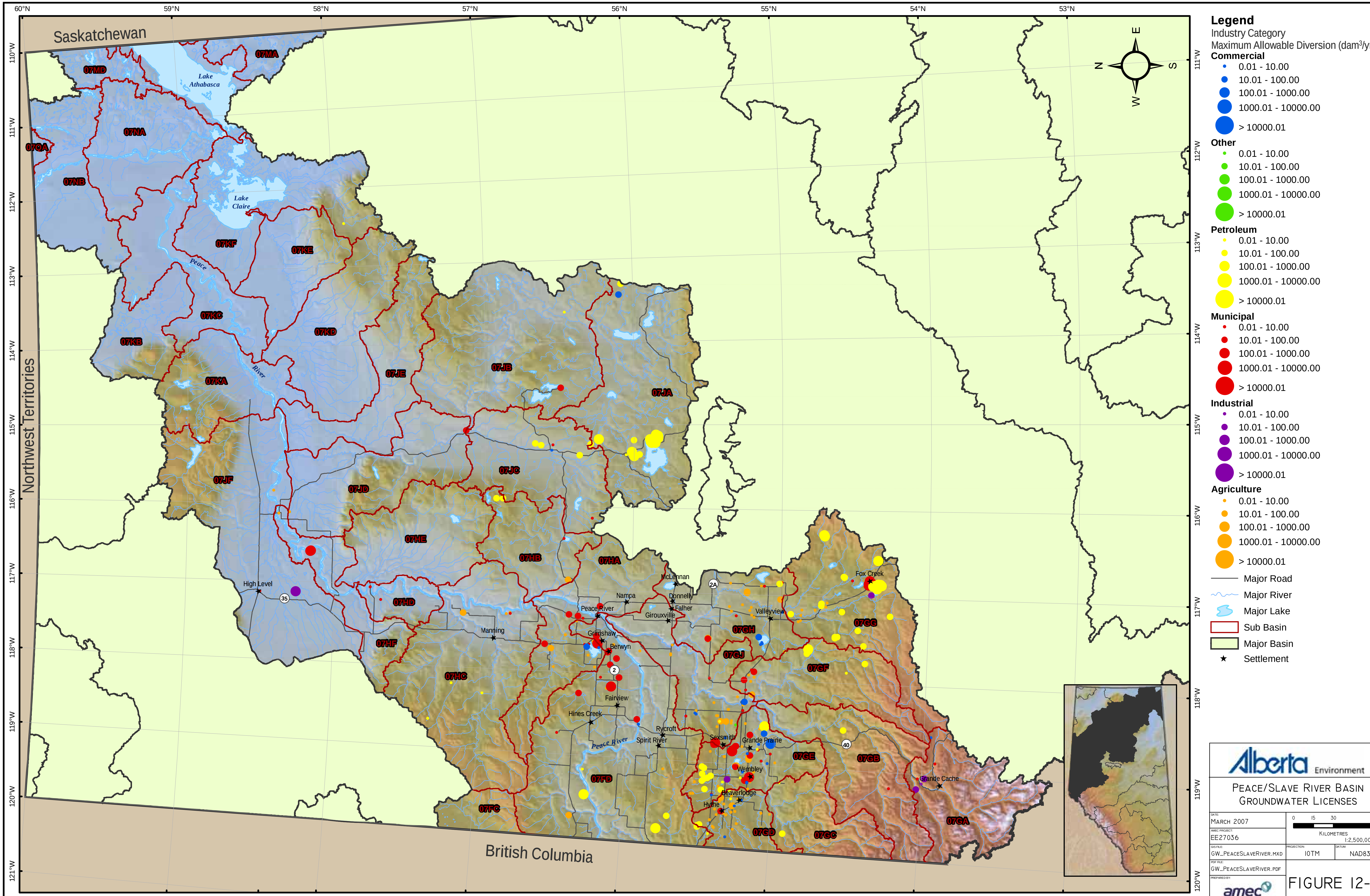
As of 2005, 248 licences had been issued to 77 municipal water users in the Peace/Slave Basin. These licences allow withdrawals of up to 27,141 dam^3. Municipal water uses account for 11 percent of all licensed water allocations in Peace/Slave Basin. Licences issued to urban municipalities account for 95 percent of municipal allocations, and the balance has been issued to rural municipalities.

The majority of municipal allocations are for surface water. Surface water licences allow withdrawals of up to 22,770 dam^3; this represents 84 percent of total municipal water allocations. Urban municipalities have been issued 55 licences that allow diversions of up to 22,169 dam^3. Rural municipalities are entitled to divert up to 548 dam^3 of surface water.

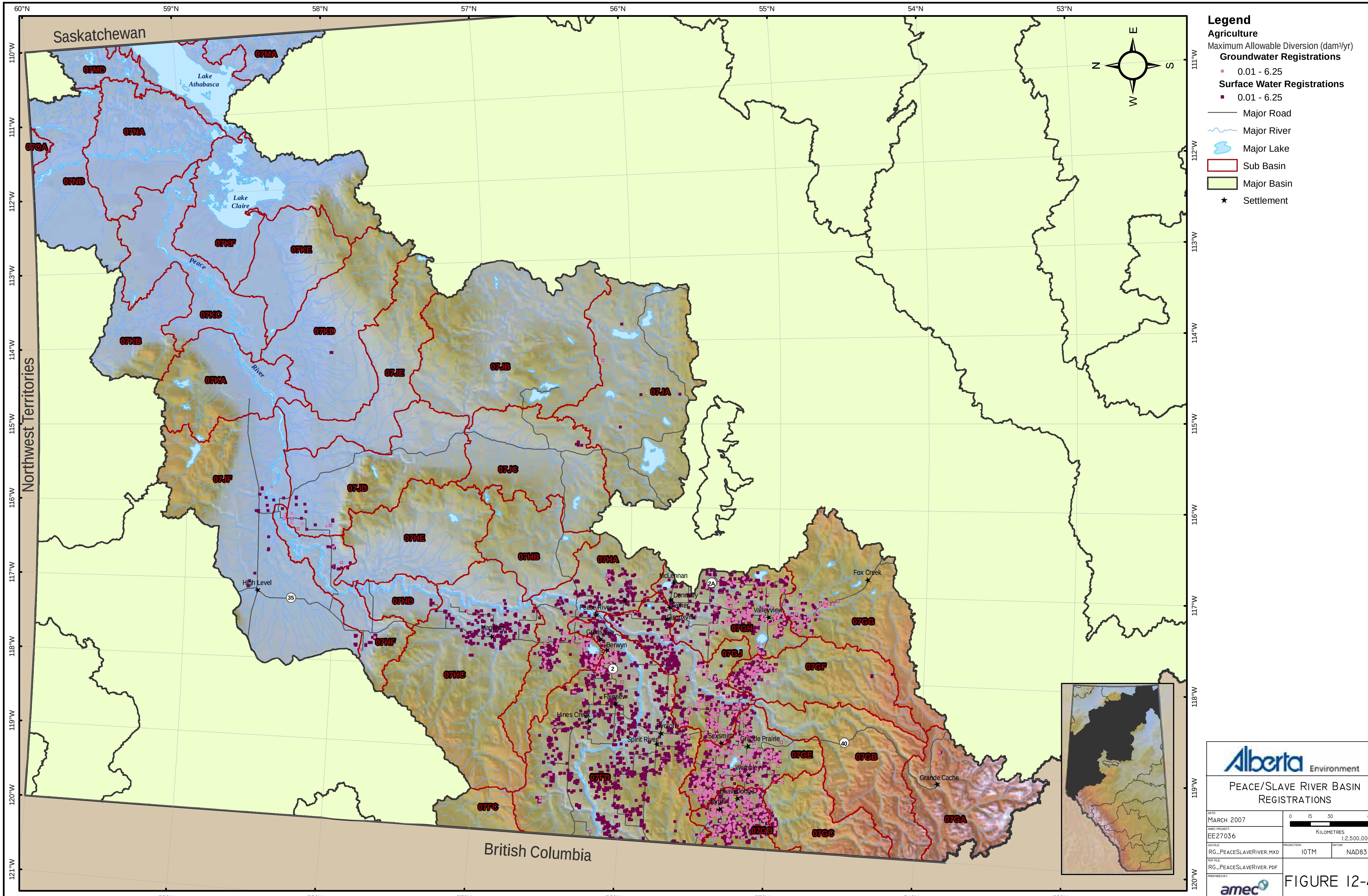
Municipal users in the Peace/Slave basin are licensed to withdraw 4,370 dam^3 of groundwater. Licences for groundwater represent 16 percent of total municipal water allocations and include 40 licences issued to urban municipalities (3,559 dam^3) and 46 licences issued to rural municipalities (772 dam^3).



Legend
Industry Category
Maximum Allowable Diversion (dam³/yr)
Commercial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Other
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Petroleum
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Municipal
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Industrial
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Agriculture
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
Saskatchewan
Northwest Territories
British Columbia
Lake Athabasca
Lake Claire
Peace River
07MA
07MD
07NA
07QA
07NB
07KF
07KE
07KC
07KD
07KB
07KA
07JE
07JB
07JA
07JF
07JD
07JC
07HE
07HB
07HA
07HD
07HF
07HC
07GH
07GG
07GJ
07GF
07GE
07GB
07FC
07FD
07GD
07GC
07GA
High Level
Manning
Peace River
Grimshaw
Berwyn
McLennan
Donnelly
Falher
Girouxville
Valleyview
Fox Creek
Fairview
Hines Creek
Rycroft
Spirit River
Sexsmith
Grande Prairie
Wembley
Beaverlodge
Hythe
Grande Cache
Alberta Environment
Peace/Slave River Basin
Surface Water Licenses
March 2007
EE27036
SW_PeaceSlaveRiver.mxd
SW_PeaceSlaveRiver.pdf
10TM
NAD83
Kilometres
1:2,500,000
amec
FIGURE 12-2



Saskatchewan
Northwest Territories
British Columbia
Lake Athabasca
Lake Claire
Peace River
07MA
07MD
07NA
07QA
07NB
07KF
07KE
07KC
07KD
07KB
07KA
07JE
07JB
07JA
07JF
07JD
07JC
07HE
07HB
07HA
07HD
07HF
07HC
07GH
07GJ
07GG
07GF
07GE
07GB
07FD
07FC
07GD
07GC
07GA
High Level
Manning
Peace River
Grimshaw
Berwyn
Nampa
McLennan
Donnelly
Falher
Girouxville
Valleyview
Fox Creek
Fairview
Hines Creek
Rycroft
Spirit River
Sexsmith
Grande Prairie
Wembley
Beaverlodge
Hythe
Grande Cache
Legend
Industry Category
Maximum Allowable Diversion (dam3/yr)
Commercial
Other
Petroleum
Municipal
Industrial
Agriculture
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
Alberta Environment
Peace/Slave River Basin Groundwater Licenses
Date: March 2007
AMEC Project: EE27036
GIS File: GW_PeaceSlaveRiver.mxd
PDF File: GW_PeaceSlaveRiver.pdf
Prepared by: amec
Kilometres 1:2,500,000
Projection: 10TM
Datum: NAD83
FIGURE 12-3



Legend
Agriculture
Maximum Allowable Diversion (dam³/yr)
Groundwater Registrations
0.01 - 6.25
Surface Water Registrations
0.01 - 6.25
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
Saskatchewan
Northwest Territories
British Columbia
Lake Athabasca
Lake Claire
Peace River
07MA
07MD
07NA
07QA
07NB
07KF
07KE
07KC
07KB
07KD
07KA
07JE
07JB
07JA
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07HF
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07GE
07GB
07FD
07FC
07GD
07GC
07GA
High Level
McLennan
Donnelly
Falher
Girouxville
Peace River
Manning
Grimshaw
Berwyn
Valleyview
Fox Creek
Fairview
Hines Creek
Rycroft
Spirit River
Sexsmith
Grande Prairie
Wembley
Beaverlodge
Hythe
Grande Cache
Alberta Environment
Peace/Slave River Basin Registrations
March 2007
EE27036
RG_PeaceSlaveRiver.mxd
RG_PeaceSlaveRiver.pdf
0 15 30 60
Kilometres
1:2,500,000
10TM
NAD83
amec
FIGURE 12-4

Table 12-2 2001 Urban and Rural Populations and Water Allocations within Peace/Slave River Basin

Urban Municipalities		2001 Population in Basin	Water Source	Allocation (dam^3)
Cities	GRANDE PRAIRIE	36,983		
Towns	PEACE RIVER	6,240	Surface	5,748
	GRANDE CACHE	3,828	Surface	1,357
	HIGH LEVEL	3,444	Surface	570
	FAIRVIEW	3,150	Surface	2,244
	GRIMSHAW	2,435	Groundwater	501
	FOX CREEK	2,337	Groundwater	1,017
	BEAVERLODGE	2,110	Surface	691
	VALLEYVIEW	1,856	Surface	668
	SEXSMITH	1,653		
	WEMBLEY	1,497	Groundwater	152
	MANNING	1,293	Surface	123
	FALHER	1,109		
	SPIRIT RIVER	1,100	Surface	335
	MCLENNAN	804		
Villages	RYCROFT	609	Surface	185
	HYTHE	582		
	BERWYN	546	Groundwater	117
	HINES CREEK	437	Surface	179
	DONNELLY	377		
	NAMPA	372	Surface	150
	GIROUXVILLE	306		
Total		**73,068**		**14,037**

Rural Populations		2001 Population In Basin	Water Source	Allocation (dam^3)
Rural or Regional Municipalities	CTY OF GRANDE PRAIRIE NO. 1	15,638	Groundwater	457
	M. D. OF GREENVIEW NO. 16	4,979		
	M.D. OF MACKENZIE NO. 23	4,440	Groundwater Surface	744 248
	M.D. OF NORTHERN LIGHTS NO. 22	4,084		
	CLEAR HILLS COUNTY	2,667		
	M. D. OF OPPORTUNITY NO. 17	2,620	Surface	296
	SADDLE HILLS COUNTY	2,566		
	M. D.OF SMOKY RIVER NO. 130	2,303		
	NORTHERN SUNRISE COUNTY	2,228	Surface	168
	REG. MUN. OF WOOD BUFFALO	2,143	Surface	1,026
	M. D. OF FAIRVIEW NO. 136	1,806		
	BIRCH HILLS COUNTY	1,644	Surface	217
	M. D. OF PEACE NO. 135	1,496	Groundwater	137
	M. D. OF SPIRIT RIVER NO. 133	824		
	M. D. OF BIG LAKES	596		
	IMPROVEMENT DISTRICT NO. 24	356		
	TOTAL	**50,390**		**3,293**
Aboriginal	LITTLE RED RIVER CREE NATION	2,731	Surface	159
	BIGSTONE CREE NATION	1,960		
	STURGEON LAKE BAND	1,130		
	WHITEFISH LAKE FIRST NATION	989		
	GIFT LAKE METIS SETTLEMENT	755		
	WOODLAND CREE BAND	628		
	PADDLE PRAIRIE MÉTIS SETTLEMENT	531		
	TALLCREE BAND	473		
	BEAVER FIRST NATION	353		
	DENE THA' FIRST NATION	303		
	HORSE LAKE BAND	303		
	MIKISEW CREE FIRST NATION	155		
	DUNCAN'S BAND	111		
	PEAVINE METIS SETTLEMENT	10		
	LUBICON LAKE BAND	8		
	Total	**10,440**		**159**

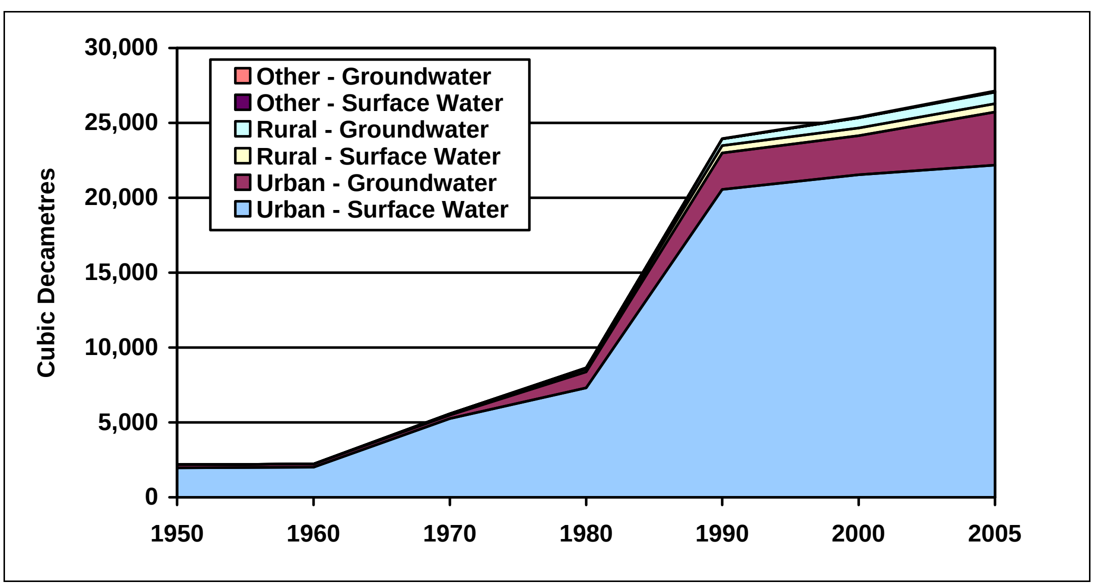
Table 12-2 identifies the urban and rural communities in the Peace/Slave Basin that have large municipal water allocations of 100 dam^3 or more. The City of Grande Prairie does not have its own water licence; its municipal water needs are served by Aquatera Utilities Inc. which is a for-profit company formed through the partnership of the City of Grande Prairie, the County of Grande Prairie, and the Town of Sexsmith. Table 12-3 identifies other large municipal holders in the basin and the surface water allocation to Aquatera Utilities Inc. is the largest in the basin.

Table 12-3 Other Large Peace/Slave Basin Municipal Water Licensees and Sources

Licensee	Water Source	Allocation (dam^3)
AQUATERA UTILITIES INC.	Surface	7,279
ALBERTA MUNICIPAL AFFAIRS	Surface	438
AQUATERA UTILITIES INC.	Groundwater	302
LITTLE BURNT RIVER WATER CO-OP LTD	Groundwater	140
SILVER POINTE VILLAGE INC.	Groundwater	125
ALBERTA MUNICIPAL AFFAIRS	Groundwater	113

Figure 12-5 provides a history of licences issued for municipal purposes in the Peace/Slave Basin up to 2005. Municipal uses accounting for less than 0.1 percent of MAD are not included. Figure 12-5 shows that, for all uses, allocations increased in the 1960s, grew rapidly during the 1980s, and have increased more slowly since then. Figure 12-5 also shows that the majority of allocations have always been for urban municipalities, more of the recent increase in allocations has been for groundwater.

Figure 12-5 Peace/Slave Basin Historical Municipal Water Allocations



12.1.3 Licensed Water Use

Table 12-4 summarizes licence information for the municipal sector in Peace/Slave Basin. These licences expect municipalities to use 8,307 dam^3 (i.e. 31 percent is consumed and/or lost) and to return the balance (up to 18,834 dam^3). Return flow allowances in licences issued to urban municipalities are nearly the same for surface water licences (72 percent) and groundwater licences (71 percent). Return flow allowances for rural municipalities are lower, ranging from 45 percent for surface water licences to 31 percent for groundwater licences. Licences issued to other municipal users assume almost no return flow: six percent for groundwater users and none for surface water users.

12.1.4 Actual Water Use

In 2005, five licensees reported their water diversions to the provincial government through the Water Use Reporting System (WURS). These licensees had licensed allocations of 3,624 dam^3, which only amounts to 13.3 percent of all municipal allocations in the basin. Their reported diversions in 2005 amounted to 23,776 dam^3, which is represents 5.5 times more that their licences allow them to withdraw. This is attributable to one licensee that reported having diverted 22,017 dam^3, which is equivalent to 81 percent of all municipal allocations in the entire basin, and likely reflects a reporting or data entry error. The WURS database has no information on return flow for municipal licensees in the Peace/Slave Basin.

Environment Canada's Municipal Water Use database (MUD) contains water diversion information for 15 municipalities that accounted for 55 percent of Peace/Slave Basin's 2001 population. However, only one municipality (Manning) reported return flow.

Due to the lack of actual water use information in WURS and MUD, municipal water use must be estimated for the majority of municipal users. For urban licensees, these estimates were based on the ratio of water use to diversions for Manning. For non-urban licensees, water use was estimated based on the ratio of allocations to actual diversions for urban licensees in combination with information on the ratio of licence allocation to licensed use. The resulting estimates of water use are provided in Table 12-5.

Available information suggests that municipalities using surface water diverted 45 percent of their maximum withdrawals and actually used only eight percent of the volumes allowed in water licences. However, this is likely an underestimate because it was based on the low ratio of actual water use to licensed water use and the return flow information for the Town of Manning, which was the only municipality to report this information. Available information suggests that municipalities using groundwater diverted and used 51 percent of the amounts allowed in their licences. Overall, municipal water use in Peace/Slave Basin is estimated to be 18 percent of the amount allowed on the licences.

Table 12-4 Licensed and Reported Diversions, Water Use and Returns by Type of Municipal Use for Peace/Slave Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Diversion	Reported Use	Return
Urban*	Surface	55	22,169	6,155	16,014	1,109	N/A	N/A
	Groundwater	40	3,559	1,044	2,515	650	N/A	N/A
	Subtotal	**95**	**25,728**	**7,199**	**18,529**	**1,759**	**N/A**	**N/A**
Rural**	Surface	33	548	299	249	N/A	N/A	N/A
	Groundwater	46	772	729	43	22,017	N/A	N/A
	Subtotal	**79**	**1,320**	**1,028**	**292**	**22,017**	**N/A**	**N/A**
Other***	Surface	60	54	54	0	N/A	N/A	N/A
	Groundwater	14	39	27	12	N/A	N/A	N/A
	Subtotal	**74**	**93**	**81**	**12**	**N/A**	**N/A**	**N/A**
Total	Surface	148	22,770	6,507	16,263	1,109	N/A	N/A
	Groundwater	100	4,370	1,800	2,570	22,667	N/A	N/A
	Total	**248**	**27,141**	**8,307**	**18,833**	**23,776**	**N/A**	**N/A**

* Urban includes villages, summer villages, towns, cities, hamlets;

** Rural includes condominiums / townhouses / mobile homes / complexes, hotels / motels, cooperatives, farmsteads, single-multi homes, colonies and subdivisions

*** Other includes camps, institutions, senior/correctional centres, nursing/children's homes, hospitals

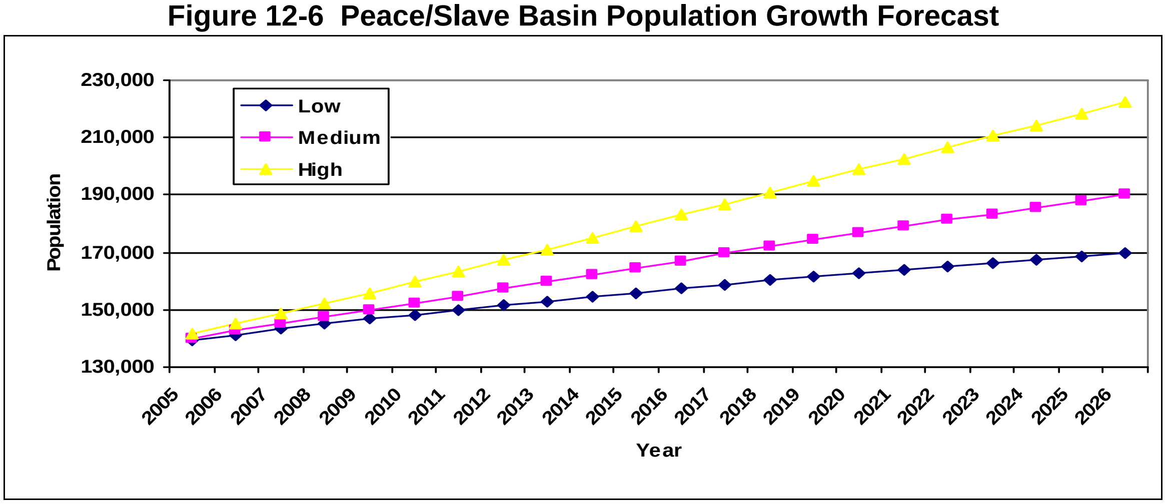
Table 12-5 Estimated Municipal Water Use in the Peace/Slave River Basin

Municipal Use	Source	Withdrawals (dam^3)	Use (dam^3)	Return Flow (dam^3)
Urban	Surface	10,014	379	9,635
	Groundwater	1,816	533	1,283
	Subtotal	**11,830**	**911**	**10,919**
Rural	Surface	248	135	112
	Groundwater	394	372	22
	Subtotal	**641**	**507**	**134**
Other	Surface	24	24	0
	Groundwater	20	14	6
	Subtotal	**44**	**38**	**6**
Total Use	Surface	10,286	538	9,748
	Groundwater	2,230	919	1,311
	Total	**12,516**	**1,457**	**11,059**
Licensed Use	Surface	22,770	6,507	16,263
	Groundwater	4,370	1,800	2,570
	Total	**27,141**	**8,307**	**18,833**
Percent of Licensed Use	Surface	45.2%	8.3%	59.9%
	Groundwater	51.0%	51.0%	51.0%
	Total	**46.1%**	**17.5%**	**58.7%**

12.1.5 Future Water Use Forecasts

Figure 12-6 shows the low, medium and high population projection scenarios for Peace/Slave Basin based on Alberta Finance Census Division projections. The population forecasts in Figure 12-6 have been used to predict future municipal surface and groundwater use. The resulting forecasts of water use are provided in Table 12-6, and are based on the estimated per capita water use in 2005.

Figure 12-6 Peace/Slave Basin Population Growth Forecast



Under the Low Growth scenario, municipal water use in 2025 is expected to be 21 percent greater than in 2005 but diversions in 2025 will still only be 56 percent of the current allocation. Under the High Growth scenario, water use will increase by 54 percent over current levels.

Total diversions of surface and groundwater are expected to be 71 percent of current municipal allocations..

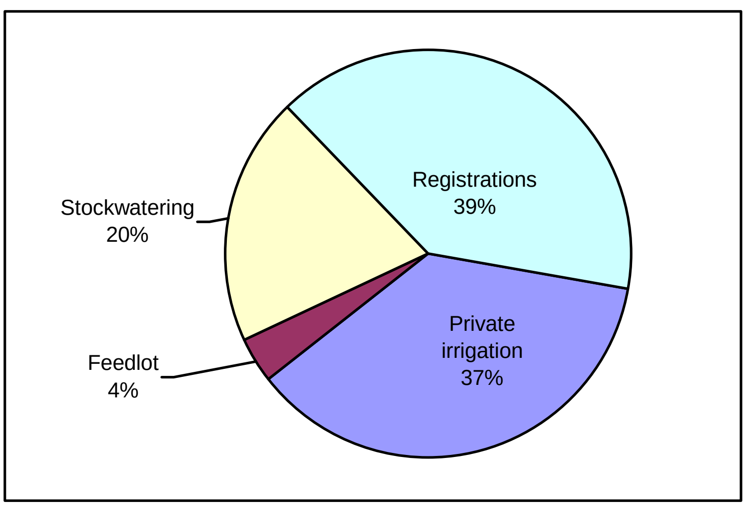
Table 12-6 Projected Water Use for the Municipal Sector in the Peace/Slave Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	538	573	602	629	652
	Groundwater	919	979	1,028	1,074	1,113
	Total	**1,457**	**1,552**	**1,630**	**1,703**	**1,765**
Medium Growth	Surface	538	585	632	678	721
	Groundwater	919	999	1,079	1,158	1,232
	Total	**1,457**	**1,584**	**1,711**	**1,835**	**1,953**
High Growth	Surface	538	606	680	755	829
	Groundwater	919	1,035	1,162	1,290	1,417
	Total	**1,457**	**1,642**	**1,842**	**2,045**	**2,246**

12.2 AGRICULTURAL SECTOR

As of December 2005 a total of 9,162 dam^3 had been allocated to the agricultural sector in the Peace/Slave River Basin. This includes 6,210 registrations representing 3,670 dam^3 and 363 licences representing 5,492 dam^3. Water allocated to agriculture accounts for four percent of all allocations in the Peace/Slave River Basin. Figure 12-7 shows how these allocations are distributed among the different agricultural uses in the basin. The largest allocation is for registrations (39 percent). Private irrigation accounts for 37 percent of allocations; stockwatering accounts for 20 percent; and feedlots account for four percent of the total allocation.

Figure 12-7 Water Allocation for Agricultural Activities in the Peace/Slave Basin



A total of 4,873 registrations and 253 licences allow withdrawals of up to 6,975 dam^3 of surface water; this accounts for 65 percent of all water allocated to the agricultural sector. There are 363 licences and 6,210 registrations that have been issued to withdraw up to 3,793 dam^3 of groundwater (35 percent of total allocation).

12.2.1 Overview of Agriculture in the Peace/Slave Basin

Based on information from the 2001 Census of Agriculture, there were about 5,790 farms in the basin. These farms account for 11 percent of all farms in Alberta total and averaged 1,016 acres in size, which is about five percent larger than the provincial average. Farms in the Peace/Slave Basin cover an area of nearly 5.9 million acres; this is equivalent to about 24,000 km^2 or about 11 per cent of the basin. Table 12-7 shows about 57 percent of the land in the basin is used to raise crops. About 25 per cent of agricultural land is pasture. The rest of the lands is summerfallow or used for other uses.

Table 12-7 Agricultural Land Use in the Peace/Slave River Basin, 2001

Land Use	Acres	Percent
Crop Land	3,352,940	57.0%
Summerfallow	299,665	5.1%
Tame/Seeded Pasture	535,264	9.1%
Natural Pasture	950,684	16.2%
Other	696,384	11.8%
Total	**5,879,697**	**100.0%**

The types of farming activity vary within the Peace/Slave Basin. Table 12-8 shows the classification of farms based on the commodity groups that accounted for 51 per cent or more of total gross farm receipts. The table shows that about 30 percent of the farms in the basin raise beef cattle and about 30 percent of the farms are grain and oilseeds. About 17 percent of farms raise field crops and specialty farms make up about 10 percent of the farms in the basin. Compared to the Alberta, the Peace/Slave Basin has a much higher proportion of farms that raise field crops, grain and oilseed farms, other combinations farms and wheat farms. The basin has a much lower proportion of livestock farms (cattle, dairy, hogs and poultry) than are found in Alberta.

12.2.2 Stockwatering

As noted in Table 12-8 about 30 percent of the farms in the Peace/Slave Basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species in 2001 are provided in Table 12-9. The table shows that there about 200,000 cattle and calves which, together, accounted for about 90 percent of livestock population in the Peace/Slave Basin. This is about 1.6 times the human population of the Basin. Other livestock in the Peace/Slave Basin included pigs, sheep and lamb, horses and ponies, bison, deer and elk.

Table 12-8 Classifications of Farms in the Peace/Slave Basin and Alberta, 2001

Farm Type (Farms with Gross Receipts >$2,500)	Percent of Farms in the Peace/Slave Basin	Percent Share of Alberta	Alberta Farm Type (Percent)
Dairy Farms	0.3%	1.9%	1.5%
Cattle (beef) Farms	29.5%	7.0%	45.4%
Hog Farms	0.6%	3.9%	1.7%
Poultry & Egg Farms	0.4%	5.2%	0.9%
Wheat Farms	9.2%	13.5%	7.4%
Grain & Oilseed Farms	28.0%	16.3%	18.4%
Field Crop Farms	16.9%	19.5%	9.3%
Fruit Farms	0.2%	12.8%	0.1%
Misc.Speciality Farms	10.2%	10.1%	10.9%
Sum of Livestock Comb. Farms	1.7%	7.9%	2.3%
Sum of Vegetable Farms	0.1%	4.2%	0.1%
Sum of Other Comb Farms	2.9%	16.0%	2.0%
Total	**100.0%**	**10.7%**	**100.0%**

Table 12-9 Estimated Livestock Populations in the Athabasca Basin and Alberta

	Basin Total	Alberta	% Alberta
Hens and Chicken	258,346	12,175,246	2.1%
Turkey	1,963	864,438	0.2%
Cattle	309,749	6,615,201	4.7%
Calves	115,924	2,169,607	5.3%
Pigs	28,391	2,027,533	1.4%
Sheep and Lamb	22,691	307,302	7.4%
Horse and Ponies	13,893	159,962	8.7%
Bison	18,391	79,731	23.1%
Deer	189	8,331	2.3%
Elk	5,311	31,304	17.0%

12.2.2.1 Water Allocation

Overall 6,501 licences and registrations have been issued for livestock watering with total allocation amounting to 5,805 dam^3. In addition to these allocations, farmers are able to obtain up to 1,250 m^3 of water for household purposes. The numbers of such households in the basin is not known. Furthermore, the numbers of “exempted agricultural” users are also not known in the Peace/Slave Basin.

A historical perspective on water used for livestock is provided in Figure 12-8. The figure shows that some registrations were issued with priority dates in the 1890s while licences for stockwatering began to be issued from the early 1900s. Allocations for stockwatering have risen steadily since the 1920s with groundwater and surface water registrations accounting for most of that increase. Since 1990 additional allocations have been issued for livestock watering, but the rate of increase has slowed compared to the period between 1960 and 1990. Most of the increase since 1990 has been licences for surface water. As of 2005, about

5,800 dam^3 had been allocated for livestock in the Peace/Slave Basin. In recent years there has been a trend in Alberta toward the intensification of livestock operations and the establishment of feedlots. In the Peace/Slave Basin the first licences were issued for feedlots in 1990s and currently account for about six percent of total livestock water allocation.

Figure 12-8 Historical Trends in Water Allocation for Livestock in the Peace/Slave Basin

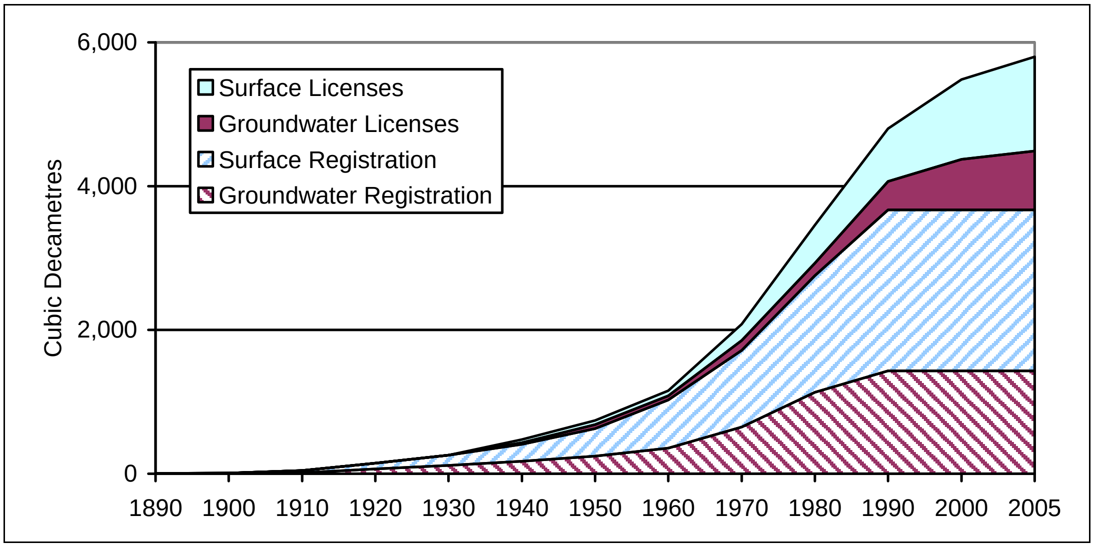


Table 12-10 summarizes the water licences and registrations issued for livestock by water source. A total of about 5,805 dam^3 of water has been allocated: 37 percent through licences and 63 percent through registrations. The table also shows that 61 percent of water allocations for livestock is surface water, while groundwater accounts for the other 39 percent.

12.2.2.2 Licensed Water Use

None of the licences or registrations has any allowances for return flow. Thus, all water diverted or withdrawn for stockwatering purposes is assumed to be used.

12.2.2.3 Actual Water Use

There is no information in Alberta Environment's WURS that indicates the extent to which water allocations are actually used in the Peace/Slave Basin. However, a reasonable estimate of water use can be derived using the actual animal population in the basin as shown in Table 12-9.

Table 12-10 Summary of Water Licences and Registrations Issued for Livestock Watering in the Peace/Slave Basin

Activity	Source	Number of Licenses/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensee Reporting	Reported Use
Feedlot	Surface	6	274.2	274.2	0.0	0	N/A
	Groundwater	4	70.3	70.3	0.0	0	N/A
	Subtotal	**10**	**344.5**	**344.5**	**0.0**	**0**	**N/A**
Stockwatering	Surface	159	1,043.6	1,043.6	0.0	0	N/A
	Groundwater	122	747.3	747.3	0.0	0	N/A
	Subtotal	**281**	**1,790.9**	**1,790.9**	**0.0**	**0**	**N/A**
Registration	Surface	4,873	2,238.3	2,238.3	0.0	0	N/A
	Groundwater	1,337	1,431.5	1,431.5	0.0	0	N/A
	Subtotal	**6,210**	**3,669.8**	**3,669.8**	**0.0**	**0**	**N/A**
Total	Surface	5,038	3,556.1	3,556.1	0.0	0	N/A
	Groundwater	1,463	2,249.1	2,249.1	0.0	0	N/A
	Total	**6,501**	**5,805.2**	**5,805.2**	**0.0**	**0**	**N/A**

Based on livestock populations for the Peace/Slave Basin in 2001, the total water required for livestock was estimated to be 2,808 dam^3, or about 48 percent of the licensed allocation. The calculations for this estimate are provided also in Table 12-11 which shows livestock populations in the basin and the daily water requirements for various livestock species as provided by Alberta Environment in its "Guide to Calculate Quantities for Water for Raising Animals". In terms of water requirements by species, cattle account for about 82 percent of total water demand, about three percent is required by pigs, one percent is required by poultry and all other species accounted for the remaining 15 percent.

Table 12-11 Estimated Livestock Water Requirements for 2001

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chickens	258,346	0.045	19.3
Turkey	1,963	0.15	0.5
Bulls	6,540	9.0	97.6
Milk Cows	459	30.0	22.8
Beef Cows	71,892	9.0	1,073.0
Heifers	37,302	6.0	371.2
Steers	16,998	6.0	169.1
Calves	115,924	3.0	576.7
Boars	228	6.5	2.5
Sows and Gilts - Breeding	2,509	6.5	27.0
Nursing and Weaner Pigs	8,160	0.5	6.8
Grower and Finishing Pigs	16,558	1.5	41.2
Sheep and Lambs	22,691	2.0	75.3
Horse and Ponies	13,893	10.0	230.4
Bison	18,391	2.0	61.0
Deer	189	10.0	3.1
Elk	5,311	3.5	30.8
Total			**2,808.3**

While the estimated actual consumption based on livestock populations (2,808 dam^3**)** appears to be less than the amount of water allocated (5,805 dam^3), the data in Table 12-11 do not include an allowance for the evaporative and seepage losses associated with storing water for livestock use. Typically, licensed consumption accounts for only 35 per cent of surface water allocated for livestock use while losses account for 65 per cent (Watrecon 2005). Since 39 percent of livestock water consumption comes from groundwater (no losses) and the balance comes from surface water with 65 per cent losses, a total allocation of 3,730 dam^3 would be required to support the animal populations in Table 12-9. This water requirement is about is about 64 percent of the water allocation through licences and registrations. Consequently, it is assumed that actual water use is less than the amount of water allocated for livestock.

12.2.2.4 Forecasts of Future Stockwatering Water Use

The key factor affecting future livestock water demand is changes in cattle populations in the basin. Cattle account for about 83 percent of livestock water demand in the Peace/Slave Basin, so changes in the populations of other livestock species will have a minimal overall impact on future water demand. The historical trend analysis in Figure 12-8 shows that the amount of water allocated for livestock has been increasing over time, including the last decade, suggesting an increasing livestock population. The data from the Census of Agriculture corroborates this finding as it shows that the cattle population increased between 1996 and 2001.

Some indication of the potential for expansion of cattle populations in the Peace/Slave River Basin can be determined by examining applications for new and expanded confined feeding operations, which must be approved by the NRCB in accordance with *AOPA*. Information from the NRCB indicates that, as of December 31, 2005, there had been nine applications from farmers throughout the basin for cattle and dairy operations most of which were approved (Table 12-12).

Table 12-12 Status of Applications Under *AOPA* in the Peace/Slave Basin

Type of Application	Number	Withdrawn	Approved	Denied
Approval	4	0	2	2
Registrations	3	0	3	0
Authorizations	2	0	2	0
Total	**9**	**0**	**7**	**2**

A study undertaken by Alberta Agriculture in the late 1990s also provides some insights regarding the potential for expansion of the beef industry in the province. That study identified several criteria – manure, odour and population densities, local silage supplies, water supply, landscape characteristics and land for manure spreading – to be considered in evaluating the capability of supporting a 5,000-head backgrounding operation and a 20,000-head finishing operation. Townships suitable for livestock expansion are shown in Figures 2-2 and 2-3 in Section 2.3. These townships are located in the western portion of the Basin, around the Grande Prairie. The figure shows that more townships meet all of the criteria for backgrounding operations than for finishing operations. For most townships that meet some of the criteria the limiting factors include groundwater, silage and landscape for both backgrounding and finishing operations. Based on Alberta Agriculture's assessment, it would appear that livestock expansion in the Peace/Slave Basin in the Peace region could occur and would most likely consist of 5,000-head operations, although 20,000-head operations can also be supported. This assessment is corroborated by the application information from the NRCB. Other studies (e.g. Toma and Bouma 1997)[1] have also identified the Peace region as being able to accommodate livestock expansion, especially confined feeding operations, since ability to support expansion is decreasing in southern Alberta.

[1] Toma and Bouma Management Consultants. 1997. The Pursuit of Quality: A Sustainable Growth Strategy for the Alberta Agri-Food Sector. Prepared for Alberta Agriculture, Food and Rural Development, 134 pp.

Projections are based on the expectations that cattle populations will increase at annual rates somewhere between 0.5 percent (Low Growth) and 2.2 percent (High Growth), which reflects average annual growth rate in cattle population in Alberta during 1958-2005. For the Medium Growth scenario, an annual growth rate of 1.2 percent has been assumed. This forecast also assumes that the current mix of livestock water use (83 percent cattle) and balance of surface and groundwater use will remain unchanged over the forecast period. The resulting projections are shown in Table 12-13.

Table 12-13 Projected Water Use for Livestock in the Peace/Slave Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	2,635	2,702	2,770	2,840	2,912
	Groundwater	1,095	1,123	1,151	1,180	1,210
	Total	**3,730**	**3,825**	**3,921**	**4,020**	**4,122**
Medium Growth	Surface	2,635	2,797	2,969	3,152	3,345
	Groundwater	1,095	1,162	1,234	1,310	1,390
	Total	**3,730**	**3,960**	**4,203**	**4,461**	**4,735**
High Growth	Surface	2,635	2,938	3,274	3,652	4,072
	Groundwater	1,095	1,221	1,361	1,518	1,692
	Total	**3,730**	**4,159**	**4,637**	**5,170**	**5,765**

Under the Low Growth scenario, water demand is projected to increase to 4,122 dam^3 by 2025; this represents an 11 percent increase over current use but is within current allocations. Under the High Growth scenario, livestock water use would increase to 5,765 dam^3 by 2025. This increase is 1.5 times higher than current livestock use and is also within current allocations.

12.2.3 Irrigation

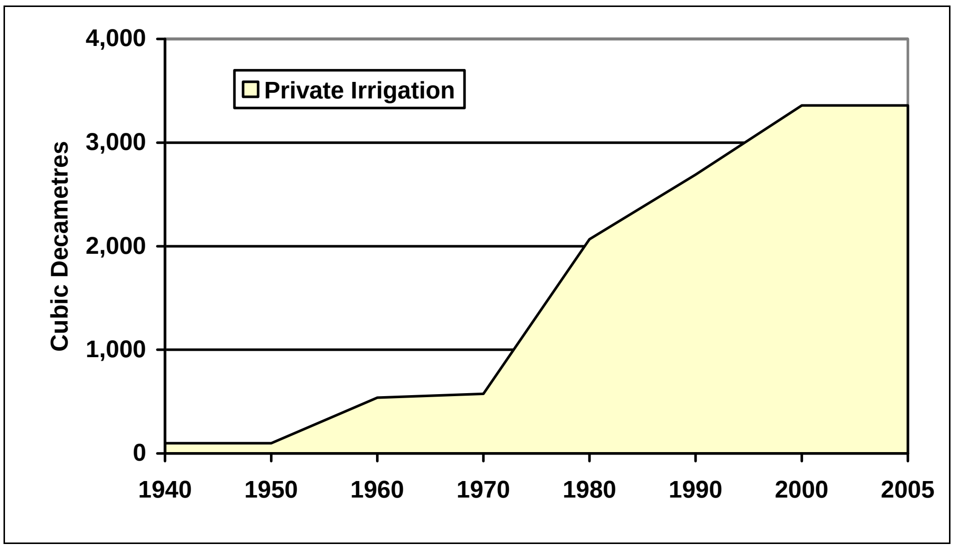
The other major use of water for agricultural purposes is irrigation or crop watering. There are no licences for district irrigation in the Peace/Slave Basin. The farmers in this basin are private irrigators who have their own water licences and divert water using their own pumps and water distribution equipment.

When aggregate information from the 2001 Census of Agriculture for individual counties and municipal districts is modified to reflect river basin boundaries, the resulting estimates suggest that about 554 acres of land in the Peace/Slave River Basin were irrigated in 2001. This number is not correct however, because irrigation acres are not evenly distributed throughout each county that make up the Basin and because of likelihood of inaccuracy in the Census data. A better estimate of the irrigated acres can be made based on water allocations and irrigation requirement of about 450 mm (18 inches) per acre. Based on this requirement it is estimated that water allocations are sufficient to support irrigation on about 2,760 acres. There is no information on the mix of crops grown by private irrigators; AAFRD has indicated that most private irrigation in Alberta is used to raise supplemental forages to feed livestock.

12.2.3.1 Water Allocation

There are 72 licences that allocate maximum withdrawals of 3,356 dam^3 for crop watering. Nearly all of this (99 percent) is for surface water. This Peace/Slave River Basin accounts for less than one percent of allocations for private irrigation in Alberta. A historical perspective on water used for irrigation is provided in Figure 12-9. It shows that the first licences for irrigation were issued in the 1940s, but the demand for water increased significantly in the 1970s. While the demand for water has increased at a lower rate since 1980, no new allocations have been issued since 2000.

Figure 12-9 Historical Trends in Surface Water Allocation for Irrigation in the Peace/Slave Basin



12.2.3.2 Licensed Water Use

Table 12-14 summarizes the water licences issued for irrigation according to water source. It shows that up to 96 percent of withdrawals of surface water is expected to be used and that four percent (137 dam^3) will be returned to surface sources. There are no return flow allowances in any licences issued for use of groundwater for irrigation.

12.2.3.3 Actual Water Use

Neither AAFRD nor AENV has any information on actual water use by private irrigators. For the purposes of this study it is assumed that actual use is equal to licensed water use. However, actual water use in any given year will depend on how much of the crop water demand can be satisfied by natural precipitation. It is noteworthy that the estimated use of water for stockwatering in the Basin (3,548 dam^3) is about the same as crop watering.

Table 12-14 Irrigation Allocations and Use and Reported Actual Water Use, Peace/Slave River Basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
Private irrigation	Surface	70	3,353.9	3,210.8	143.1	0	N/A
	Groundwater	2	2.5	2.5	0.0		
	Subtotal	**72**	**3,356.3**	**3,213.2**	**143.1**	**0**	**N/A**
Total	Surface	70	3,353.9	3,210.8	143.1	0	N/A
	Groundwater	2	2.5	2.5	0.0		
	Total	**72**	**3,356.3**	**3,213.2**	**143.1**	**0**	**N/A**

12.2.3.4 Forecasts of Future Irrigation Water Use

It is expected that the gradual expansion of livestock will result in additional demands for forage and that water use for irrigation will also increase. The historical trend provided in Figure 12-9 shows that water allocations for irrigation have been increasing over time, suggesting that past increases in livestock populations have led to increased water use for irrigating forage. Expansion of crop areas in the Basin to support the livestock expansion is possible, especially in the Peace region, which is one of the major agricultural areas in the province. However, irrigation is a capital intensive operation and the net returns from forage production are not great (Watrecon 2005). The future water use projections for irrigation are based on the assumption that available forage will be able to support some growth in livestock populations. Three scenarios are used. The Low Growth scenario assumes that available forage will be able to support limited livestock expansion and there will be no increase in water requirements for irrigation. The Medium Growth scenario assumes that requirements for irrigation will increase at a rate of about 0.5 percent per year while the High Growth scenario assumes that water use will increase annually at a rate of 1.0 percent. The resulting projections are show in Table 12-15.

Table 12-15 Projected Water Use for Irrigation in the Peace/Slave River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	3,210	3,210	3,210	3,210	3,210
	Groundwater	3	3	3	3	3
	Total	**3,213**	**3,213**	**3,213**	**3,213**	**3,213**
Medium Growth	Surface	3,210	3,292	3,375	3,460	3,547
	Groundwater	3	3	3	3	3
	Total	**3,213**	**3,294**	**3,378**	**3,463**	**3,550**
High Growth	Surface	3,210	3,375	3,547	3,728	3,918
	Groundwater	3	3	3	3	3
	Total	**3,213**	**3,377**	**3,550**	**3,731**	**3,921**

Under the Low Growth scenario, water demand is projected to remain constant at 3,213 dam^3 through 2025. Under the High Growth scenario, irrigation water use would increase to 3,921 dam^3 by 2025; this is a 20 percent increase over current allocations and water use.

12.2.4 Summary

Current agricultural water use in the Peace/Slave Basin is estimated to be about 6,944 dam^3: 46 percent of which is for irrigation and 56 percent for livestock. In the future, agricultural water demand in the basin is expected to increase as a result of expansion of livestock populations and increased forage production. A summary of future agricultural water demand is provided in Table 12-16. Agricultural water use in 2025 would be about 7,335 dam^3 (an increase of six percent from 2005) under the Low Growth scenario. Under the High Growth scenario, water use is projected to be 9,685 dam^3 by 2025 (an increase of nearly 40 percent from 2005).

Table 12-16 Projected Water Use for Agriculture in the Peace/Slave River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	5,846	5,913	5,981	6,051	6,122
	Groundwater	1,098	1,125	1,154	1,183	1,213
	Total	**6,944**	**7,038**	**7,134**	**7,233**	**7,335**
Medium Growth	Surface	5,846	6,089	6,344	6,612	6,893
	Groundwater	1,098	1,165	1,236	1,312	1,393
	Total	**6,944**	**7,254**	**7,581**	**7,924**	**8,286**
High Growth	Surface	5,846	6,313	6,823	7,380	7,990
	Groundwater	1,098	1,224	1,364	1,521	1,695
	Total	**6,944**	**7,536**	**8,187**	**8,901**	**9,685**

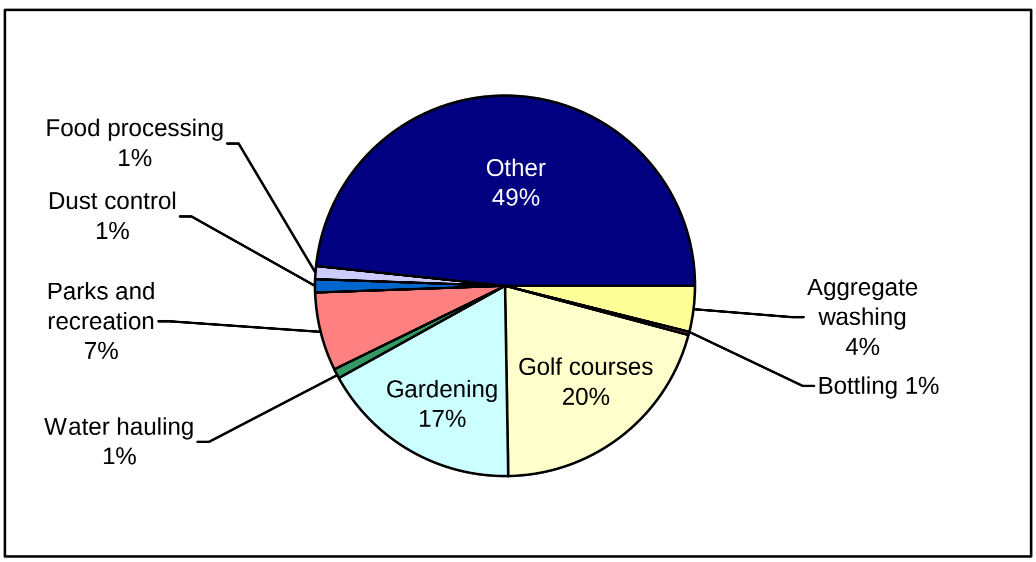
12.3 COMMERCIAL SECTOR

A total of 223 licences have been issued for commercial purposes in the Peace/Slave River Basin and they allow withdrawals of up to 3,383 dam^3 of water. This allocation accounts for 1.4 percent of total allocations in the basin.

12.3.1 Water Allocations

As shown in Figure 12-10, the three largest allocations for the commercial sector are for other activities (49 percent), golf courses (20 percent), and gardening (17 percent). Together, these three activities account for about 86 percent of the total commercial allocation.

Figure 12-10 Water Allocation by Volume for Commercial Activities in the Peace/Slave Basin

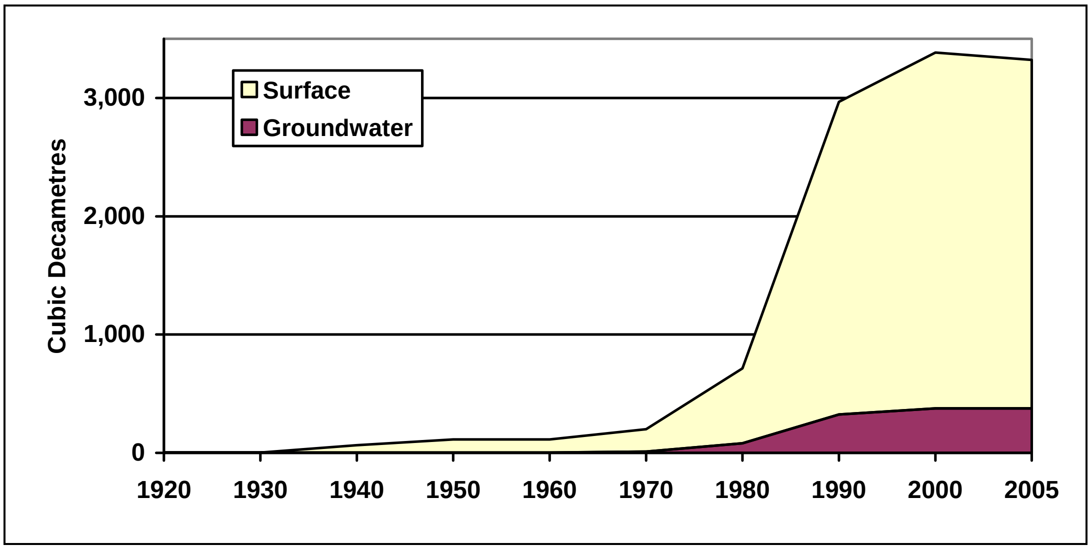


Licences issued to the commercial sector allow maximum withdrawals of about 3,006 dam^3 of

surface water which accounts for 89 percent of total allocation for this sector. The largest allocation of surface water is for other activities (45 percent of surface water allocations). Commercial sector licences also allow withdrawals of up to 372 dam^3 of groundwater and about half of this has been allocated for other activities.

The history of allocations for the commercial sector in the Peace/Slave Basin is provided in Figure 12-11. The earliest licences of groundwater for commercial activities were issued in the in the 1920s for groundwater but the allocations remained very small constant until the 1970s. There was a significant increase in groundwater allocations between 1980 and 1990, but there has been little change since then. Licences for small amounts of surface water were issued in the 1930s and allocations increased sharply between in the 1980s. Allocations of surface water increased again in the 1990s but have dropped slightly since 2000.

Figure 12-11 Historical Trend in Commercial Sector Water Allocation in the Peace/Slave Basin



12.3.2 Licensed Water Use

Table 12-17 provides a summary of licensed water allocations, use and return for various activities within the commercial sector in the Peace/Slave Basin. It shows that very few licences have any allowances for return flow so that all withdrawals can be used. Only some of the groundwater licences issued for other activities expect any water to be returned and the amount of return flow (5.0 dam^3) is very small (1.3 percent of allocations for other commercial activities).

Table 12-17 Licensed Commercial Allocations and Reported Actual Water Use, Peace/Slave Basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Licensees Reporting	Reported Use	Percent of Allocation
Aggregate washing	Surface	9	69.4	69.4	0.0	0	N/A	N/A
	Groundwater	2	59.2	59.2	0.0	0	N/A	N/A
	Subtotal	**11**	**128.6**	**128.6**	**0.0**	**0**	**N/A**	**N/A**
Bottling	Surface	2	6.2	6.2	0.0	0	N/A	N/A
	Groundwater	2	6.2	6.2	0.0	0	N/A	N/A
	Subtotal	**4**	**12.3**	**12.3**	**0.0**	**0**	**N/A**	**N/A**
Golf course	Surface	17	687.4	687.4	0.0	0	N/A	N/A
	Groundwater	4	3.4	3.4	0.0	0	N/A	N/A
	Subtotal	**21**	**690.7**	**690.7**	**0.0**	**0**	**N/A**	**N/A**
Gardening	Surface	10	588.2	588.2	0.0	0	N/A	N/A
	Groundwater	1	1.2	1.2	0.0	0	N/A	N/A
	Subtotal	**11**	**589.5**	**589.5**	**0.0**	**0**	**N/A**	**N/A**
Water hauling	Surface	0	0.0	0.0	0.0	0	N/A	N/A
	Groundwater	1	24.0	24.0	0.0	0	N/A	N/A
	Subtotal	**1**	**24.0**	**24.0**	**0.0**	**0**	**N/A**	**N/A**
Parks and Recreation	Surface	6	177.6	177.6	0.0	0	N/A	N/A
	Groundwater	14	49.3	49.3	0.0	0	N/A	N/A
	Subtotal	**20**	**226.9**	**226.9**	**0.0**	**0**	**N/A**	**N/A**
Dust control	Surface	136	36.2	36.2	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**136**	**36.2**	**36.2**	**0.0**	**0**	**N/A**	**N/A**
Food processing	Surface	0	0.0	0.0	0.0	0	N/A	N/A
	Groundwater	3	41.4	41.4	0.0	0	N/A	N/A
	Subtotal	**3**	**41.4**	**41.4**	**0.0**	**0**	**N/A**	**N/A**
Other	Surface	7	1,441.0	1,441.0	0.0	0	N/A	N/A
	Groundwater	9	192.2	187.2	5.0	0	N/A	N/A
	Subtotal	**16**	**1,633.2**	**1,628.2**	**5.0**	**0**	**N/A**	**N/A**
Total	Surface	187	3,006.0	3,006.0	0.0	0	N/A	N/A
	Groundwater	36	376.8	371.8	5.0	0	N/A	N/A
	Total	**223**	**3,382.8**	**3,377.8**	**5.0**	**0**	**N/A**	**N/A**

12.3.3 Actual Water Use

At the present time Alberta Environment's Water Use Reporting System (WURS) contains no information on actual water use in 2005 by the any of the licensees in commercial sector in the Peace/Slave Basin. With no information on actual use, it is assumed that all licensees are withdrawing and using the full amounts of water to which they are entitled. While this assumption may overstate actual water use in the basin, the commercial sector accounts for 1.4 percent of total allocations so it will not appreciably affect the overall water use estimate for the Peace/Slave Basin.

12.3.4 Forecasts of Future Water Use

Since most of the allocation for the commercial sector (86 percent) is for other commercial activities, golf courses and gardening, forecasts of future demand will focus on these activities.

12.3.4.1 Other Commercial Activities

Future water use for other commercial activities is assumed to be related to general economic growth. Annual growth rates of 1.2, 2.2 and 3.2 percent have been assumed for the Low Growth, Medium Growth and High Growth scenario. The resulting estimates are shown in Table 12-18.

Table 12-18 Projected Water Use for Other Commercial Activities, Peace/Slave Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,441	1,530	1,624	1,723	1,829
	Groundwate	187	199	211	224	238
	Total	**1,628**	**1,728**	**1,835**	**1,947**	**2,067**
Medium Growth	Surface	1,441	1,607	1,791	1,997	2,227
	Groundwate	187	209	233	259	289
	Total	**1,628**	**1,815**	**2,024**	**2,257**	**2,516**
High Growth	Surface	1,441	1,687	1,975	2,311	2,706
	Groundwate	187	219	257	300	351
	Total	**1,628**	**1,906**	**2,231**	**2,612**	**3,057**

Water use is expected to increase to 2,067 dam^3 by 2025 under the Low Growth scenario and this represents a 27 percent increase over current use. For the High Growth scenario, water use is projected to increase to 3,057 dam^3 by 2025 and this is almost double the current water use for other commercial activities.

12.3.4.2 Golf Courses

The water use forecast for golf courses is based on the approach outlined in Watrecon (2005) which links water use to expansion of the golf course which is tied to population growth rates. The forecasts assume that the proportion of surface and groundwater use will not change over the forecast period. The resulting projections are shown in Table 12-19.

Table 12-19 Projected Water Use for Golf Course, Peace/Slave Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	687	760	820	876	924
	Groundwate	3	4	4	4	5
	Total	**691**	**764**	**824**	**880**	**929**
Medium Growth	Surface	687	883	1,080	1,272	1,453
	Groundwate	3	4	5	6	7
	Total	**691**	**888**	**1,085**	**1,278**	**1,460**
High Growth	Surface	687	1,120	1,588	2,063	2,535
	Groundwate	3	6	8	10	12
	Total	**691**	**1,125**	**1,595**	**2,073**	**2,547**

Water use is expected to increase to 929 dam^3 by 2025 under the Low Growth scenario and this represents a 34 percent increase over use in 2005. For the High Growth scenario, water demand is projected to increase to 2,547 dam^3 by 2025; this is 3.7 times the volume of water that was used for golf courses in 2005

12.3.4.3 Gardening

The forecast of water used for gardening (nurseries, greenhouses and sod farms) for the Medium Growth scenario assumes an annual increase of 0.5 percent, which was the average annual growth rate of greenhouse farms (acres) in the Basin between 1996 and 2001 (Census of Agriculture). The Low Growth scenario assumes that there will be no increase in water for gardening while the High Growth scenario assumes a 1.2 percent annual increase. The resulting projections are presented in Table 12-20.

Table 12-20 Projected Water Use for Gardening, Peace/Slave Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	588	588	588	588	588
	Groundwater	1	1	1	1	1
	Total	**590**	**590**	**590**	**590**	**590**
Medium Growth	Surface	588	603	618	634	650
	Groundwater	1	1	1	1	1
	Total	**590**	**604**	**620**	**635**	**651**
High Growth	Surface	588	624	663	704	747
	Groundwater	1	1	1	2	2
	Total	**590**	**626**	**664**	**705**	**748**

Water use is expected to remain unchanged at 590 dam^3 under the Low Growth scenario. Using the High Growth scenario, water use for gardening is projected to increase to 748 dam^3 by 2025 and this represents a 27 percent increase from current water use.

12.3.4.4 Summary

A summary of projected water demand for the commercial sector in the Peace/Slave Basin is provided in Table 12-21. This summary combines the water use projections for the three main

activities described above (other, golf courses and gardening) with the assumption that water use for the other activities remains constant over the forecast period.

Table 12-21 Projected Water Use for the Commercial Sector in the Peace/Slave Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	3,006	3,167	3,322	3,477	3,631
	Groundwater	372	384	396	409	423
	Total	**3,378**	**3,551**	**3,718**	**3,886**	**4,054**
Medium Growth	Surface	3,006	3,382	3,779	4,193	4,619
	Groundwater	372	394	419	447	478
	Total	**3,378**	**3,777**	**4,198**	**4,639**	**5,097**
High Growth	Surface	3,006	3,720	4,514	5,367	6,277
	Groundwater	372	406	446	492	545
	Total	**3,378**	**4,126**	**4,960**	**5,859**	**6,822**

Under the Low Growth scenario, commercial water use is projected to rise to 4,054 dam^3 by 2025 and this is 20 percent higher than current use. For the High Growth Scenario, water use is predicted to rise to 6,822 dam^3 by 2025 and this is about twice the amount of water currently being used by the commercial sector.

12.4 PETROLEUM SECTOR

In the Peace/Slave Basin, 136 licences have been issued to the petroleum sector and they allow withdrawals of up to 20,586 dam^3 of water. These licences account for eight percent of all water allocations in the basin. Allocations of surface water amount to 11,201 dam^3 and account for 54 percent of the total for the petroleum sector. As shown in Figure 12-12, the petroleum sector includes water allocations for thermal extraction, gas/petrochemical plants, and various other activities.

Figure12-12 Petroleum Water Allocation by Use in the Peace/Slave Basin

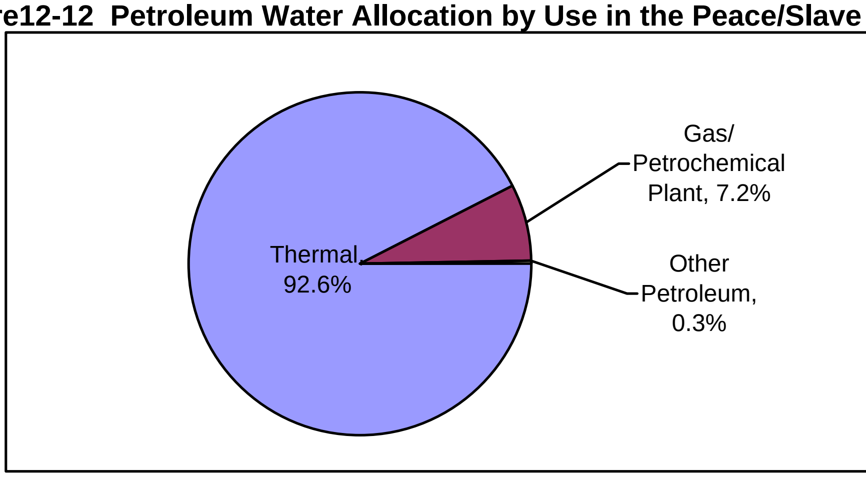


Table 12-22 summarizes the water allocation, use, and return associated with the licences for each activity in the Peace/Slave Basin.

Table 12-22 Licensed Allocations and Estimated Water Use by the Petroleum Sector, Peace/Slave Basin

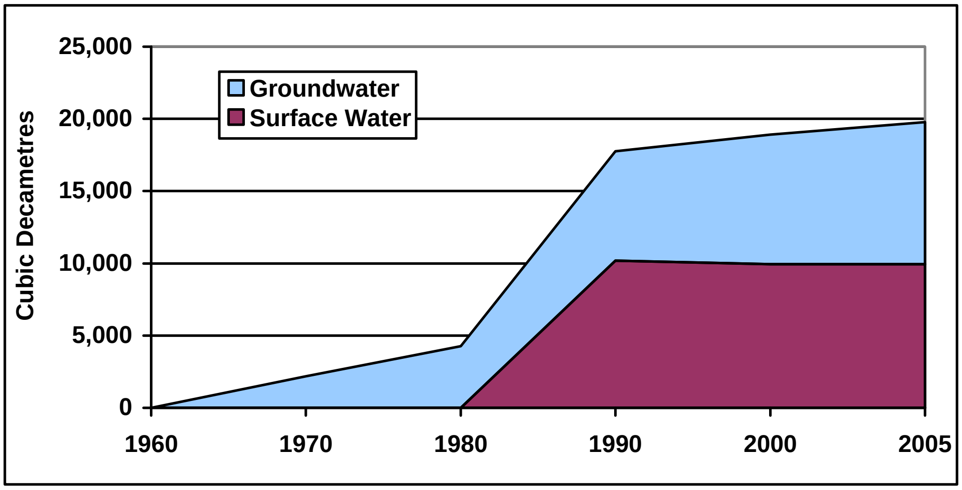
Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Thermal	Surface	15	9,948.0	8,992.9	955.1	3,863.9	43.0%	38.8%
	Groundwater	85	9,106.0	9,106.0	0.0	1,518.4	16.7%	16.7%
	Subtotal	**100**	**19,054.0**	**18,098.9**	**955.1**	**5,382.3 ***	**29.7%**	**28.2%**
Gas/Petrochemical Plant	Surface	2	1,237.2	1,237.2	0.0	1,237.2	100.0%	100.0%
	Groundwater	28	238.8	238.8	0.0	238.8	100.0%	100.0%
	Subtotal	**30**	**1,476.0**	**1,476.0**	**0.0**	**1,476.0****	**100.0%**	**100.0%**
Other petroleum	Surface	2	15.6	15.6	0.0	15.6	100.0%	100.0%
	Groundwater	4	40.6	40.6	0.0	40.6	100.0%	100.0%
	Subtotal	**6**	**56.2**	**56.2**	**0.0**	**56.2****	**100.0%**	**100.0%**
Total	Surface	19	11,200.7	10,245.6	955.1	5,116.6	49.9%	45.7%
	Groundwater	117	9,385.4	9,385.4	0.0	1,797.8	19.2%	19.2%
	Total	**136**	**20,586.2**	**19,631.0**	**955.1**	**6,914.5**	**35.2%**	**33.6%**

* Estimates based on EUB data (Geowa).
** Estimates assume 100 percent of licensed use.

12.4.1 Thermal

Table 12-22 shows that the majority (93 percent) of the allocations for the petroleum sector in the Peace/Slave Basin is for thermal extraction. Licences issued for thermal extraction allow up to 19,054 dam^3 to be withdrawn and surface water allocations account for 52 percent of this amount. The first licences allowing use of groundwater for thermal extraction were issued in the 1960s, and have increased gradually since then. Figure 12-13 shows that all of the allocations of surface water were issued in the 1980s and decreased slightly since then,

Figure 12-13 Historical Trends in Water Allocations for Thermal



12.4.1.1 Licensed Water Use

According to the licence information in Table 12-22, it is expected that all allocations of groundwater will be used as there are no return flow allowances in any of those licences. Some of the licences issued for surface water have return flow allowances. These total 955 dam^3 and account for about 10 percent of surface water allocations. Overall, licences issued for thermal extraction expect 95 percent of allocations to be used.

12.4.1.2 Actual Water Use

Detailed estimates of water used for thermal proposes have been prepared by Geowa based on EUB data. These estimates are also presented in Table 12-22. According to Geowa, an estimated 5,382 dam^3 of fresh water was diverted for thermal purposes in 2005. This volume includes 3,864 dam^3 of surface water and 9,106 dam^3 of groundwater. The activity also used 2,368 dam^3 of saline water. Based on these estimates, licensees actually used 43 percent of their surface water entitlements and 17 percent of their groundwater entitlements.

12.4.1.3 Forecasts of Future Water Use

The general trend in Alberta is for bitumen production to increase as new fields are developed. The most recent forecast from the EUB and CAPP have bitumen production increasing. The EUB predicts that in-situ crude bitumen production involving thermal extraction will increase from 69,700 m^3/day in 2005 to 170,000 m^3/day by 2015. CAPP forecasts that in-situ crude oil production (thermal) will increase to 277,433 m^3/day by 2015, and then decrease to about 274,094 m^3/day by 2020.

The Peace/Slave basin is expected to follow the overall Alberta production trend since the province's third largest reserve, the Peace River Bluesky-Gething, is located within the Peace/Slave Basin (EUB, 2006). The forecast of future water use for thermal extraction in the Peace/Slave basin in Table 12-23 assumes the amount of water required for thermal extraction activities in the basin is expected to increase to 2015 and then decline slightly. The Low and Medium Growth scenarios reflect the more conservative estimates provided by the EUB, while the High Growth scenario is based on the forecasts provided by CAPP. For the purposes of this analysis it is assumed that production forecasts for 2010 and 2020 are the same as the previous five years. Forecasts also assume the current ratio of surface to groundwater use.

Table 12-23 Forecast of Thermal Water Use in the Peace/Slave Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	3,864	3,864	14,612	14,612	14,263
	Groundwater	1,518	1,518	5,742	5,742	5,605
	Total	**5,382**	**5,382**	**20,355**	**20,355**	**19,868**
Medium Growth	Surface	3,864	3,864	15,382	15,382	15,014
	Groundwater	1,518	1,518	6,044	6,044	5,900
	Total	**5,382**	**5,382**	**21,426**	**21,426**	**20,913**
High Growth	Surface	3,864	3,864	25,822	25,822	25,201
	Groundwater	1,518	1,518	10,147	10,147	9,903
	Total	**5,382**	**5,382**	**35,970**	**35,970**	**35,104**

Under the Low Growth scenario, water use for thermal extraction in 2025 will increase to 19,868 dam^3, which is decline by 3.7 times the amount of water used for thermal extraction in 2005. Under the High Growth scenario, water use would increase to 35,105 dam^3 by 2025 and this is 6.5 times higher than actual use in 2005.

12.4.2 Gas/Petrochemical Plants

Thirty licences have been issued for gas/petrochemical plants and they allow withdrawals of up to 1,476 dam^3. This accounts for less than seven percent of the water allocations for the petroleum sector in the Peace/Slave Basin. About 84 percent of this allocation is for surface water. The first surface water licences for small amounts of water were issued in the 1960s but the majority of licences were issued in the 1970s. Groundwater allocations have increased slowly since the 1960s. Licensees are not expected to return any of the water they divert. With

no information on actual water use, gas/petrochemical plants in the Peace/Slave basin are assumed to have used all the water they were licensed to use in 2005. Water use by gas/petrol-chemical plants in the Peace/Slave basin is expected to remain the same over the forecast period.

12.4.3 Other Petroleum

Less than one percent of the allocations for the petroleum sector in the Peace/Slave basin are for other petroleum activities. Licensed allocations amount to 56 dam^3, 72 percent of which is for groundwater. Surface and groundwater licences for other petroleum purposes were issued in the 1990s. Licensees are not expected to return any of the water they divert. In the Peace/Slave basin other petroleum activities are assumed to have used all the water they were licensed to use in 2005. Water use by other petroleum activities in the Peace/Slave basin is expected to remain the same over the forecast period.

12.4.4 Summary

The petroleum sector in the Peace/Slave basin is dominated by water allocated for thermal extraction purposes. This activity accounted for almost 93 percent of allocations but only 78 percent of actual water use in 2005. Water use data shows that although water licences allow up to 19,631 dam^3 of water to be consumed for petroleum purposes, licensees are only using 35 percent of this amount.

In the future, there is expected to be an increase in the amount of water used for thermal as bitumen production increases. The overall water use projections for the petroleum sector are provided in Table 12-24. This forecast reflects major increases in water used for thermal extraction and assumes that water use by gas/petrochemical plants and other petroleum activities remains at current levels. Forecasts also assume the current ratio of surface to groundwater use and that water required in 2010 and 2020 is the same as the previous five year periods.

Table 12-24 Forecast of Petroleum Water Use in the Peace/Slave Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	5,117	5,117	15,865	15,865	15,516
	Groundwater	1,798	1,798	6,022	6,022	5,885
	Total	**6,915**	**6,915**	**21,888**	**21,888**	**21,401**
Medium Growth	Surface	5,117	5,117	16,635	16,635	16,267
	Groundwater	1,798	1,798	6,324	6,324	6,180
	Total	**6,915**	**6,915**	**22,959**	**22,959**	**22,446**
High Growth	Surface	5,117	5,117	27,075	27,075	26,454
	Groundwater	1,798	1,798	10,427	10,427	10,183
	Total	**6,915**	**6,915**	**37,503**	**37,503**	**36,637**

Table 12-24 shows that, for all three scenarios, the overall demand for water in the Peace/Slave

Basin will increase rapidly until 2015 and then decline slightly. For the High Growth scenario water use by the petroleum sector in 2025 demand is forecasted to be 430 percent higher than current use. Under the Low Growth scenario, water use would increase by 210 percent.

12.5 INDUSTRIAL SECTOR

In the Peace/Slave Basin there are currently 18 licences that allow up to 90,690 dam^3 of water to be withdrawn for use by the industrial sector. The industrial sector accounts for 37 percent of total allocations in the basin. Almost all these allocations (99.7 percent) are for surface water (90,429 dam^3). As shown in Figure 12-14, the industrial sector includes water allocations for cooling, chemical plants, forestry and coal mining.

Figure 12-14 Industrial Water Allocation by Use in the Peace/Slave Basin

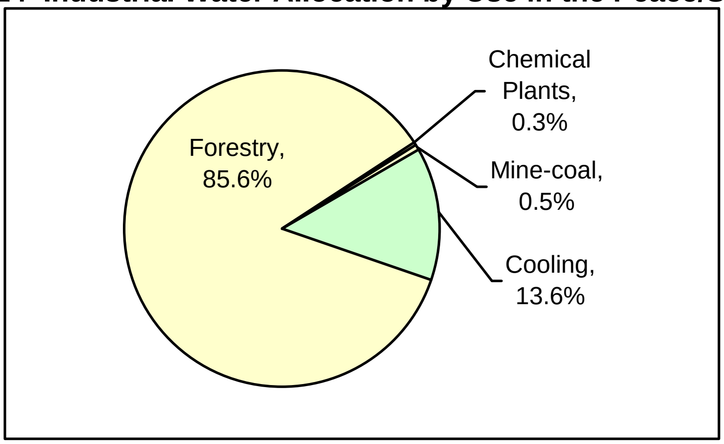


Table 12-25 summarizes the water allocation, use, and return associated with the licences for all activities in the industrial sector in the Peace/Slave Basin.

12.5.1 Cooling

About 14 percent of industrial allocations are for cooling purposes for thermal power generation or cooling such as air conditioning (12,335 dam^3). Table 12-25 shows that one surface water licence was issued for cooling purposes in the 1960s and the allocation has remained constant since. This licence was issued for the H.R. Milner power station, a 144 MW coal-fired power station near the Town of Grande Cache. The licence expects all withdrawals to be used and there is no allowance for return flow.

Information on actual water use by all thermal power plants for cooling was provided to AMEC by the licence holders. Analysis of the data indicates that plants with surface water allocations used an average of 45 percent of their allocations licensed water use. Based on available data, it is estimated that 5,551 dam^3 was used in 2005 for cooling purposes in the Peace/Slave Basin. There are no forecasts of how this water use may change in the future so, for purposes of this analysis, it is assumed that water used for cooling activities in the Peace/Slave Basin will remain constant for the forecast period.

Table 12-25 Licensed Allocations and Estimated Water Use by the Industrial Sector, Peace/Slave River Basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Cooling	Surface	1	12,334.8	12,334.8	0.0	5,550.7	45.0%	45.0%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**1**	**12,334.8**	**12,334.8**	**0.0**	**5,550.7**	**45.0%**	**45.0%**
Forestry	Surface	3	77,509.4	7,770.9	69,738.4	3,831.3	49.3%	4.9%
	Groundwater	2	128.1	38.4	89.7	38.4	100.0%	30.0%
	Subtotal	**5**	**77,637.5**	**7,809.4**	**69,828.1**	**3,869.7**	**50.7%**	**5.1%**
Chemical Plants	Surface	1	271.4	213.4	58.0	91.8	43.0%	33.8%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**1**	**271.4**	**213.4**	**58.0**	**91.8**	**43.0%**	**33.8%**
Mine-coal	Surface	2	313.6	313.6	0.0	313.6	100.0%	100.0%
	Groundwater	9	133.1	124.3	8.9	124.3	100.0%	93.4%
	Subtotal	**11**	**446.7**	**437.8**	**8.9**	**437.8**	**100.0%**	**98.0%**
Total	Surface	7	90,429.1	20,632.7	69,796.4	9,787.4	47.4%	10.8%
	Groundwater	11	261.2	162.7	98.6	162.7	100.0%	62.3%
	Total	**18**	**90,690.4**	**20,795.4**	**69,895.0**	**9,950.1**	**48.3%**	**11.1%**

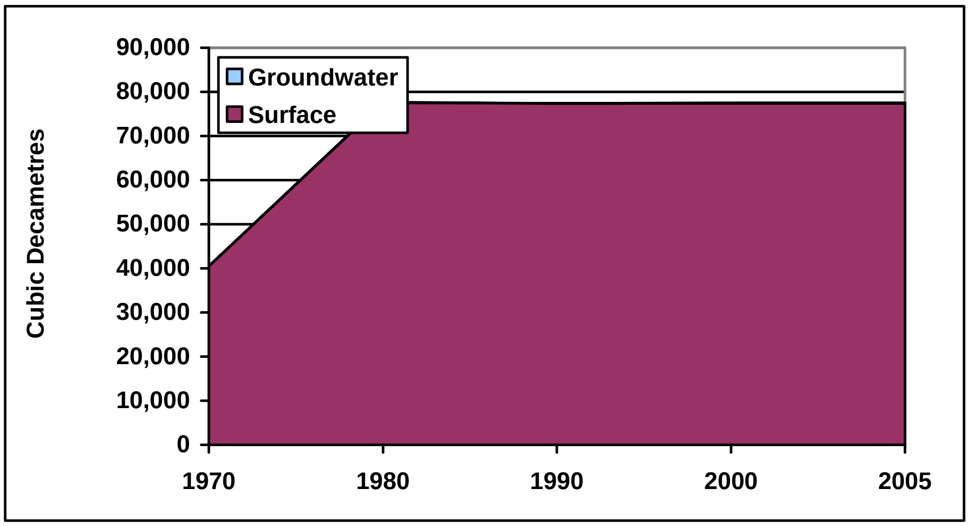
* Actual water use based on data provided by AFPA.
** Estimates of water use are based on information provided to AMEC by licence holders.
*** Actual water use is assumed to be 100 percent of licensed consumption.

12.5.2 Forestry

12.5.2.1 Water Allocations

Almost 86 percent of the industrial water allocations in the Peace/Slave Basin are for forestry. Five licences have been issued and they allow withdrawals of up to 77,638 dam^3. These include two licences for 128 dam^3 of groundwater issued to Footner Forest Products in High Level and three licences for 77,509 dam^3 of surface water issued to two pulp mills: the Diaishowa Marubeni mill north of the Town of Peace River and the Weyerhaeuser mill near Grande Prairie. As shown in Figure 12-15, the water licences for forestry were issued in the 1970s, increased significantly by the 1980s, and has decreased only slightly since then.

Figure 12-15 Historical Trends in Water Allocations for Forestry Activities



12.5.2.2 Licensed Water Use

As shown in Table 12-25, the licences issued to the forestry industry assume that 30 percent of their groundwater withdrawals and 10 percent of diversions of surface water will be used. The majority of water withdrawals (69,828 dam^3 or 90 percent) are expected to be treated and returned.

12.5.2.3 Actual Water Use

Estimates of actual water use for the forestry industry are based on the reported withdrawals of water for the two pulp mills in 2004, as provided by AFPA, and assuming 100 percent consumption for OSB plant at High Level. The two pulp mills located in the Peace/Slave basin are licensed to divert 77,509 dam^3 and are allowed to consume 7,771 dam^3. However, based on this information it is estimated that forestry companies were using an average of five percent of their allocations and 51 percent of the water that they are entitled to consume. Consequently, the total water use by the forest industry in 2005 is estimated to be 3,870 dam^3, consisting of

3,831 dam^3 of surface water and 38 dam^3 of groundwater.

12.5.2.4 Forecasts of Future Water Use

The general trend in Alberta is for forestry to decrease its water use due to improved operating efficiencies. The AFPA anticipates that by 2025 the two pulp mills, which hold most of the forestry water allocations, will have decreased their use of water by between two percent under the Medium Growth scenario and five percent under the Low Growth scenario. The High Growth scenario assumes that there is no decline in water use over the forecast period. The use of groundwater is assumed to remain constant for the entire forecast period.

Table 12-26 Forecast of Forestry Water Use in the Peace/Slave Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	3,831	3,831	3,831	3,640	3,640
	Groundwater	38	38	38	38	38
	Total	**3,869**	**3,869**	**3,869**	**3,678**	**3,678**
Medium Growth	Surface	3,831	3,831	3,831	3,755	3,755
	Groundwater	38	38	38	38	38
	Total	**3,869**	**3,869**	**3,869**	**3,793**	**3,793**
High Growth	Surface	3,831	3,831	3,831	3,831	3,831
	Groundwater	38	38	38	38	38
	Total	**3,869**	**3,869**	**3,869**	**3,869**	**3,869**

Table 12-26 shows that, under the Low Growth scenario, water use by the forest industry is expected to drop to 3,678 dam^3 by 2025, a decrease of five percent. Under the High Growth scenario, water use by the forestry sector in the Peace/Slave Basin remains constant at 3,869 dam^3.

12.5.3 Chemical Plants

One licence has been issued to a chemical plant in the Peace/Slave basin. This licence allows the plant to withdraw of up to 271 dam^3 of surface water. The licence for this plant was issued in the 1990s and the allocation has remained constant since then. The licensee is expected to consume 79 percent of the surface water. There is no information on actual water diversions and consumption for the chemical plant and, for purposes of this analysis, it is assumed that licensee is using its full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by the chemical plant in the Peace/Slave Basin will remain constant for the forecast period.

12.5.4 Coal Mining

Eleven licences have been issued for coal mining activities in the Peace/Slave Basin. These licences allow withdrawals of up to 314 dam^3 of surface water and 133 dam^3 of groundwater. The licences for coal mining were issued in the 1970s for surface water and the 1980s for

groundwater. Allocations of both surface and groundwater have slowly increased since then. Licensees are expected to consume 70 percent of their surface water allocations and 93 percent of groundwater allocations. There is no information on actual water diversions and consumption for coal mining and, for purposes of this analysis, it is assumed that licensees are using their full entitlement. In the absence of information about this component of the industrial sector, it is assumed that water used by coal mining in the Peace/Slave Basin will remain constant for the forecast period.

12.5.5 Summary

The industrial sector in the Peace/Slave basin is dominated by water allocations by the forestry sector. This sector accounted for 86 percent of water allocations but only 40 percent of actual water use in 2005. More than half (57 percent) of the actual water use in 2005 was for cooling purposes. Water use data shows that although water licences expect up to 20,795 dam^3 of water to be consumed for industrial purposes, licensees are only using 9,950 dam^3 or 48 percent of licensed water use.

In the future, there is expected to be light decline in water requirements for forestry activities as existing mills implement new technology to reduce their water consumption. The forecasts in Table 12-27 assume that future water use by all other industrial activities will remain the same over the forecast period.

Table 12-27 Forecast of Industrial Water Use in the Peace/Slave Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	9,787	9,787	9,787	9,596	9,596
	Groundwater	163	163	163	163	163
	Total	**9,950**	**9,950**	**9,950**	**9,759**	**9,759**
Medium Growth	Surface	9,787	9,787	9,787	9,711	9,711
	Groundwater	163	163	163	163	163
	Total	**9,950**	**9,950**	**9,950**	**9,874**	**9,874**
High Growth	Surface	9,787	9,787	9,787	9,787	9,787
	Groundwater	163	163	163	163	163
	Total	**9,950**	**9,950**	**9,950**	**9,950**	**9,950**

Table 12-27 shows that, for Low Growth and Medium Growth scenarios, the overall use of water in the Peace/Slave Basin is expected to decrease by 2025 due to the decline in water required for pulp mills. In 2025, water use is expected to have declined by two percent under the Low Growth scenario and by one percent under the Medium Growth scenario. The High Growth scenario assumes that the current water use will remain the same at least until 2025.

12.6 OTHER SECTOR

In the Peace/Slave Basin 119 licences have been issued for other purposes and they allow up to 92,436 dam^3 of water to be withdrawn. The allocations to the other sector account for about

39 percent of licensed water use in the Peace/Slave Basin. Allocations of surface water (92,436 dam^3) account for more than 99 percent of allocations for the other sector. Figure 12-16 shows that the other sector includes water licences issued for water management for flood control and lake stabilization, and for fish, wildlife and habitat enhancement.

Figure 12-16 Other Water Allocation by Use in the Peace/Slave Basin

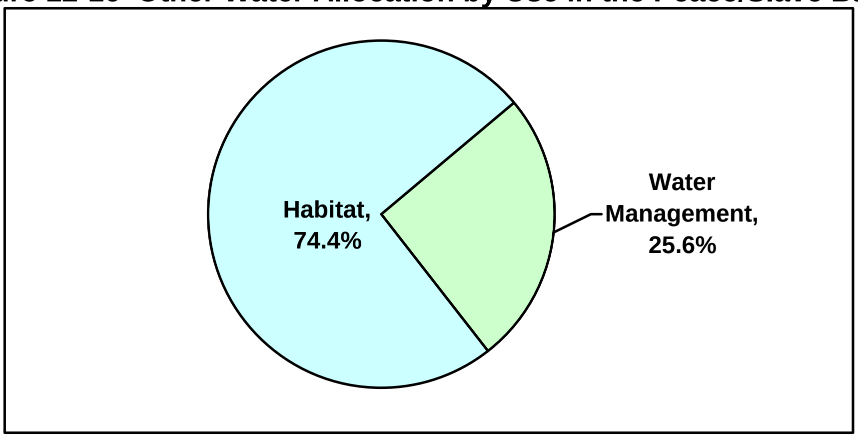


Table 12-28 summarizes the water allocation, use, and return associated with the licences for each activity in the Peace/Slave Basin.

12.6.1 Water Management

About 26 percent of the allocations are for water management purposes such flood control and lake stabilization (23,635 dam^3). Table 12-28 shows that 59 surface water licences have been issued for water management purposes. Licences for water management were first issued in the 1940s but grew rapidly in the 1970s and especially the 1980s. Figure 12-17 shows that allocations for water management have remained constant since 1990.

Table 12-28 Licensed Allocations and Estimated Water Use by the Other Sector, Peace/Slave River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Water Management	Surface	59	23,634.9	21,526.5	2,108.4	21,526.5	100%	91.1%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**59**	**23,634.9**	**21,526.5**	**2,108.4**	**21,526.5**	**100%**	**91.1%**
Habitat	Surface	58	68,799.2	68,304.6	494.6	68,304.6	100%	99.3%
	Groundwater	1	0.5	0.0	0.4	0.0	100%	10.0%
	Subtotal	**59**	**68,799.7**	**68,304.6**	**495.0**	**68,304.6**	**100%**	**99.3%**
Specified	Surface	1	1.5	1.5	0.0	1.5	100%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**1**	**1.5**	**1.5**	**0.0**	**1.5**	**100%**	**100.0%**
Total	Surface	118	92,435.6	89,832.6	2,603.0	89,832.6	100%	97.2%
	Groundwater	1	0.5	0.0	0.4	0.0	100%	10.0%
	Total	**119**	**92,436.1**	**89,832.6**	**2,603.4**	**89,832.6**	**100%**	**97.2%**

Figure 12-17 Historical Trends in Water Allocations for Water Management

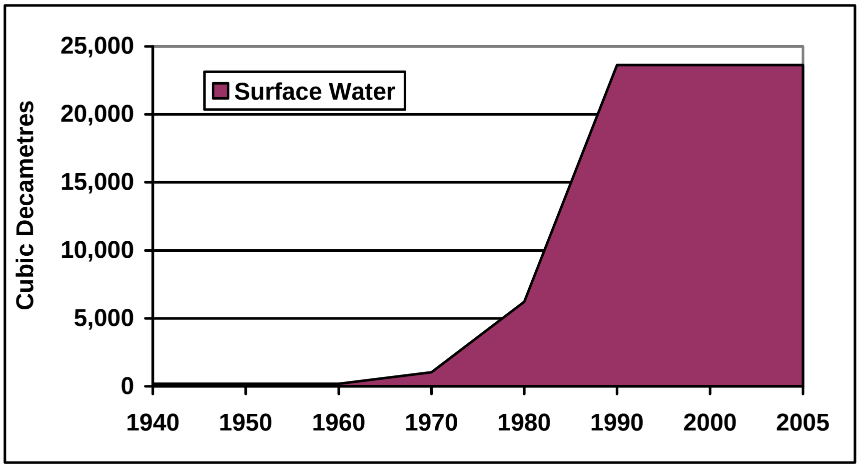


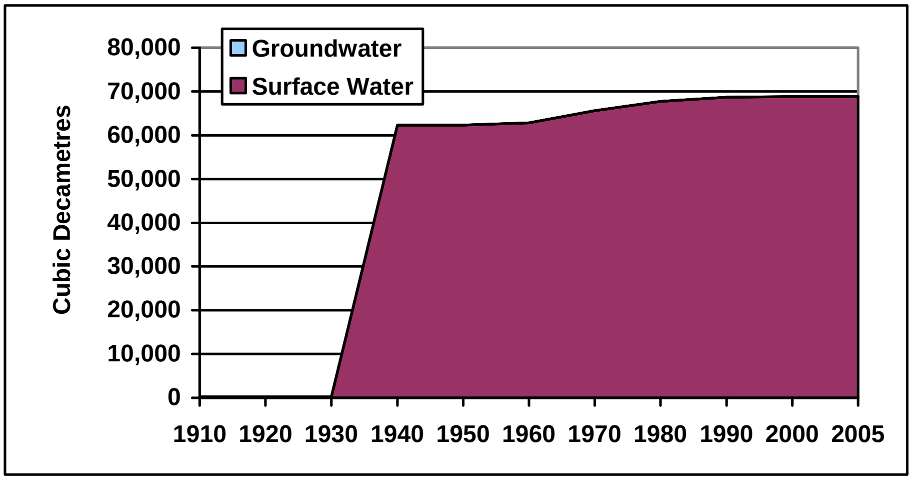
Table 12-28 shows that the licences issued for water management purposes expect that about 91 percent of surface water allocations will be used. Return flow allowances in licences amounted to 2,108 dam^3 of surface water. There is no information on actual water diversions and consumption for water management activities and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the other sector, it is assumed that water used for water management in the Peace/Slave Basin will remain constant for the forecast period.

12.6.2 Habitat Enhancement

12.6.2.1 Water Allocations

Almost 75 percent of the allocations for the other sector are for fish, wildlife and habitat enhancement (68,800 dam^3). Table 12-28 shows that 58 surface water licences and one groundwater licence have been issued for habitat projects. The groundwater licence allows withdrawals of only 0.5 dam^3 and was issued in the early 2000s. Licences for surface water use for habitat enhancement were first issued in the 1910s but, as shown in Figure 12-18, increased rapidly between the 1940s and the 1990s. Allocations of surface water have increased only slightly since the 1990s.

Figure 12-18 Historical Trends in Water Allocations for Habitat Enhancement



12.6.2.2 Licensed Water Use

Table 12-28 shows that the licences issued for habitat enhancement purposes expect that about 99 percent of surface water diversions and 20 percent of groundwater withdrawals will be used. The return flow allowances in licences amounted to 495 dam^3 for surface water and 0.4 dam^3 for groundwater.

12.6.2.3 Actual Water Use

There is no information on actual water diversions and consumption for habitat enhancement activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement.

12.6.2.4 Forecasts of Future Water Use

Forecasts of future water use by the other sector are based on consultation with large licence holders. Neither Ducks Unlimited nor Alberta Environment have formal forecasts of their future water needs. The number of new projects developed by Ducks Unlimited depends on a number of factors such as their budget, the state of the economy, and environmental objectives. Ducks Unlimited anticipates that an increased emphasis will be placed on restoring drained wetlands to pre-drainage or natural conditions but this will not require new water licences.

In terms of new water licences, Ducks Unlimited foresees developing one new project per year, each requiring about 300 dam^3. This has been adopted as the Medium Growth scenario. Table 12-28 includes a Low Growth scenario that assumes water use will increase by two percent every five years. The High Growth scenario of assumes that water use will increase by five percent every five years.

Table 12-29 Forecast of Water Use by Habitat Enhancement Projects in Peace/Slave Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	68,305	69,671	71,064	72,485	73,935
	Groundwater	0	0	0	0	0
	Total	**68,305**	**69,671**	**71,064**	**72,485**	**73,935**
Medium Growth	Surface	68,305	69,805	71,305	72,805	74,305
	Groundwater	0	0	0	0	0
	Total	**68,305**	**69,805**	**71,305**	**72,805**	**74,305**
High Growth	Surface	68,305	71,720	75,306	79,071	83,025
	Groundwater	0	0	0	0	0
	Total	**68,305**	**71,720**	**75,306**	**79,071**	**83,025**

Under the Low Growth scenario, water use for water management projects in 2025 will be eight percent higher than current use. Under the High Growth scenario, water use could increase by 22 percent.

12.6.3 Specified Activities

One surface water licence was issued in 2000 for director-specified activities in the Peace/Slave Basin. The licence allows up to 1.5 dam^{3}of water to be diverted and consumed. There is no information on actual water diversions and consumption for activities specified by the director and, for purposes of this analysis, it is assumed that licensee is using its full entitlement and will continue to do so for the forecast period.

12.6.4 Summary

The other sector in the Peace/Slave basin is dominated by water allocations for habitat enhancement projects. These projects account for over 74 percent of the water allocations for the other sector and 76 percent of the licensed water use.

In the future, there is expected to be an increase in the amount of water used for other sector activities. The overall water use projections for the other sector are provided in Table 12-30. The forecasts assume that there will be a slight increase in water use for habitat enhancement projects but it is assumed that water use for water management, water conservation and director-specified activities will remain the same for the forecasted period. The resulting estimates are provided in Table 12-30.

Under the Low Growth scenario, water use is expected to increase to 95,463 dam^3 in 2025; this represents a six percent over current water use. Water use under the High Growth scenario is predicted to be 1041,553 dam^3 in 2025 and is 16 percent higher than current water use.

Table 12-30 Forecast of Other Water Use in Peace/Slave Basin
(dam^3)

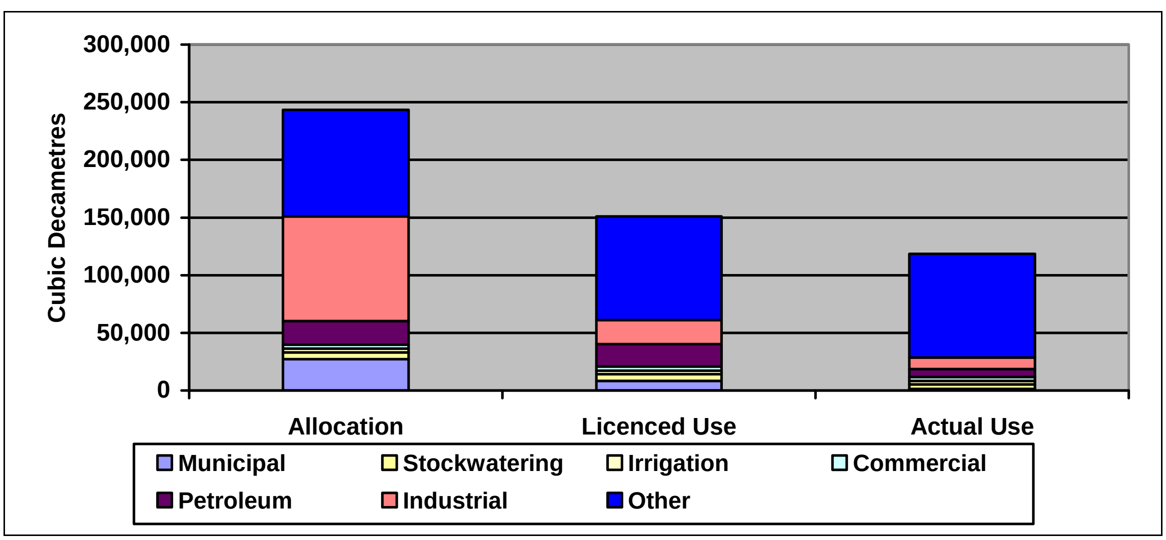
Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	89,833	91,199	92,592	94,013	95,463
	Groundwater	0	0	0	0	0
	Total	**89,833**	**91,199**	**92,592**	**94,013**	**95,463**
Medium Growth	Surface	89,833	91,333	92,833	94,333	95,833
	Groundwater	0	0	0	0	0
	Total	**89,833**	**91,333**	**92,833**	**94,333**	**95,833**
High Growth	Surface	89,833	93,248	96,834	100,599	104,553
	Groundwater	0	0	0	0	0
	Total	**89,833**	**93,248**	**96,834**	**100,599**	**104,553**

12.7 SUMMARY

Table 12-31 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the Peace/Slave basin. In total, existing licences and registrations allow a maximum of 243,398 dam^3 of water to be withdrawn for use. Of this, up to 150,962 dam^3 is expected to be used and 92,435 dam^3 will be returned to surface water. As noted previously, the largest amounts of water have been allocated to the industrial sector, particularly forestry. However, licences issued to the other sector account for 60 percent of licensed water use.

With respect to actual use, the exact volumes withdrawn and used in 2005 are not known because very few water use reports have been filed with Alberta Environment. However, based on the assumptions used in the previous sections, it is estimated that 118,476 dam^3 were actually used in 2005. This represents 78 percent of water use allowed in existing licences and registrations. Based on estimated use, the other sector accounted for 76 percent of total water use in the Peace/Slave Basin in 2005. Figure 12-19 shows how actual use compares to licensed allocations and use for each of the water use sectors.

Figure 12-19 Water Allocations and Actual Use, by Sector, Peace/Slave Basin



Forecasts of future water use in the Peace/Slave basin are provided in Tables 12-32 to 12-34 for the Low, Medium and High Growth scenarios. Predicted water use under the Medium Growth scenario is shown in Figure 12-20. This figure shows that most of the growth in water use will occur in the petroleum sector, particularly thermal extraction. However, water used for water management and habitat enhancement accounts for the majority of water use throughout the forecast period, and will account for 67 percent of total water use by 2025. Under the Medium Growth scenario, water use in 2025 will be about 29 percent higher than at present. For the other scenarios, the increase in water demand over 20 years will range from 18 percent for the Low Growth scenario and 43 percent for the High Growth scenario.

Figure 12-20 Forecast Water Use in the Peace/Slave: Medium Scenario

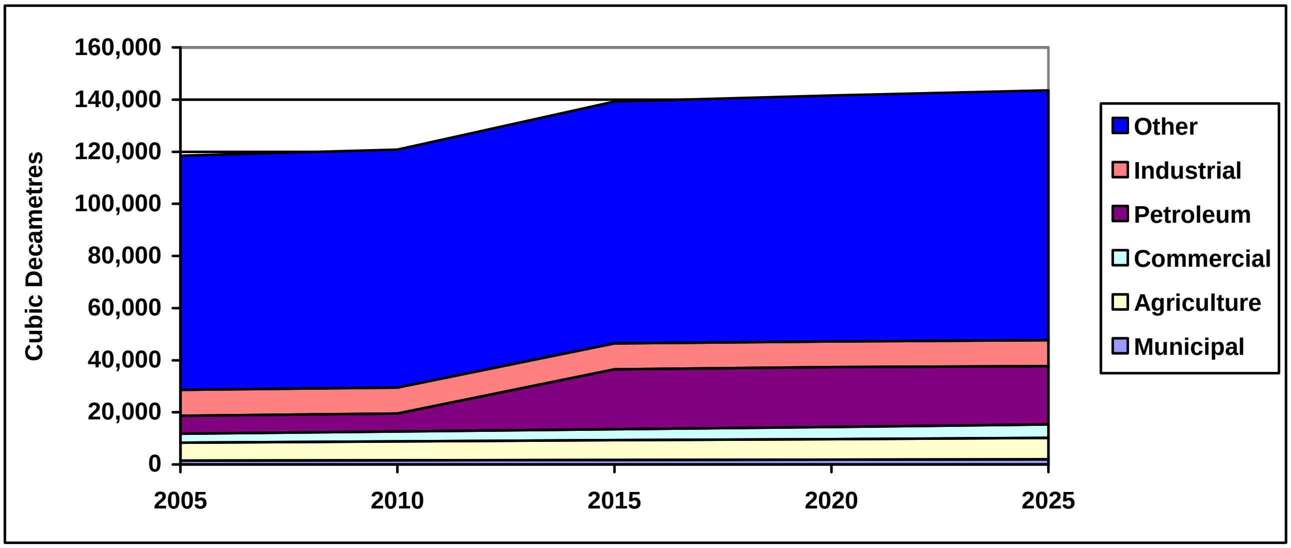


Table 12-31 Summary of Allocations and Estimated Water Use, Peace/Slave Basin

Sector		Licensed Allocation and Use (dam^3)				Estimated Water Use (dam^3)		
		Allocation	Water Use	Return	Percent of Total Use	Use	Percent of Licensed Use	Percent of Total Use
Municipal		27,141	8,307	18,833	6%	1,457	18%	1%
Agricultural	Stockwatering	5,805	5,805	0	4%	3,730	64%	3%
	Irrigation	3,356	3,213	143	2%	3,213	100%	3%
Commercial		3,383	3,378	5	2%	3,378	100%	3%
Petroleum		20,586	19,631	955	13%	6,915	35%	6%
Industrial		90,690	20,795	69,895	14%	9,950	48%	8%
Other		92,436	89,833	2,603	60%	89,833	100%	76%
Total		**243,398**	**150,962**	**92,435**	**100%**	**118,476**	**78%**	**100%**

Table 12-32 Forecast Water Use, By Sector, Peace/Slave Low Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	538	573	602	629	652
	Agricultural	5,846	5,913	5,981	6,051	6,122
	Commercial	3,006	3,167	3,322	3,477	3,631
	Petroleum	5,117	5,117	15,865	15,865	15,516
	Industrial	9,787	9,787	9,787	9,596	9,596
	Other	89,833	91,199	92,592	94,013	95,463
	Total	114,127	115,756	128,148	129,631	130,980
Groundwater	Municipal	919	979	1,028	1,074	1,113
	Agricultural	1,098	1,125	1,154	1,183	1,213
	Commercial	372	384	396	409	423
	Petroleum	1,798	1,798	6,022	6,022	5,885
	Industrial	252	252	252	252	252
	Other	0	0	0	0	0
	Total	4,439	4,538	8,852	8,940	8,886
Total	Municipal	1,457	1,552	1,630	1,703	1,765
	Agricultural	6,944	7,038	7,134	7,233	7,335
	Commercial	3,378	3,551	3,718	3,886	4,054
	Petroleum	6,915	6,915	21,887	21,887	21,401
	Industrial	10,039	10,039	10,039	9,848	9,848
	Other	89,833	91,199	92,592	94,013	95,463
	Total	118,566	120,294	137,000	138,571	139,866

Table 12-33 Forecast Water Use, By Sector, Peace/Slave Basin: Medium Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	538	585	632	678	721
	Agricultural	5,846	6,089	6,344	6,612	6,893
	Commercial	3,006	3,382	3,779	4,193	4,619
	Petroleum	5,117	5,117	16,635	16,635	16,267
	Industrial	9,787	9,787	9,787	9,711	9,711
	Other	89,833	91,333	92,833	94,333	95,833
	Total	114,127	116,293	130,010	132,162	134,044
Groundwater	Municipal	919	999	1,079	1,158	1,232
	Agricultural	1,098	1,165	1,236	1,312	1,393
	Commercial	372	394	419	447	478
	Petroleum	1,798	1,798	6,324	6,324	6,180
	Industrial	163	163	163	163	163
	Other	0	0	0	0	0
	Total	4,350	4,519	9,221	9,404	9,446
Total	Municipal	1,457	1,584	1,711	1,836	1,953
	Agricultural	6,944	7,254	7,580	7,924	8,286
	Commercial	3,378	3,776	4,198	4,640	5,097
	Petroleum	6,915	6,915	22,959	22,959	22,447
	Industrial	9,950	9,950	9,950	9,874	9,874
	Other	89,833	91,333	92,833	94,333	95,833
	Total	118,477	120,812	139,231	141,566	143,490

Table 12-34 Forecast Water Use, By Sector, Peace/Slave Basin: High Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	538	606	680	755	829
	Agricultural	5,846	6,313	6,823	7,380	7,990
	Commercial	3,006	3,720	4,514	5,367	6,277
	Petroleum	5,117	5,117	27,075	27,075	26,454
	Industrial	9,787	9,787	9,787	9,596	9,596
	Other	89,833	93,248	96,834	100,599	104,553
	Total	114,127	118,791	145,713	150,772	155,699
Groundwater	Municipal	919	1,035	1,162	1,290	1,417
	Agricultural	1,098	1,224	1,364	1,521	1,695
	Commercial	372	406	446	492	545
	Petroleum	1,798	1,798	10,427	10,427	10,183
	Industrial	163	163	163	163	163
	Other	0	0	0	0	0
	Total	4,350	4,626	13,562	13,893	14,003
Total	Municipal	1,457	1,641	1,842	2,045	2,246
	Agricultural	6,944	7,537	8,187	8,901	9,685
	Commercial	3,378	4,126	4,960	5,859	6,822
	Petroleum	6,915	6,915	37,502	37,502	36,637
	Industrial	9,950	9,950	9,950	9,759	9,759
	Other	89,833	93,248	96,834	100,599	104,553
	Total	118,477	123,417	159,275	164,665	169,702

Hay River Basin

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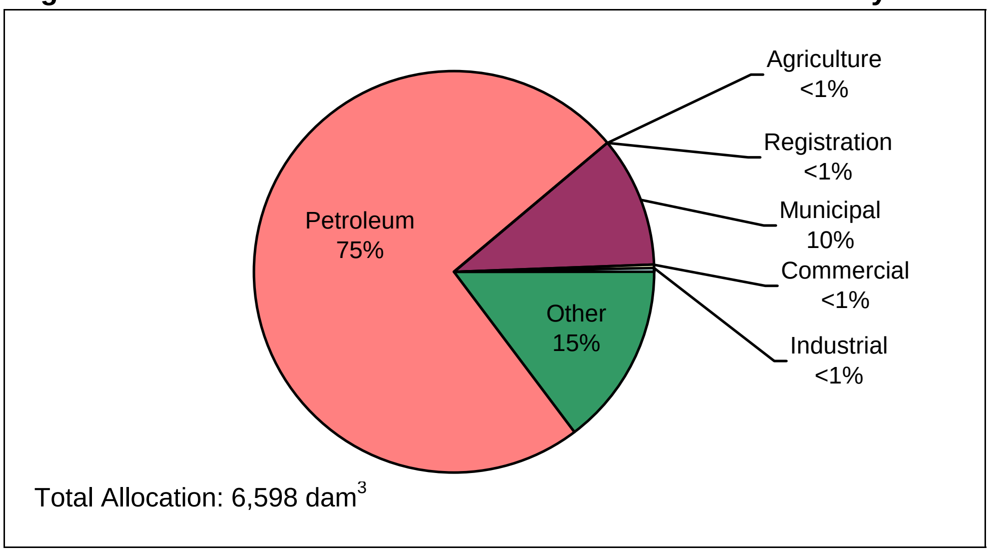
13.0 HAY RIVER BASIN

The Hay Basin, at about 40,000 km^2, occupies approximately six percent of Alberta by area. The mean annual natural river discharge of the Hay River is 3,600,000 dam^3. It comprises part of the Mackenzie River system, which drains eventually into the Arctic Ocean. In 2001, the basin had a population of 7,015 people, or 0.2 percent of the provincial population. The basin had a population density of just 0.2 people per square kilometre. The Hay Basin includes all or parts of three rural or regional municipalities and contains one urban municipality and two Aboriginal settlements.

An overview of existing surface and groundwater allocations is provided in Figure 13-1. It shows that the petroleum sector accounts for 75 percent of allocations (4,893 dam^3) and the other sector accounts for 15 percent of total allocations (960 dam^3) in 2005. The municipal sector accounts for most of the remaining allocations with 686 dam^3 (10 percent). Total allocations in the basin in 2005 totalled 6,598 dam^3.

Figure 13-1 Distribution of Active Water Allocations in the Hay Basin



Figures 13-2 and 13-3 show the location, allocation and sector of all active water licences in Hay River Basin. Figure 13.4 shows the location of all registrations issued for the basin.

13.1 MUNICIPAL AND RESIDENTIAL SECTOR

13.1.1 Population

In 2001, just over 7,000 people lived in the Hay River Basin. The majority of these people (65 percent) lived in rural or regional municipalities, particularly the Municipal District of Mackenzie No. 23. Another 31 percent of the population lived in Aboriginal settlement. Only 14 percent of the population lived in the sole urban settlement: the Town of Rainbow Lake. As shown in Table 13-1, the population of the basin only grew by 4.5 percent between 1996 and 2001. Most of the growth occurred in the rural areas, where the population increased by nearly 10 percent. For the same time period, the population of Rainbow Lake dropped by more than 14 percent. The Aboriginal population increased at a rate just below the average for the basin.

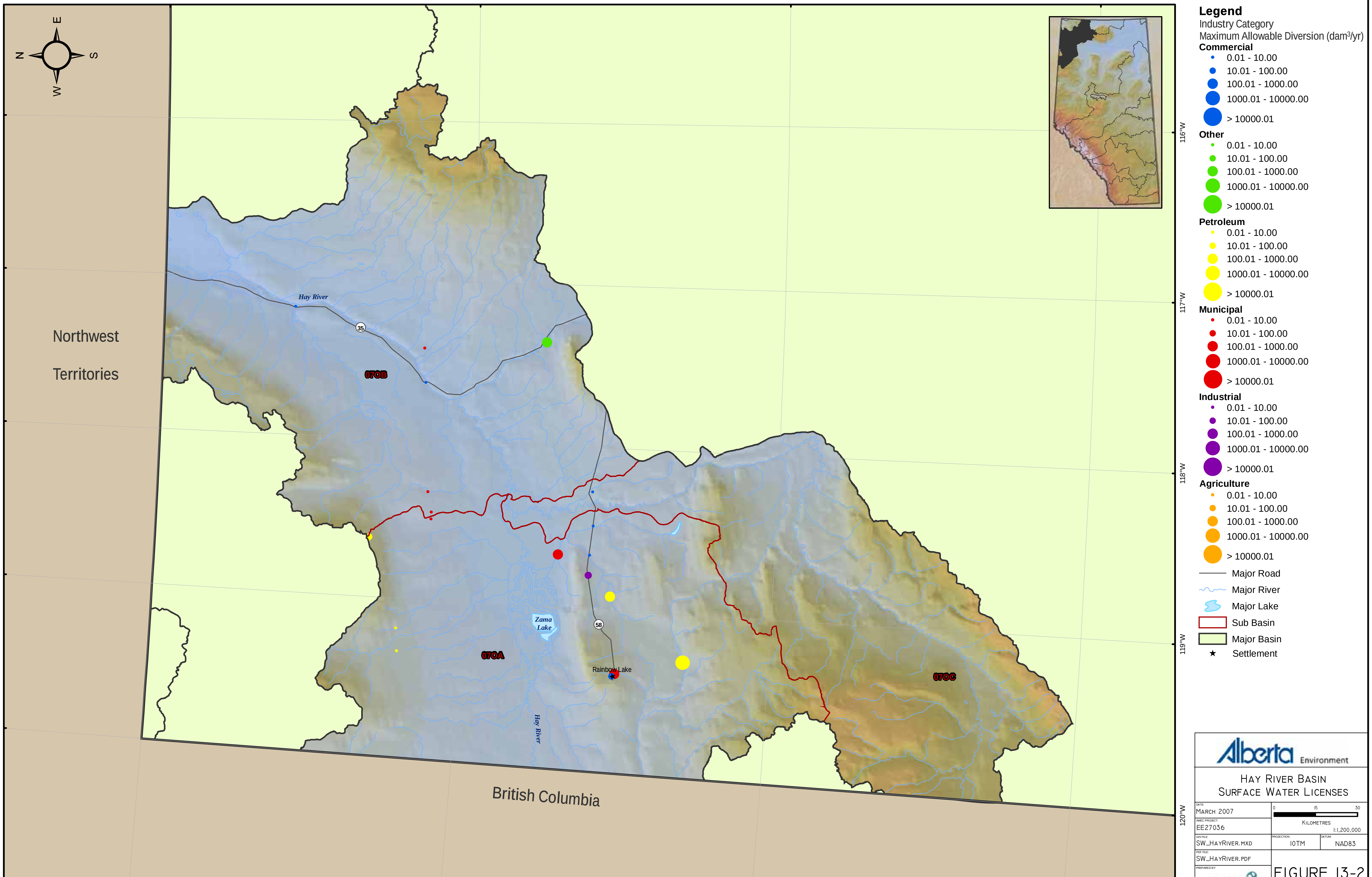
Table 13-1 Population Distribution and Growth in Hay River Basin, 2001

	2001		1996	1996 to 2001 Population Change
	Population	Percent	Population	Percent
Urban Municipality	976	13.9%	1,138	-14.2%
Rural or Regional Municipality	4,544	64.8%	4,141	9.7%
First Nations and Métis Settlements	1,496	21.3%	1,436	4.2%
Total	**7,016**	**100%**	**6,715**	**4.5%**

Table 13-2 lists all municipalities situated in the Hay River Basin, their estimated 2001 population, and the water licence information for those communities that are licensed to withdraw 100 dam^3 or more. The Town of Rainbow Lake is the only urban centre, with 976 residents. The most populous rural or regional municipality is the Municipal District of Mackenzie No. 23 (4,307). The Dene Tha' First Nation has the largest population among the Aboriginal communities.

Table 13-2 Municipal Populations and Water Allocations within Hay River, 2001

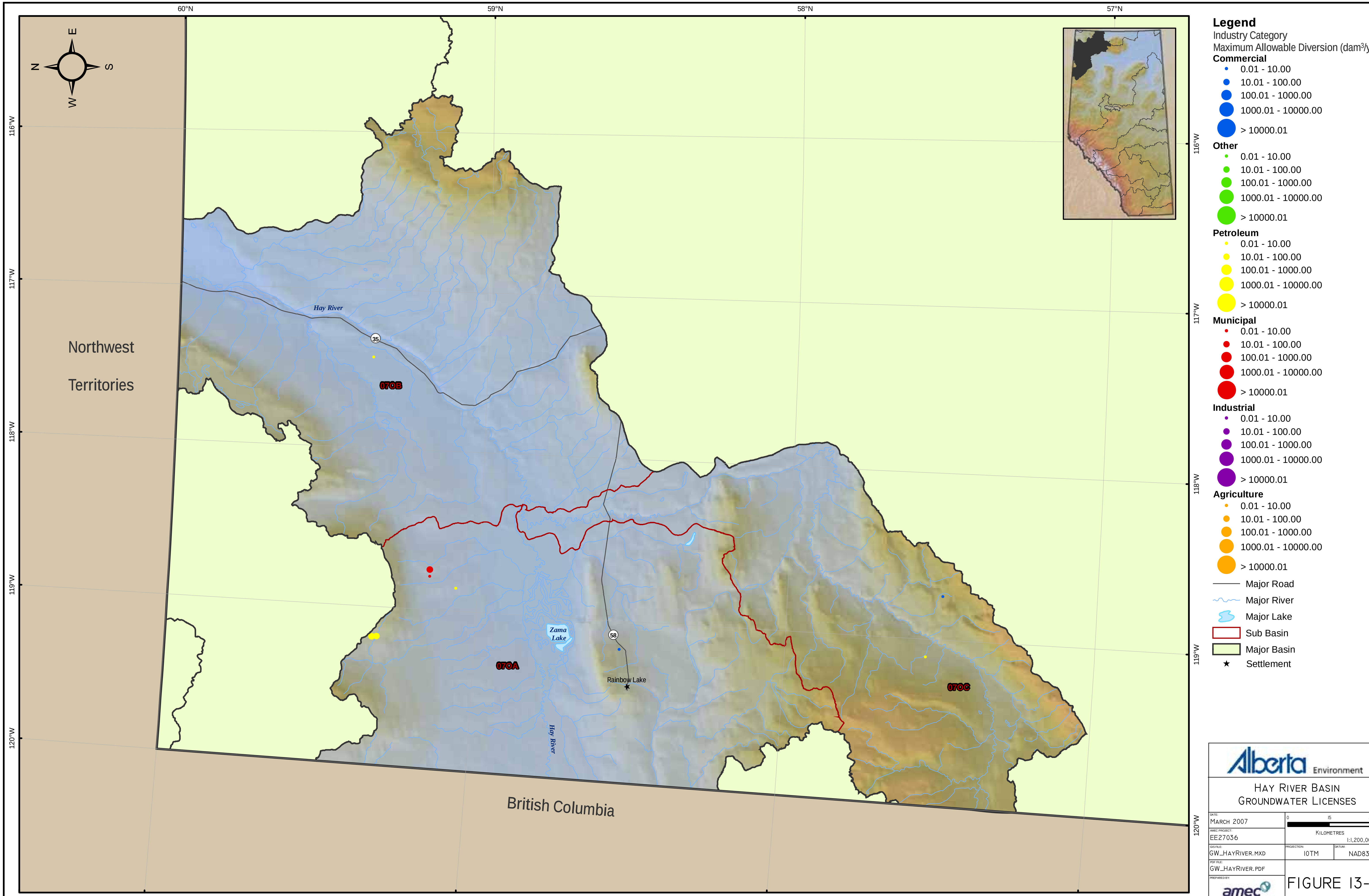
Municipality Name		2001 Population Within Basin	Water Source	Allocation (dam^3)
Urban	TOWN OF RAINBOW LAKE	976	Surface	296
Rural	M.D.OF MACKENZIE NO. 23	4,307		
	M. D. OF NORTHERN LIGHTS NO. 22	133		
	CLEAR HILLS COUNTY	103		
Aboriginal	DENE THA' FIRST NATION	1,445	Surface	306
	PADDLE PRAIRIE MÉTIS SETTLEMENT	51		
Total		**7,015**		**602**



Alberta Environment

HAY RIVER BASIN
SURFACE WATER LICENSES

DATE: MARCH 2007	0 15 30 KILOMETRES	1:1,200,000
AMEC PROJECT: EE27036		
GIS FILE: SW_HAYRIVER.MXD	PROJECTION: 10TM	DATUM: NAD83
PDF FILE: SW_HAYRIVER.PDF		
PREPARED BY: amec	FIGURE 13-2	



Alberta Environment

HAY RIVER BASIN
GROUNDWATER LICENSES

March 2007
EE27036
GW_HayRiver.mxd
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Kilometres
1:1,200,000
10TM
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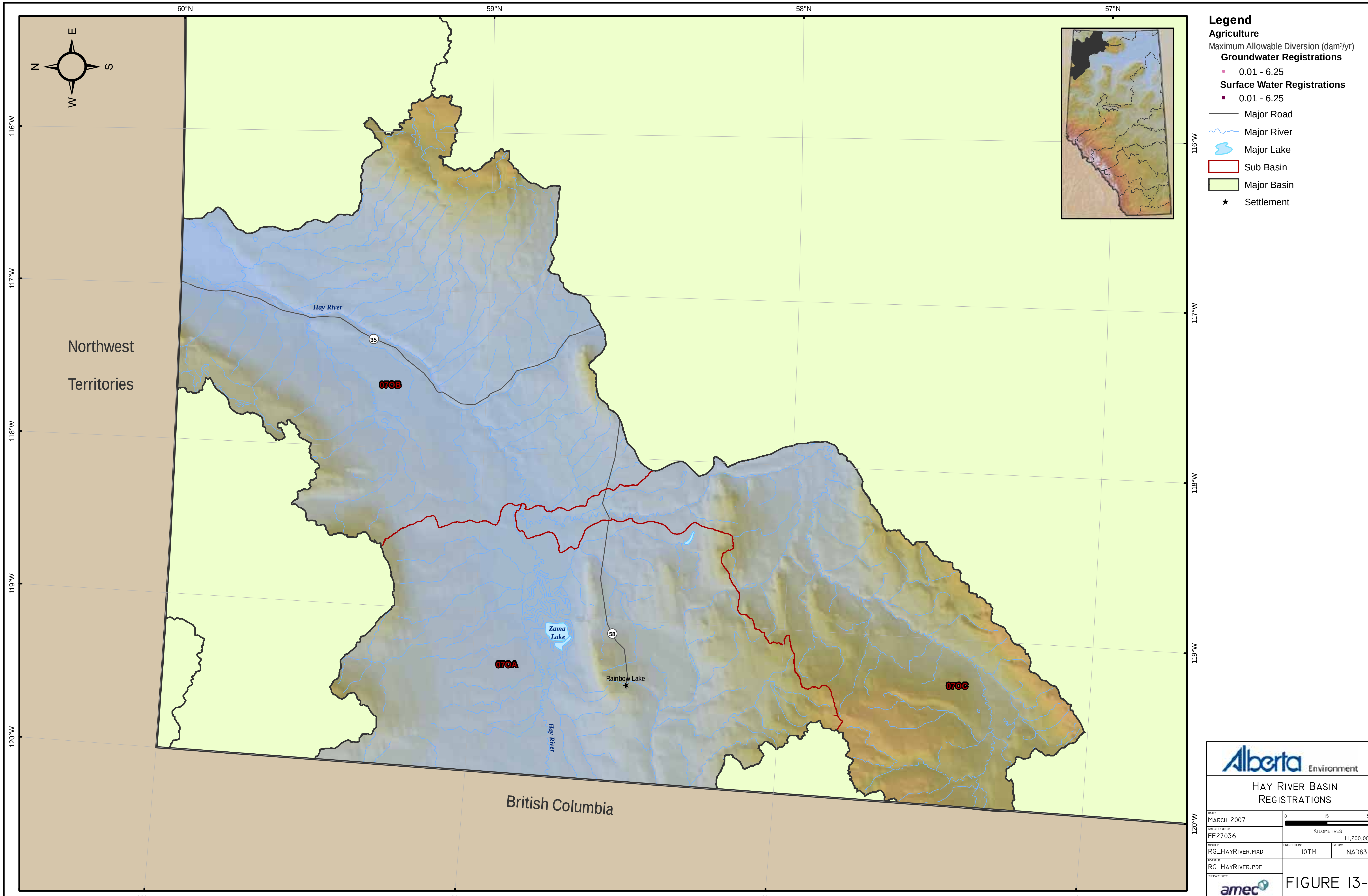
FIGURE 13-3



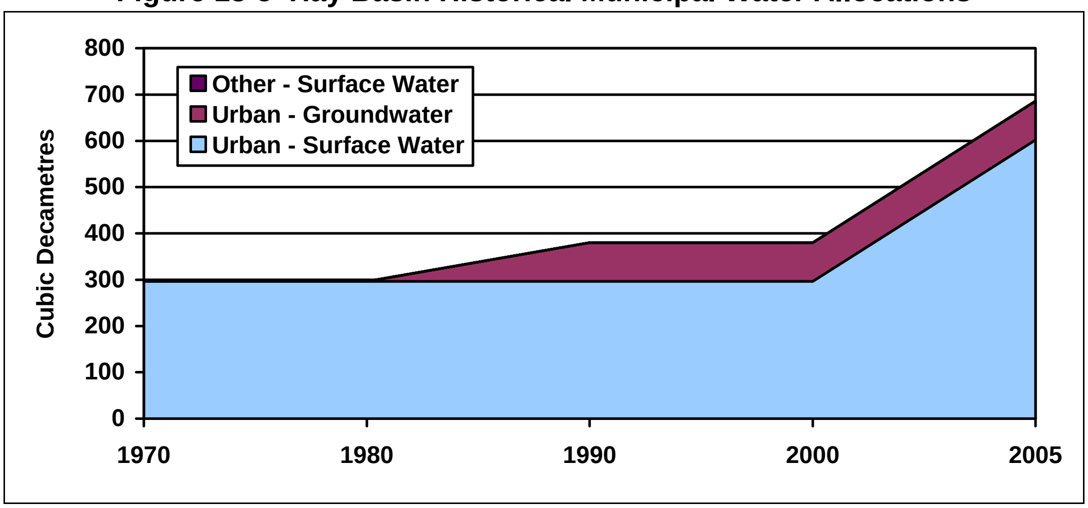
Legend
Agriculture
Maximum Allowable Diversion (dam³/yr)
Groundwater Registrations
0.01 - 6.25
Surface Water Registrations
0.01 - 6.25
Major Road
Major River
Major Lake
Sub Basin
Major Basin
Settlement
Northwest Territories
British Columbia
Hay River
07OB
07OA
07OC
Zama Lake
Rainbow Lake
35
58
N
E
S
W
60°N
59°N
58°N
57°N
116°W
117°W
118°W
119°W
120°W
Alberta Environment
Hay River Basin Registrations
March 2007
EE27036
RG_HayRiver.mxd
RG_HayRiver.pdf
Kilometres
1:1,200,000
10TM
NAD83
amec
FIGURE 13-4

13.1.2 Water Allocations

As of 2005, 12 water licences had been issued to three municipalities in the Hay River Basin. These licences allow maximum withdrawals of 686 dam^3. Municipal water uses account for 10 percent of licensed water allocations in the Hay River Basin. Licences issued to urban users accounted for almost 100 percent of total municipal allocations. A total of 602 dam^3 of surface water has been allocated to the municipal sector; this represents 88 percent of total municipal water allocations. A small amount of surface water (eight licences with total allocations of 0.3 dam^3) has been allocated ion is for fire protection. Two licences for municipal groundwater use have been issued and allocations total 84 dam^3. It should be noted that although the Municipal District of Opportunity No. 23 lies within both the Peace/Slave and Hay Basins, it draws its water from the Peace/Slave Basin rather than the Hay River Basin.

Figure 13-5 shows the history of water allocations for municipal purposes in the Hay River Basin up to 2005. Municipal uses accounting for less than 0.1 percent of MAD are not shown. The figure shows that allocations of surface water remain uncharged from 1970, but have doubles since 2000. Licences for use of groundwater were issued in the 1980s and have remained unchanged since then.

Figure 13-5 Hay Basin Historical Municipal Water Allocations



13.1.3 Licensed Water Use

Table 13-3 summarizes licensed water use for the municipal sector in Hay River Basin. Under the terms of these licences, a maximum of 619 dam^3 is expected to be used. This means that 90 percent of withdrawals will be consumed and/or lost and 67 dam^3 will be returned. Licensees assume that 80 percent of urban groundwater withdrawals will be returned but that all surface water withdrawals will be used.

Table 13-3 Licensed Diversions, Water Use and Returns for the Municipal Sector, Hay River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Diversion	Reported Use	Return
Urban*	Surface	2	602	602	0	NA	NA	NA
	Groundwater	2	84	17	67	NA	NA	NA
	Subtotal	**4**	**686**	**619**	**67**	**NA**	**NA**	**NA**
Other**	Surface	8	0	0	0			
	Groundwater	0	0	0	0			
	Subtotal	**8**	**0**	**0**	**0**			
Total	Surface	10	602	602	0	NA	NA	NA
	Groundwater	2	84	17	67	NA	NA	NA
	Total	**12**	**686**	**619**	**67**	**NA**	**NA**	**NA**

* Urban includes villages, summer villages, towns, cities, hamlets;
** Other includes camps, institutions, senior/correctional centres, nursing/children's homes, hospitals

13.1.4 Actual Water Use

In 2005, none of the municipal licensees in the Hay River Basin reported their water diversions or return flows to the provincial government through the WURS. There is also no information for these licensees in Environment Canada's Municipal Water use database. For purposes of this assessment it is assumed that municipal licensees in the Hay River Basin are withdrawing and using water at the same rates as municipalities in the neighbouring Peace/Slave Basin. Surface water users were assumed to be diverting 45 percent of their allocation and returning none. Groundwater users were assumed to be withdrawing and using 51 percent of their allocations. The resulting water use estimates are provided in Table 13-4. Total municipal water use in the Hay Basin is estimated to be 281 dam^3 or 45 percent of the allocated amount, including 272 dam^3 of surface water and nine dam^3 of groundwater.

Table 13-4 Estimated Municipal Water Use in the Hay River Basin

Municipal Use	Source	Withdrawals (dam^3)	Use (dam^3)	Return Flow (dam^3)
Total Use	Surface	272	272	0
	Groundwater	43	9	34
	Total	**315**	**281**	**34**
Licensed Use	Surface	602	602	0
	Groundwater	84	17	67
	Total	**686**	**619**	**67**
Percent of Licensed Use	Surface	45.2%	45.2%	0.0%
	Groundwater	51.0%	51.0%	51.0%
	Total	**45.9%**	**45.3%**	**51.2%**

13.1.5 Future Water Use Forecasts

Figure 13-6 shows low, medium and high population projection scenarios for Hay Basin based on Alberta Finance Census Division projections. The population forecasts in Figure 13-6 have been used to predict future municipal surface and groundwater use. The resulting forecasts of water use are provided in Table 13-5 and are based on the estimated per capita water use in 2005.

Under the Low Growth scenario, municipal water use in 2025 is expected to be 36 percent greater than at present and diversions will rise to 62 percent of current maximum allocations. Water use is expected to increase by 56 percent over current licensed use under the Medium Growth scenario in 2025. Under the High Growth scenario, water use will increase by 73 percent over current levels and total diversions of surface and groundwater will amount to 80 percent of current municipal allocations.

Figure 13-6 Hay Basin Population Growth Forecast

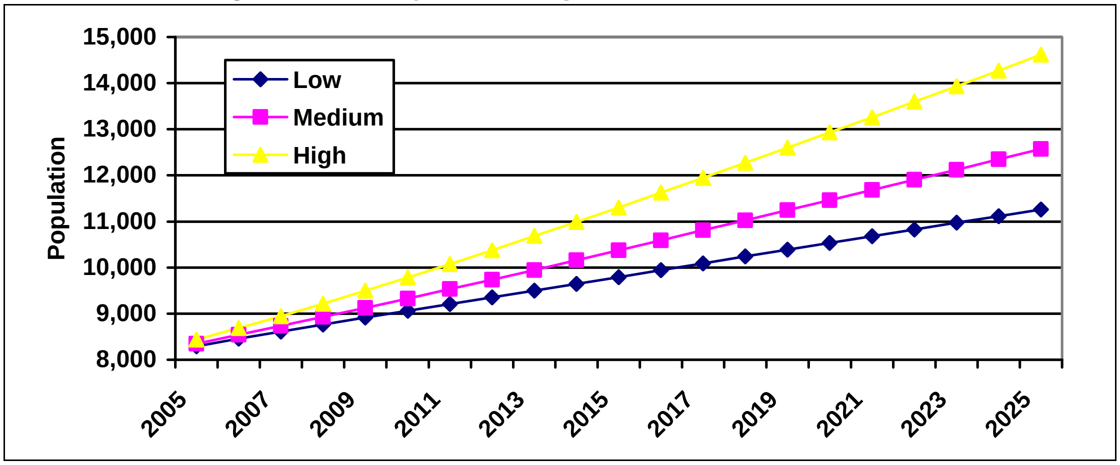


Table 13-5 Projected Water Use for the Municipal Sector in the Hay River Basin
(dam³)

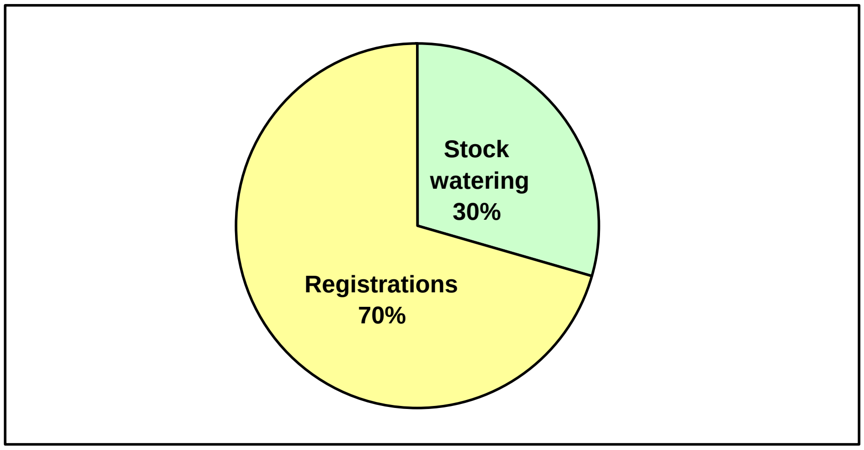
Scenario	Source	2005	2010	2015	2020	2025
Low Population Growth	Surface	272	297	321	346	370
	Groundwater	9	10	11	11	12
	Total	**281**	**307**	**332**	**357**	**382**
Medium Population Growth	Surface	272	304	338	374	410
	Groundwater	9	10	11	12	14
	Total	**281**	**314**	**349**	**386**	**423**
High Population Growth	Surface	272	315	365	417	471
	Groundwater	9	10	12	14	16
	Total	**281**	**326**	**377**	**431**	**487**

13.2 AGRICULTURAL SECTOR

As of December 2005 only nine dam^3 had been allocated to agricultural sector in the Hay River Basin. This includes four registrations allowing diversions of up to six dam^3 and two licences that allow diversions of three dam^3 of water. Water allocated to agriculture accounts for one percent of all allocations in the Hay River Basin. Figure 13-7 shows that all of the water allocations for agriculture in the basin are for livestock. There are no allocations for irrigation or crop watering in the Hay River Basin.

Four registrations and one licence have been issued for agricultural purposes and allow withdrawals of up to five dam^3 of surface water; this accounts for 56 percent of allocations to the agricultural sector. One registration has been issued to withdraw up to four dam^3 of groundwater (44 percent of total allocation).

Figure 13-7 Water Allocations for Agricultural Activities in the Hay Basin



13.2.1 Overview of Agriculture in the Hay River Basin

Based on information from the 2001 Census of Agriculture, there were about 530 farms in the Hay River Basin. These farms represent one percent of Alberta total. Farms in the basin were slightly larger (962 acres on average) than the provincial average (970 acres). Farms in the Hay River Basin cover an area of nearly 0.5 million acres; this is equivalent to about 2,000 km^2 or about five percent of the basin. Table 13-6 shows about 46 percent of the land in the basin is used to raise crops. About 42 percent of the agricultural land is used for pasture. The rest of the lands are in summer fallow or other uses.

Table 13-6 Agricultural Land Use in the Hay River Basin, 2001

Land Use	Acres	Percent
Crop Land	235,370	46.2%
Summerfallow	29,895	5.9%
Tame/Seeded Pasture	53,976	10.6%
Natural Pasture	161,594	31.7%
Other	28,887	5.7%
Total	**509,720**	**100.0%**

Table 13-7 shows the classification of farms based on the commodity groups that accounted for 51 per cent or more of total gross farm receipts. The table shows that about 37 percent of the farms in the basin are grain and oilseeds farms, about 24 percent raise beef cattle and about 16 percent of the farms are field crop farms. Compared to the Alberta average, the Hay River Basin has a higher percentage of grain and oilseed crops, and field crop farms, but lower percentages of all other farm types. , the single largest farm type in the Hay Basin is grain and oilseeds farms with cattle accounting for much lower proportion of farms than in Alberta.

Table 13-7 Classifications of Farms in Hay Basin and Alberta, 2001

Farm Type (Farms with Gross Receipts >$2,500)	Percent of Farms in the Hay Basin	Percent Share of Alberta	Alberta Farm Type (Percent)
Dairy Farms	0.4%	0.3%	1.5%
Cattle (beef) Farms	24.0%	0.5%	45.4%
Hog Farms	0.5%	0.3%	1.7%
Poultry & Egg Farms	0.5%	0.5%	0.9%
Wheat Farms	9.4%	1.3%	7.4%
Grain & Oilseed Farms	36.7%	2.0%	18.4%
Field Crop Farms	16.3%	1.7%	9.3%
Fruit Farms	0.1%	0.5%	0.1%
Misc.Speciality Farms	6.9%	0.6%	10.9%
Sum of Livestock Comb. Farms	2.7%	1.1%	2.3%
Sum of Vegetable Farms	0.0%	0.0%	0.1%
Sum of Other Comb Farms	2.6%	1.3%	2.0%
Total	**100.0%**	**1.0%**	**100.0%**

13.2.2 Stockwatering

As noted in Table 13-7 about 25 percent of the farms in the Hay Basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species in 2001 are provided in Table 13-8. The table shows that there about 30,000 cattle and calves in the basin and, together, they accounted for about 90 percent of livestock population in the basin. This is about 4.3 times the human population of the Hay River Basin. Other livestock in the basin include pigs, sheep and lamb, horses and ponies, bison, and elk.

Table 13-8 Estimated Livestock Populations in the Hay River Basin and Alberta, 2001

	Basin Total	Alberta	% Alberta
Hens and Chicken	18,943	12,175,246	0.2%
Turkey	307	864,438	0.0%
Cattle	20,819	6,615,201	0.3%
Calves	8,735	2,169,607	0.4%
Pigs	1,535	2,027,533	0.1%
Sheep and Lamb	1,675	307,302	0.5%
Horse and Ponies	937	159,962	0.6%
Bison	1,216	79,731	1.5%
Deer	0	8,331	0.0%
Elk	302	31,304	1.0%

13.2.2.1 <u>Water Allocation</u>

Overall six licences and registrations have been issued for livestock watering and allow withdrawals of up to nine dam^3. In addition to these allocations, farmers are able to obtain up to 1,250 m^3 of water for household purposes. The numbers of such households in the basin is not known. Furthermore, the numbers of “exempted agricultural” users are also not known in the Hay Basin.

A historical perspective on water used for livestock is provided in Figure 13-8. The figure shows that the registrations were issued with priority dates in the 1980s. The water licences for stockwatering were issued in the 1990s. The volume of water allocated for livestock has remained constant 2000. As of 2005, around nine dam^3 had been allocated for livestock in the Hay Basin. There are no allocations for intensive livestock operations in the basin.

Figure 13-8 Historical Trends in Water Allocation for Livestock in the Hay Basin

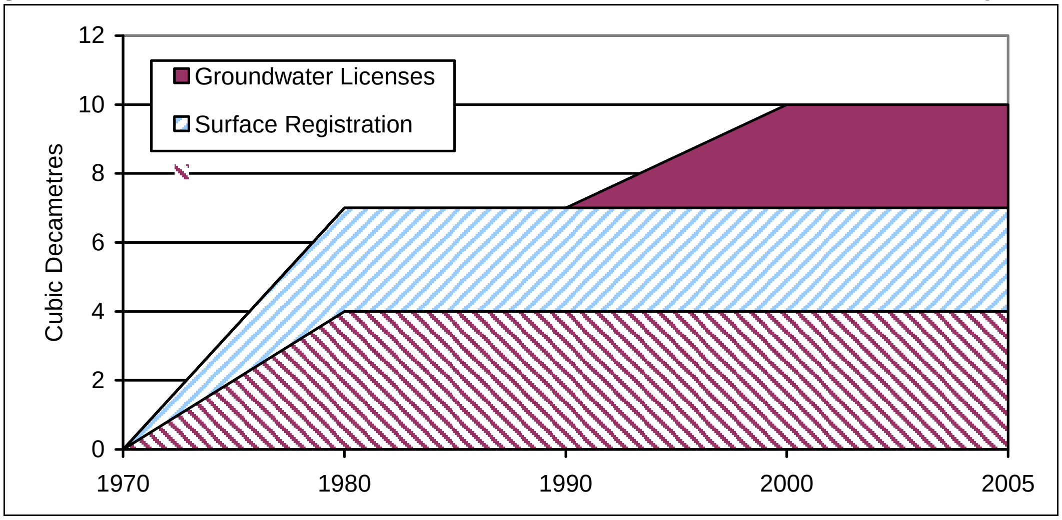


Table 13-9 summarizes current water licences and registrations issued for livestock. It shows that surface water accounts for about 60 percent of allowable diversions for livestock and that registrations account for 70 percent of the allocations.

13.2.2.2 <u>Licensed Water Use</u>

Table 13-9 shows that neither the registrations nor the licences have any return flow allowances. Thus, it is expected that all water diversions will be consumed or lost.

13.2.2.3 <u>Actual Water Use</u>

There is no information in Alberta Environment's WURS that indicates the extent to which water allocations are actually used in Hay River Basin. However, a reasonable estimate of water use can be derived using the actual animal population in the basin as shown in Table 13-8. Based on livestock populations for the Hay Basin in 2001, the total water required for livestock was estimated to be 223 dam^3, or about 25 times the licensed allocation.

Table 13-9 Summary of Water Licences and Registrations Issued for Livestock Watering in the Hay Basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licensees Reporting	Reported Use
Stock watering	Surface	2	2.6	2.6	0.0	0	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Subtotal	**2**	**2.6**	**2.6**	**0.0**	**0**	**N/A**
Registrations	Surface	3	2.7	2.7	0.0	0	N/A
	Groundwater	1	3.6	3.6	0.0	0	N/A
	Subtotal	**4**	**6.2**	**6.2**	**0.0**	**0**	**N/A**
Total	Surface	5	5.3	5.3	0.0	0	N/A
	Groundwater	1	3.6	3.6	0.0	0	N/A
	Total	**6**	**8.9**	**8.9**	**0.0**	**0**	**N/A**

The calculations for this estimate are provided also in Table 13-10 which shows livestock populations in the basin and the daily water requirements for various livestock species as provided by Alberta Environment in its “Guide to Calculate Quantities for Water for Raising Animals”. In terms of water requirements by species, cattle accounts for about 85 per cent of the total, about two percent is required by pigs, about one percent is required by poultry and all other species accounted for the remaining 12 per cent.

Table 13-10 Estimated Livestock Water Requirements for 2001

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chickens	18,943	0.045	1.4
Turkey	307	0.15	0.1
Bulls	425	9.0	6.3
Milk Cows	65	30.0	3.2
Beef Cows	7,142	9.0	106.6
Heifers	2,450	6.0	24.4
Steers	580	6.0	5.8
Calves	8,735	3.0	43.5
Boars	32	6.5	0.3
Sows and Gilts - Breeding	273	6.5	2.9
Nursing and Weaner Pigs	670	0.5	0.6
Grower and Finishing Pigs	561	1.5	1.4
Sheep and Lambs	1,675	2.0	5.6
Horse and Ponies	937	10.0	15.5
Bison	1,216	2.0	4.0
Deer	0	10.0	0.0
Elk	302	3.5	1.8
Total			**223.4**

Although the consumption based on livestock populations was estimated to be 223 dam^3**,** the data in Table 13-10 do not include an allowance for the evaporative and seepage losses associated with storing water for livestock use. Typically, licensed consumption accounts for only 35 per cent of surface water allocated for livestock use while losses account for 65 per cent (Watrecon 2005). Since 40 percent of livestock water consumption comes from groundwater (no losses) and the balance comes from surface water with 65 percent losses, a total allocation of 295 dam^3 would be required to support the animal populations in Table 13-8. This water requirement is about 33 times the water allocation through licences and registrations. Consequently, it is assumed that actual water use is greater than the amount of water allocated for livestock through registrations and licences, and suggests livestock watering is being done as part of household purposes or as exempted agricultural uses.

13.2.2.4 <u>Forecasts of Future Stockwatering Water Use</u>

The key factor affecting future livestock water demand is changes in cattle populations in the basin. Cattle accounts for about 85 percent of livestock water demand in the Hay Basin, so

changes in the populations of other livestock species will have a minimal overall impact on future water demand. The historical trend analysis in Figure 13-8 shows that the water allocation for livestock began relatively recently and has remained constant since 2000 suggesting large changes in population are not likely.

Some indication of the potential for expansion of cattle populations in the Hay River Basin can be determined by examining applications for new and expanded confined feeding operations, which must be approved by the NRCB in accordance with *AOPA*. Information from the NRCB indicates that, as of December 31, 2005, there had been two applications from farmers throughout the basin for cattle and dairy operations, all of which were approved (Table 13-11).

Table 13-11 Status of Applications Under *AOPA* in the Hay Basin

Type of Application	Number	Withdrawn	Approved	Denied
Approval	0	0	0	0
Registrations	1	0	1	0
Authorizations	1	0	1	0
Total	**2**	**0**	**2**	**0**

A study undertaken by AAFRD in the late 1990s also provides some insights regarding the potential for expansion of the beef industry in the province. That study identified several criteria – manure, odour and population densities, local silage supplies, water supply, landscape characteristics and land for manure spreading – to be considered in evaluating the capability of supporting a 5,000-head backgrounding operation or a 20,000-head finishing operation. Townships suitable for livestock expansions are shown in Figures 2-2 and 2-3 in Section 2.3. The figures show that there are very few townships in the Hay River Basin that meet any of the criteria. Some townships meet some of the criteria but are limited by silage and groundwater. Based on AAFRD's assessment, it would appear that major livestock expansion in the Hay River Basin is not likely.

Projections are based on the expectations that cattle populations will increase at annual rates somewhere between 0.0 percent (Low Growth scenario) and 1.2 percent (High Growth scenario). For the Medium Growth scenario, the annual rate of increased agricultural water use is assumed to be 0.5 percent. This forecast assumes that the current mix of livestock water use (85 percent cattle) and balance of surface and groundwater use will remain unchanged over the forecast period. The resulting projections, based on actual use are shown in Table 13-12.

Under the Low Growth, water demand is projected to remain the same as current use, 295 dam^3 by 2025. Under the High Growth, livestock water use would increase to 375 dam^3 by 2025. This increase is 1.3 times higher than current livestock use.

Table 13-12 Projected Water Use for Livestock in the Hay River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	206	206	206	206	206
	Groundwater	89	89	89	89	89
	Total	**295**	**295**	**295**	**295**	**295**
Medium Growth	Surface	206	211	216	222	227
	Groundwater	89	92	94	96	99
	Total	**295**	**303**	**310**	**318**	**326**
High Growth	Surface	206	219	232	246	261
	Groundwater	89	95	101	107	113
	Total	**295**	**313**	**332**	**353**	**375**

13.2.3 Irrigation

The other major use of water for agricultural purposes in most basins is irrigation or crop watering. However, no licences for irrigation have been issued for the Hay River Basin. It is assumed that current forage production from non irrigated acres is sufficient to support the expansion of livestock population in the Hay Basin.

13.2.4 Summary

In summary, current agricultural water use in the Hay Basin is estimated to be about 295 dam^3 for livestock watering. In the future, agricultural water demand in the basin is expected to increase as a result of expansion of small increases in livestock populations. A summary of future agricultural water demand is provided in Table 13-13. Under the Medium Growth scenario, agricultural water use in 2025 would be about 326 dam^3, which represents an increase of 11 percent from 2005). Under the Low Growth scenario, agricultural water use would remain at 2005 levels. Under the High Growth scenario agricultural water use is projected to be 375 dam^3 by 2025 and this represents an increase of 27 percent from 2005.

Table 13-13 Projected Water Use for Agriculture in the Hay River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	206	206	206	206	206
	Groundwater	89	89	89	89	89
	Total	**295**	**295**	**295**	**295**	**295**
Medium Growth	Surface	206	211	216	222	227
	Groundwater	89	92	94	96	99
	Total	**295**	**303**	**310**	**318**	**326**
High Growth	Surface	206	219	232	246	261
	Groundwater	89	95	101	107	113
	Total	**295**	**313**	**332**	**353**	**375**

13.3 COMMERCIAL WATER SECTOR

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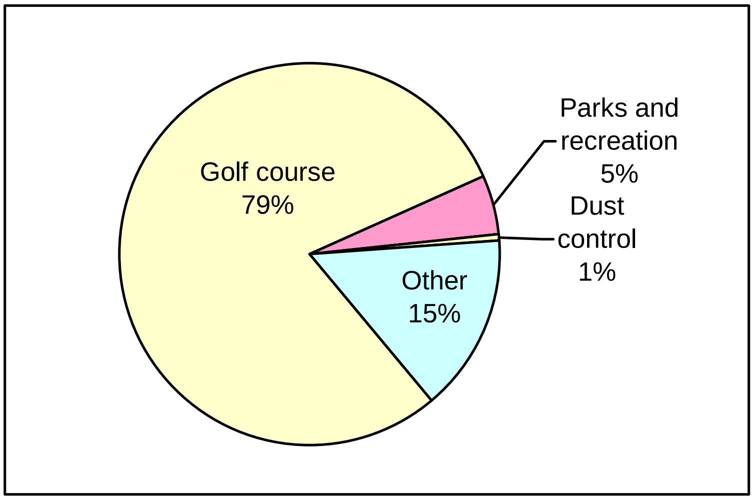
Eight licences have been issued for commercial purposes in the Hay River Basin and they allow diversion of up to 25 dam^3 of water. Commercial allocations account for 0.4 percent of total allocations in the basin.

13.1.1 Water Allocations

As shown in Figure 13-9, allocations for golf courses account for 79 percent of commercial allocations. Other commercial uses account for 15 percent; allocations for parks and recreation account for five percent; and licences for dust control account for one percent.

Figure 13-9 Water Allocation for Commercial Activities in the Hay Basin



Licences issued for the commercial sector allow maximum withdrawals of 20 dam^3 of surface water; surface water accounts for 80 percent of total commercial allocation. The largest surface water allocation is for golf courses, which accounts for all of the total surface water allocation. Groundwater licences allow diversions of up to five dam^3 (20 percent of commercial allocations), mostly for other commercial purposes. The earliest licence for commercial purpose (approximately 1,000 dam^3) was issued for parks and recreation in the 1980s but was cancelled in the 1990s. Allocations for commercial purposes have not changes since 1990s.

13.1.2 Licensed Water Use

Table 13-14 provides a summary of licensed water allocations, use and return for various activities within the commercial sector in the Hay River Basin. The licensees have no return flow allowances; this means that all diversions are expected to be consumed or lost.

Table 13-14 Licensed Commercial Allocations and Reported Actual Water Use, Hay Basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Licensees Reporting	Reported Use	Percent of Allocation
Golf course	Surface	1	19.7	19.7	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**1**	**19.7**	**19.7**	**0.0**	**0**	**N/A**	**N/A**
Parks and Recreation	Surface	0	0.0	0.0	**0.0**	0	N/A	N/A
	Groundwater	1	1.2	1.2	**0.0**	0	N/A	N/A
	Subtotal	**1**	**1.2**	**1.2**	**0.0**	**0**	**N/A**	**N/A**
Dust control	Surface	5	0.2	0.2	**0.0**	0	N/A	N/A
	Groundwater	0	0.0	0.0	**0.0**	0	N/A	N/A
	Subtotal	**5**	**0.2**	**0.2**	**0.0**	**0**	**N/A**	**N/A**
Other	Surface	0	0.0	0.0	**0.0**	0	N/A	N/A
	Groundwater	1	3.7	3.7	**0.0**	0	N/A	N/A
	Subtotal	**1**	**3.7**	**3.7**	**0.0**	**0**	**N/A**	**N/A**
Total	Surface	6	19.9	19.9	0.0	0	N/A	N/A
	Groundwater	2	4.9	4.9	0.0	0	N/A	N/A
	Total	**8**	**24.8**	**24.8**	**0.0**	**0**	**N/A**	**N/A**

13.1.3 Actual Water Use

At the present time Alberta Environment's Water Use Reporting System (WURS) contains no information on actual water use in 2005 by the any of the licensees in commercial sector in the Hay River Basin. Therefore, it is assumed that all licensees are withdrawing and using the full amounts of water to which they are entitled. While this assumption may overstate actual water use in the basin, the commercial sector accounts for 0.4 percent of total allocations so it will not appreciably affect overall water use estimate for the Hay Basin.

13.1.4 Forecasts of Future Water Use

Since most of the allocation (80 percent) is for golf courses, forecasts of future demand will focus on that activity.

13.3.1.1 Golf Courses

Water demand forecasts for golf courses were made using the approach outlined in Watrecon (2005) which related water use to expansion of golf course facilities which is related to population growth. Based on the population forecasts for the Hay River Basin, water use is expected to increase to 208 dam^3 by 2025 under the Low Growth scenario and represents a 2.6 times increase from current use. Table 13-15 shows that, for the High Growth scenario, water demand is projected to increase to 1,036 dam^3 by 2025 which is almost 12 times the current water use. . This method assumes that the proportion of surface and groundwater use would not change over the forecast period relative to 2005.

Table 13-15 Projected Water Use for Golf Courses, Hay River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	20	22	25	28	30
	Ground water	0	0	0	0	0
	Total	**20**	**22**	**25**	**28**	**30**
Medium Growth	Surface	20	27	34	41	49
	Ground water	0	0	0	0	0
	Total	**20**	**27**	**34**	**41**	**49**
High Growth	Surface	20	34	50	66	84
	Ground water	0	0	0	0	0
	Total	**20**	**34**	**50**	**66**	**84**

13.3.1.2 Summary

A summary of projected water demand for the commercial sector in the Hay Basin is provided in Table 13-16. These forecasts combine the projections for golf courses, as presented in Table 13-15, with the assumption that water use for all other commercial activities remains unchanged from current levels. Under the Low Growth scenario, water demand is projected to rise to

35 dam^3 by 2025, a 40 percent increase from current levels. Under the High Growth scenario, water demand is projected to rise to 89 dam^3 by 2025 which is 3.6 times current levels by 2025.

Table 13-16 Projected Water Use for Commercial Sector in the Hay Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	20	22	25	28	30
	Groundwater	5	5	5	5	5
	Total	**25**	**27**	**30**	**33**	**35**
Medium Growth	Surface	20	27	34	41	49
	Groundwater	5	5	5	5	5
	Total	**25**	**32**	**39**	**46**	**54**
High Growth	Surface	20	34	50	66	84
	Groundwater	5	5	5	5	5
	Total	**25**	**39**	**55**	**71**	**89**

13.4 PETROLEUM SECTOR

In the Hay River Basin, 23 licences have been issued to the petroleum sector and allow a maximum of 4,918 dam^3 to be withdrawn. These allocations account for 75 percent of total allocations in the basin. The majority of water allocations for the petroleum sector (89 percent) are for surface water (4,356 dam^3). As shown in Figure 13-10, the petroleum sector includes water allocations for oilfield injection, gas/petrochemical plants, and various other activities.

Figure 13-10 Petroleum Water Allocation by Use in the Hay Basin

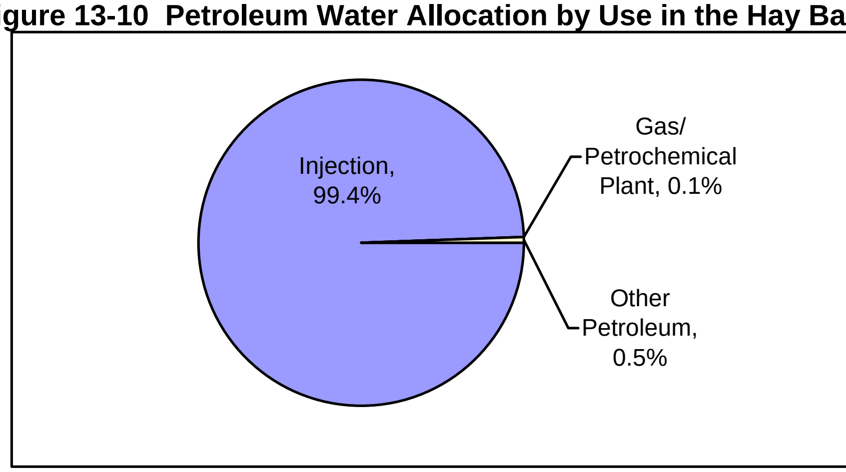


Table 13-17 summarizes the water allocation, use, and return associated with the licences for each activity in the Hay River Basin.

Table 13-17 Licensed Allocations and Reported Actual Water Use for the Petroleum Sector, Hay River Basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Injection	Surface	9	4,330.7	4,330.7	0.0	1,322.6	30.5%	30.5%
	Groundwater	9	556.2	556.2	0.0	246.3	44.3%	44.3%
	Subtotal	**18**	**4,887.0**	**4,887.0**	**0.0**	**1,568.8 ***	**32.1%**	**32.1%**
Gas/Petrochemical Plant	Surface	0	0.0	0.0	0.0	0.0		
	Groundwater	4	5.7	5.7	0.0	5.7	100.0%	100.0%
	Subtotal	**4**	**5.7**	**5.7**	**0.0**	5.7 **	100.0%	100.0%
Other petroleum	Surface	1	25.0	25.0	0.0	25.0	100.0%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**1**	**25.0**	**25.0**	**0.0**	**25.0 ****	**100.0%**	**100.0%**
Total	Surface	10	4,355.7	4,355.7	0.0	1,347.6	30.9%	30.9%
	Groundwater	13	561.9	561.9	0.0	252.0	44.8%	44.8%
	Total	**23**	**4,917.7**	**4,917.7**	**0.0**	**1,599.5**	**32.5%**	**32.5%**

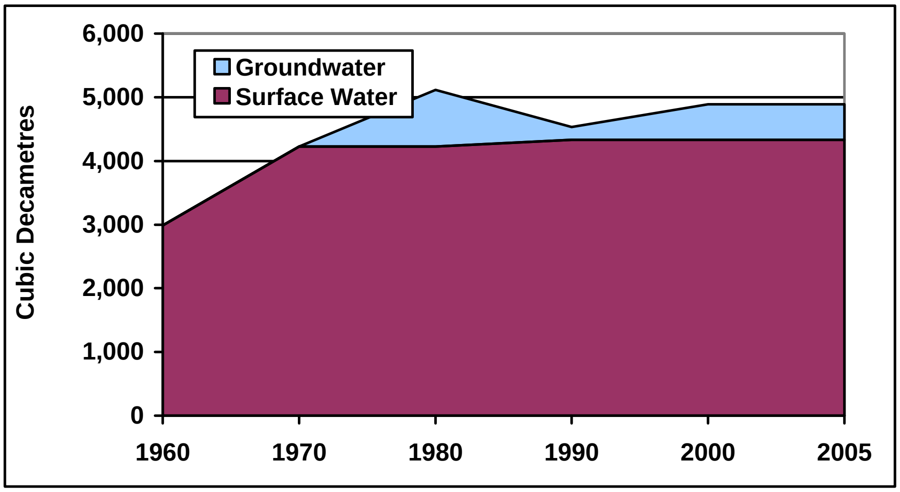
* Estimated water use based on EUB data (Geowa 2006).
** Estimated water use assumes 100 percent consumption of licensed use.

13.4.1 Injection

13.4.1.1 Water Allocations

About 99 percent of allocations for the petroleum sector are for injection purposes for enhanced oil and gas recovery (4,887 dam^3). Eighteen licences have been issued for injection purposes. Six of the licences are for surface water and account for 89 percent of allocations. The first licences for injection activities were issued in the 1960s and allocations increased in the 1970s but have remained relatively constant since. Figure 13-11 shows that the first licences for use of groundwater for injection purposes were issued in the 1980s, declined, and then increased slightly to 2000 and have remained constant since 2000.

Figure 13-11 Historical Trends in Water Allocations for Injection



13.4.1.2 Licensed Water Use

Table 13-17 shows that licences issued for injection purposes assume 100 percent of allocations will be used.

13.4.1.3 Actual Water Use

Detailed estimates of water used for injection proposes have been prepared by Geowa based on EUB data and are also presented in Table 13-17. According to the Geowa analysis, an estimated 1,569 dam^3 of fresh water was diverted for injection purposes in 2005. This volume includes 1,323 dam^3 of surface water and 246 dam^3 of groundwater.

13.4.1.4 Forecasts of Future Water Use

The general trend in Alberta is for conventional crude oil production to decline as existing fields mature and there are fewer new finds. The most recent forecast from the EUB and CAPP have oil production decreasing by between 30 and 38 percent between 2005 and 2015, and a further decline of about 23 percent by 2020. Oil production in the Hay River Basin is expected to follow

the overall Alberta production trend since most of the basin's production is from existing wells. The forecast of future water use for injection in the Hay River Basin in Table 13-18 assumes declining rates of water use required that match the rates at which oil production in Alberta is expected to decline. Forecasts for 2010 and 2020 assume no change from five years previously. Forecasts also assume the current ratio of surface to groundwater use.

Table 13-18 Forecast of Injection Water Use in the Hay River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,323	1,323	775	775	462
	Groundwater	246	246	144	144	86
	Total	**1,569**	**1,569**	**919**	**919**	**549**
Medium Growth	Surface	1,323	1,323	816	816	487
	Groundwater	246	246	152	152	91
	Total	**1,569**	**1,569**	**968**	**968**	**577**
High Growth	Surface	1,323	1,323	926	926	553
	Groundwater	246	246	172	172	103
	Total	**1,569**	**1,569**	**1,099**	**1,099**	**656**

Under the High Growth scenario, water use for injection purposes in 2025 will be 35 percent lower than at present. Under the Low Growth scenario, the water use for injection will decline by 42 percent.

13.4.2 Gas/Petrochemical Plants

Less than one percent of Allocations for the petroleum sector in the Hay River Basin are for gas/petrochemical plants. Total allocations amounted to six dam^3 of groundwater. Licences for gas/petrochemical plants were first issued in the 1980s and have declined since the 1990s. The licensees are not expected to return any of the water they divert. There is no information on actual water diversions and consumption for gas and petrochemical plants and, for purposes of this analysis; it is assumed that licensees are using their full entitlement. In the absence of information about this component of the petroleum sector, it is assumed that water used by gas and petrochemical plants in the Hay basin will remain constant for the forecast period.

13.4.3 Other Petroleum

One licence issued for other petroleum activities (25 dam^3) also account for less than one percent of allocations for the petroleum sector in the Hay River Basin. This licence was issued for surface water in 2003. The licensee is not expected to return any of the water they divert. There is no information on actual water diversions and consumption for other petroleum activities and, for purposes of this analysis; it is assumed that the licensee is using its full entitlement. In the absence of information about this component of the petroleum sector, it is assumed that water used for other petroleum purposes in the Hay River Basin will remain constant for the forecast period.

13.4.4 Summary

The petroleum sector in the Hay basin is dominated by water allocated for injection purposes. These activities account for 99 percent of allocations and 78 percent of actual water use in 2005. Water use data shows that although water licences expect up to 4,918 dam^3 of water to be consumed for petroleum purposes, licensees are only using 33 percent of this amount.

In the future, there is expected to be a decline in the amount of water used for injection as oil production from existing oilfields declines. The overall water use projections for the petroleum sector are provided in Table 13-19. Forecasts assume that the amount of water used by gas and petrochemical plants and other petroleum activities will remain the same over time. Forecasts also assume the current ratio of surface to groundwater use and that water required in 2010 and 2020 is the same as the previous five year periods.

Table 13-19 Forecast of Petrochemical Water Use in the Hay River Basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,348	1,348	800	800	487
	Groundwater	252	252	150	150	92
	Total	**1,600**	**1,600**	**950**	**950**	**579**
Medium Growth	Surface	1,348	1,348	841	841	512
	Groundwater	252	252	158	158	96
	Total	**1,600**	**1,600**	**998**	**998**	**608**
High Growth	Surface	1,348	1,348	951	951	578
	Groundwater	252	252	178	178	109
	Total	**1,600**	**1,600**	**1,129**	**1,129**	**686**

All three scenarios indicate that the overall demand for water in the Hay Basin is expected to decline over the forecast period. For the Low Growth scenario water use by the petroleum sector is forecast to decline by 43 percent by 2025. The High Growth scenario has water use declining by 36 percent.

13.5 INDUSTRIAL SECTOR

There are no industrial water licences in the Hay River Basin.

13.6 OTHER SECTOR

In the Hay Basin there are two active licences for the other sector which allocate 960 dam^3 of water. Licences issued for the other sector account for about 15 percent of water allocations in the Hay River Basin. Both licences are for surface water. One licence was issued in the 1980s and allows diversions of up to 960 dam^3 for habitat enhancement. The second surface water licence was issued in the 1960s for 0.01 dam^3. Both licensees expect 100 percent of withdrawals to be consumed. There is no information on actual water diversions or consumption for these activities and, for purposes of this analysis, it is assumed that licensees are using their full entitlement and will continue to do so for the duration of the forecast period.

Table 13-20 Licensed Allocations and Reported Actual Water Use for the Other Sector, Hay River Basin

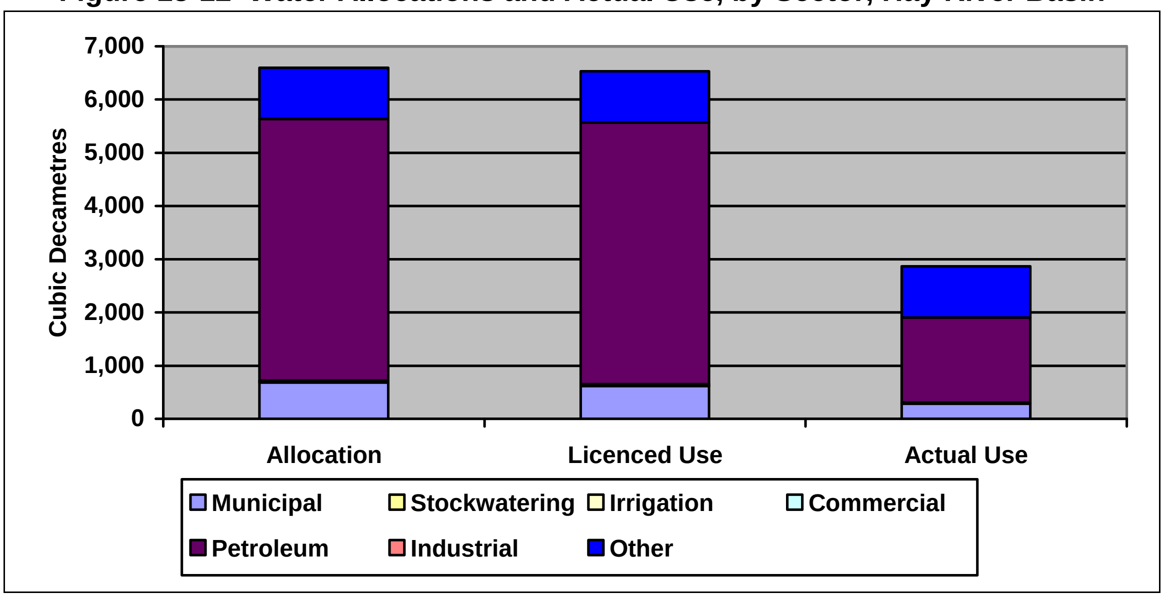
Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Water Management	Surface	1	0.01	0.01	0.0	0.01	100.0%	100.0%
	Groundwater	0	0	0	0.0	0.0		
	Subtotal	**1**	**0.01**	**0.01**	**0.0**	**0.01**	**100.0%**	**100.0%**
Habitat	Surface	1	960.1	960.1	0.0	960.1	100.0%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**1**	**960.1**	**960.1**	**0.0**	**960.1**	**100%**	**100.0%**
Total	Surface	2	960.1	960.1	0.0	960.1	100%	100.0%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Total	**2**	**960.1**	**960.1**	**0.0**	**960.1**	**100%**	**100.0%**

13.7 SUMMARY

Table 13-21 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the Hay River Basin. In total, existing licences and registrations allow a maximum of 6,598 dam^3 of water to be withdrawn for use. Of this, up to 6,531 dam^3 is expected to be used and 67 dam^3 will be returned to surface water. As noted previously, the largest amounts of water have been allocated to the petroleum sector, particularly for injection purposes.

With respect to actual use, the exact volumes withdrawn and used in 2005 are not known because very few water use reports have been filed with Alberta Environment. However, based on the assumptions used in the previous sections, it is estimated that 3,161 dam^3 were actually used in 2005. This represents 48 percent of water use allowed in existing licences and registrations. Based on estimated use, the petroleum sector accounted for 51 percent of total water use in the Hay River Basin in 2005. Figure 13-12 shows how actual use compares to licensed allocations and use for each of the water use sectors.

Figure 13-12 Water Allocations and Actual Use, by Sector, Hay River Basin



Forecasts of future water use in the Hay River Basin are provided in Tables 13-22 to 13-24 for the Low, Medium and High Growth scenarios. Predicted water use under the Medium Growth scenario is shown in Figure 13-13. This figure shows that most of the growth in water use will occur in the agricultural sector, with water used for stockwatering and irrigation accounting for 85 percent of total water use by 2025. Under the Medium Growth scenario, water demand in 2025 will be about 25 percent less than at present. For the other scenarios, the decrease in water demand over 20 years will range from 29 percent for Low Growth scenario to 18 percent for the High Growth scenario. For all scenarios, actual water use remains less than the amount that can be consumed under the terms of existing licences.

Figure 13-13 Forecast Water Use in the Hay River Basin: Medium Scenario

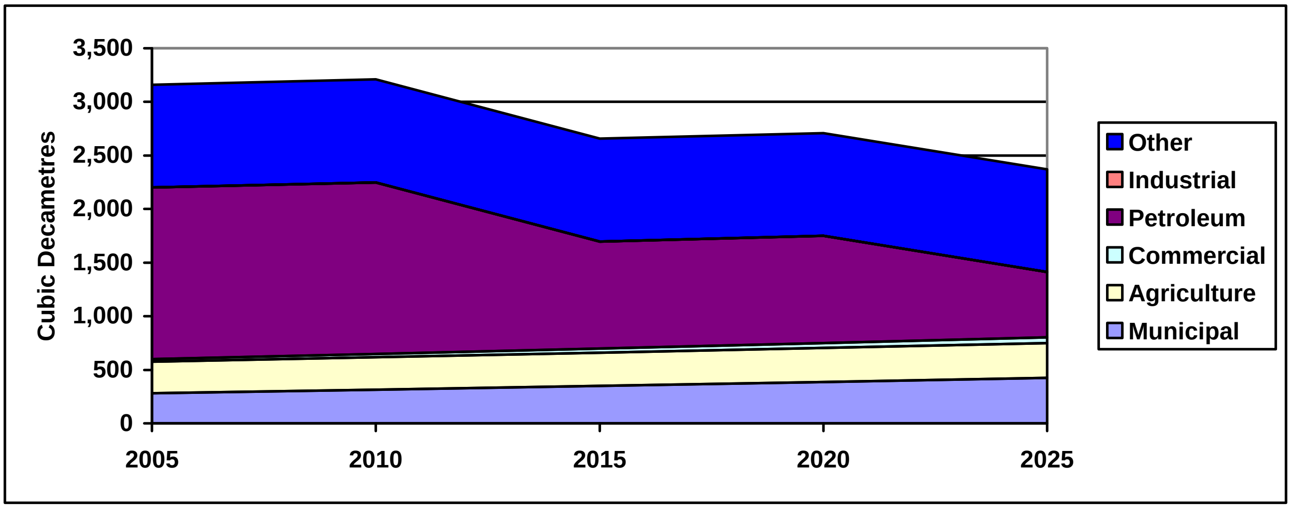


Table 13-21 Summary of Allocations and Estimated Water Use, Hay River Basin

Sector		Licensed Allocation and Use (dam^3)				Estimated Water Use (dam^3)		
		Allocation	Water Use	Return	Percent of Total Use	Use	Percent of Licensed use	Percent of Total Use
Municipal		686	619	67	9%	281	45%	9%
Agricultural	Stockwatering	9	9	0	0%	0	3315%	9%
	Irrigation	0	0	0	0%	0	0%	0%
Commercial		25	25	0	0%	25	100%	1%
Petroleum		4,918	4,918	0	75%	1,600	33%	51%
Industrial		0	0	0	0%	0	0%	0%
Other		960	960	0	15%	960	100%	30%
Total		**6,598**	**6,531**	**67**	**100%**	**3,161**	**48%**	**100%**

Table 13-22 Forecast Water Use, By Sector, Hay River Basin: Low Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	272	297	321	346	370
	Agricultural	206	206	206	206	206
	Commercial	20	22	25	28	30
	Petroleum	1,348	1,348	800	800	487
	Industrial	0	0	0	0	0
	Other	960	960	960	960	960
	Total	2,806	2,833	2,312	2,340	2,053
Groundwater	Municipal	9	10	11	11	12
	Agricultural	89	89	89	89	89
	Commercial	5	5	5	5	5
	Petroleum	252	252	150	150	92
	Industrial	0	0	0	0	0
	Other	0	0	0	0	0
	Total	355	356	255	255	198
Total	Municipal	281	307	332	357	382
	Agricultural	295	295	295	295	295
	Commercial	25	27	30	33	35
	Petroleum	1,600	1,600	950	950	579
	Industrial	0	0	0	0	0
	Other	960	960	960	960	960
	Total	3,161	3,189	2,567	2,595	2,251

Table 13-23 Forecast Water Use, By Sector, Hay River Basin: Medium Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	272	304	338	374	410
	Agricultural	206	211	216	222	227
	Commercial	20	27	34	41	49
	Petroleum	1,348	1,348	841	841	512
	Industrial	0	0	0	0	0
	Other	960	960	960	960	960
	Total	2,806	2,850	2,389	2,438	2,158
Groundwater	Municipal	9	10	11	12	14
	Agricultural	89	92	94	96	99
	Commercial	5	5	5	5	5
	Petroleum	252	252	158	158	96
	Industrial	0	0	0	0	0
	Other	0	0	0	0	0
	Total	355	359	268	271	214
Total	Municipal	281	314	349	386	424
	Agricultural	295	303	310	318	326
	Commercial	25	32	39	46	54
	Petroleum	1,600	1,600	999	999	608
	Industrial	0	0	0	0	0
	Other	960	960	960	960	960
	Total	3,161	3,209	2,657	2,709	2,372

Table 13-24 Forecast Water Use, By Sector, Hay River Basin: High Scenario

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	272	315	365	417	471
	Agricultural	206	219	232	246	261
	Commercial	20	34	50	66	84
	Petroleum	1,348	1,348	951	951	578
	Industrial	0	0	0	0	0
	Other	960	960	960	960	960
	Total	2,806	2,876	2,558	2,640	2,354
Groundwater	Municipal	9	10	12	14	16
	Agricultural	89	95	101	107	113
	Commercial	5	5	5	5	5
	Petroleum	252	252	178	178	109
	Industrial	0	0	0	0	0
	Other	0	0	0	0	0
	Total	355	362	296	304	243
Total	Municipal	281	325	377	431	487
	Agricultural	295	314	333	353	374
	Commercial	25	39	55	71	89
	Petroleum	1,600	1,600	1,129	1,129	687
	Industrial	0	0	0	0	0
	Other	960	960	960	960	960
	Total	3,161	3,238	2,854	2,944	2,597

Liard River Basin

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14.0 LIARD RIVER BASIN

The Liard River Basin, which is about 8,400 km^2 in area, is the smallest river basin in Alberta, occupying approximately one percent of the province. Currently, all water allocations (50 dam^3) are for the petroleum sector. The locations of surface and groundwater licences in the Liard River Basin are provided in Figure 14-1 and 14-2.

14.1 MUNICIPAL AND RESIDENTIAL SECTOR

There are no communities in the Liard River Basin and no municipal water licences have been issued for the Liard Basin.

14.2 AGRICULTURAL SECTOR

No licences or registrations have been issued for the agricultural sector in the Liard Basin

14.3 COMMERCIAL SECTOR

No commercial water licences have been issued for the Liard Basin.

14.4 PETROLEUM SECTOR

Two active surface water licences have been issued for injection purposes in the Liard River Basin. These licences allow withdrawals of up to 50 dam^3 of water to the petroleum sector. Licensees are expected to consume all of the water they withdraw.

Detailed estimates of water used for injection proposes have been prepared by Geowa based on data submitted to the EUB. Based on the review of the data it was determined that 79.7 dam^3 of groundwater was diverted for injection purposes in 2005. It is unclear why the petroleum sector is diverting groundwater when the EMS database only includes two licences for surface water. Furthermore, the amount of groundwater use reported exceeds the surface water allocation by almost 60 percent. Without further information it is not possible to accurately characterize water use by the petroleum sector in the Liard River Basin. For purposes of providing a provincial summary, it is assumed that licensees are using the full amount of their entitlements.

With respect to future water demands, these could increase significantly as primary production from existing oil wells starts to decline and companies implement secondary recovery schemes like waterfloods. At this time it is impossible to speculate on just what these additional demands may be.

14.5 INDUSTRIAL SECTOR

There are no industrial water licences in the Liard River Basin.

14.6 OTHER SECTOR

There are no other water licences in the Liard River Basin.

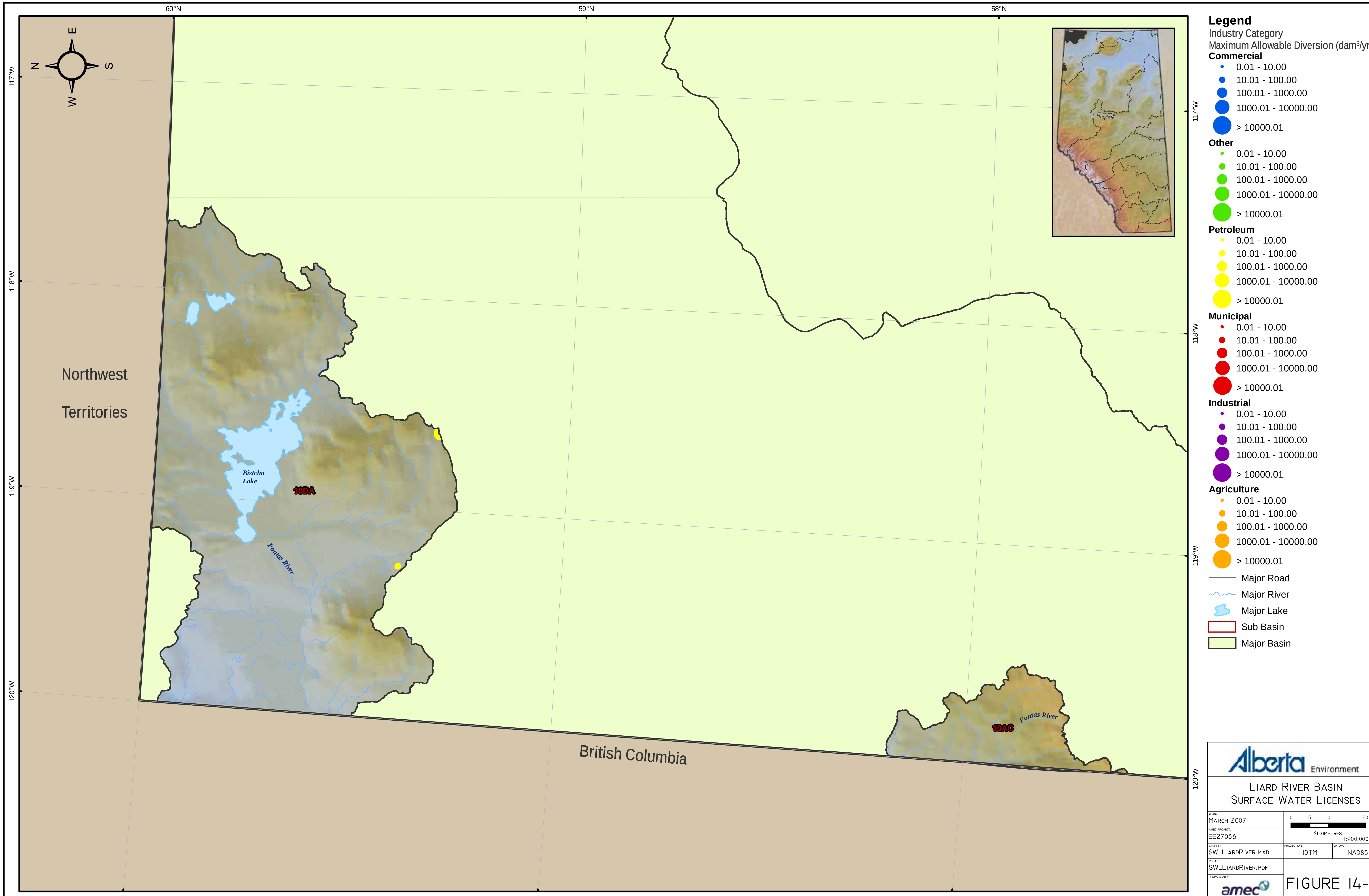
14.7 SUMMARY

At the present time, there is no significant licensed water use in the Liard River Basin. The basin area is remote, with no settlements, and existing licences only allow small amounts of surface water to be used for injection purposes.

Table 14-1 Licensed Allocations and Estimated Water Use, Petroleum Sector, Liard River Basin

	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Water Use (dam^3)		
			Allocation	Water Use	Return	Water Use	Percent of Licensed Use	Percent of Allocation
Injection	Surface	2	50.0	50.0	0.0	0		
	Groundwater	0	0.0	0.0	0.0	79.7		
	Subtotal	**2**	**50.0**	**50.0**	**0.0**	**79.7**	**159.8%**	**159.8%**
Total	Surface	2	50.0	50.0	0.0	0		
	Groundwater	0	0.0	0.0	0.0	79.7		
	Total	**2**	**50.0**	**50.0**	**0.0**	**79.7**	**159.8%**	**159.8%**

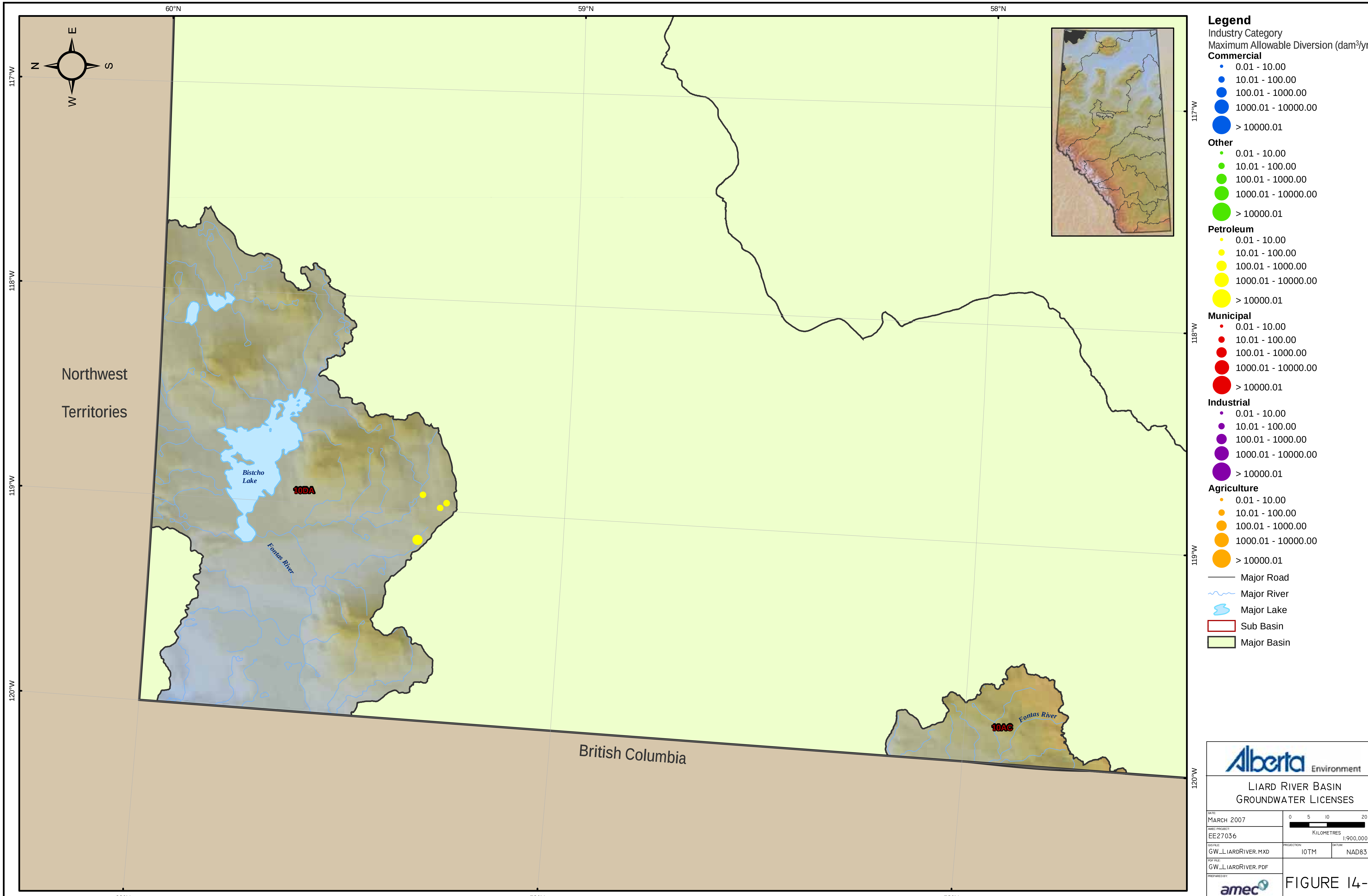
* Water use estimates based on EUB data provided by Geowa.



Alberta Environment

LIARD RIVER BASIN
SURFACE WATER LICENSES

Date: March 2007			
AMEC Project: EE27036			
GIS File: SW_LiardRiver.mxd	Projection: 10TM	Datum: NAD83	
PDF File: SW_LiardRiver.pdf			
Prepared by: amec	FIGURE 14-2		



Liard River Basin Groundwater Licenses

FIGURE 14-3

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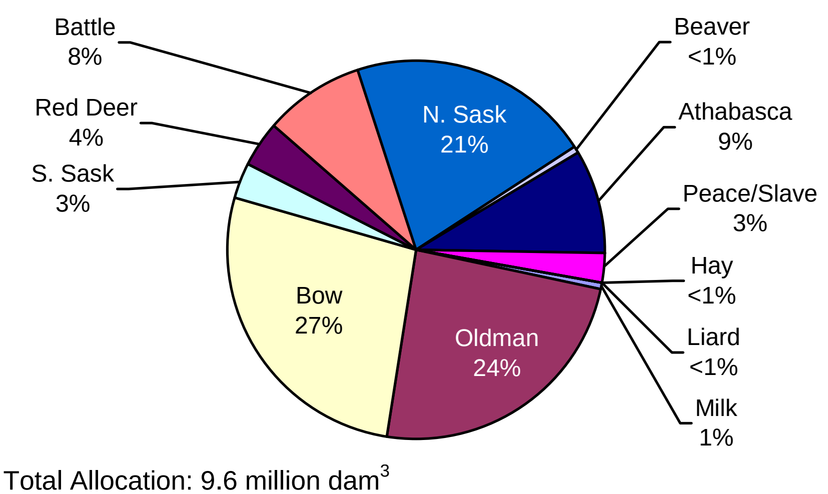
15.0 ALBERTA

In 2005, a total of about 9.6 million dam^3 of water has been allocated in Alberta through licences and registrations. Of this total, 9.3 million dam^3 or 97 percent was for surface water. As shown in Figure 15.1, water allocations in the Bow (27 percent), the Oldman (24 percent) and the North Saskatchewan river basins (21 percent), together accounted for more than 70 percent of water allocations in Alberta. Water allocations in the Bow and Oldman river basins are dominated by allocations for agricultural sector, mainly district irrigation, whereas industrial water allocations accounts for the majority of allocations in the North Saskatchewan River Basin. Water allocations in the northern basins, which include the Athabasca, Peace/Slave, Hay and Liard basins, only accounted for 12 percent of provincial allocations and consist primarily of water licences issued to the petroleum sector. In contrast, water allocations in the Milk, Red Deer and the South Saskatchewan river basin in southern Alberta are primarily for agricultural purposes.

Figure 15-1 Summary of Water Allocations by Basin



Details of provincial water allocations and use for each of the major categories of water use are provided in the remainder of this section.

15.1 MUNICIPAL AND RESIDENTIAL SECTOR

15.1.1 Population

In 2001, Alberta had a population of nearly 2.98 million people. As shown in Table 15-1, the vast majority of the population (79 percent) resided in cities, towns, villages or summer villages (79 percent) while 19 percent lived in rural communities or municipalities. About two percent lived on First Nation Reserves or in Métis Settlements.

The majority of the provincial population is concentrated in two river basins. About 35 percent of the 2001 population lived in the North Saskatchewan River Basin and 34 percent lived in the

Bow river basin. The other five basins with significant populations included the Red Deer, the Oldman, the Athabasca, the Peace/Slave, and the Battle. All other basins had populations that accounted for two percent or less of the Alberta total.

Table 15-1 Population Distribution and Growth in Alberta, 2001

River Basin	2001 Population		Urban/Rural Composition			Population Growth 1996 to 2001
	Population	Percent of Alberta	Urban	Rural	First Nations	
Milk	11,477	0.4%	49.7%	50.3%	0.0%	2.5%
Oldman	162,099	5.4%	73.8%	20.2%	6.0%	6.5%
Bow	1,006,895	33.7%	95.4%	3.8%	0.8%	15.9%
South Saskatchewan	65,451	2.2%	88.4%	11.6%	0.0%	8.3%
Red Deer	234,965	7.9%	62.2%	37.8%	0.0%	11.4%
Battle	122,477	4.1%	57.9%	34.6%	7.5%	2.8%
North Saskatchewan	1,047,017	35.1%	81.8%	17.1%	1.1%	8.0%
Beaver	38,297	1.3%	47.2%	37.0%	15.8%	3.1%
Athabasca	154,097	5.2%	35.2%	62.3%	2.5%	4.6%
Peace/Slave	133,973	4.5%	54.5%	37.7%	7.8%	6.3%
Hay	7,016	0.2%	13.9%	64.8%	21.3%	4.5%
Liard	0	0.0%				
Total	**2,983,764**	**100.0%**	**79.2%**	**18.8%**	**2.0%**	**10.3%**

Between 1996 and 2001, Alberta had the fastest growing population of any Canadian province, with the population increasing by 10.3 percent. Within Alberta, the highest population growth rates occurred in the Bow and Red Deer river basins. Moderate population growth occurred in the South Saskatchewan, North Saskatchewan, Oldman and Peace/Slave river basins. All of the other basins had population growth rates of less than five percent between 1996 and 2001.

15.1.2 Water Allocations

As of 2005, 2,019 municipal water licences had been issued to 781 licensees in Alberta. These licences allow diversions of up to 1,078,095 dam^3 for municipal purposes. The majority of municipal allocations (1,027,472 dam^3 or 95 percent) were for surface water. About 98 percent of these allocations were for urban municipalities, with the rural communities accounting for another 1.7 percent. A total of 50,623 dam^3 of groundwater has been allocated for municipal use, with urban municipalities accounting for 82 percent and rural communities accounting for 12.2 percent. Table 15-2 summarizes the municipal licence allocations for each river basin.

Table 15-2 Licensed Municipal Allocations and Use and Reported Actual Water Use, Alberta

River Basin	Source	Licensed Allocation		Licensed use		Return		Actual Use		Licence Utilization
		dam^3	Percent of Alberta	dam^3	Percent of Alberta	dam^3	Percent of Allocation	dam^3	Percent	
Milk	Surface	1949	0.2%	1605	0.5%	344	17.7%	1423	1.2%	88.7%
	Groundwater	590	1.2%	590	2.4%	0	0.0%	637	5.9%	108.0%
	Total	**2,539**	**0.2%**	**2,195**	**0.2%**	**344**	**13.5%**	**2,060**	**0.2%**	**93.8%**
Oldman	Surface	58,425	5.7%	24,389	7.5%	34,036	58.3%	14,853	12.4%	60.9%
	Groundwater	5,724	11.3%	3,379	13.5%	2,345	41.0%	1,715	15.9%	50.8%
	Total	**64,149**	**6.0%**	**27,768**	**6.0%**	**36,380**	**56.7%**	**16,568**	**6.0%**	**59.7%**
Bow	Surface	491,192	47.8%	106,298	32.8%	384,894	78.4%	58,881	49.0%	55.4%
	Groundwater	9,280	18.3%	3,005	12.0%	6,275	67.6%	1,440	13.3%	47.9%
	Total	**500,472**	**46.4%**	**109,303**	**46.4%**	**391,170**	**78.2%**	**60,321**	**46.4%**	**55.2%**
South Saskatchewan	Surface	167,503	16.3%	101,120	31.2%	66,382	39.6%	8,101	6.7%	8.0%
	Groundwater	2,111	4.2%	652	2.6%	1,459	69.1%	102	0.9%	15.6%
	Total	**169,613**	**15.7%**	**101,772**	**15.7%**	**67,841**	**40.0%**	**8,203**	**15.7%**	**8.1%**
Red Deer	Surface	59,234	5.8%	27,449	8.5%	31,785	53.7%	21,391	17.8%	77.9%
	Groundwater	10,105	20.0%	6,284	25.2%	3,821	37.8%	1,362	12.6%	21.7%
	Total	**69,339**	**6.4%**	**33,733**	**6.4%**	**35,606**	**51.4%**	**22,752**	**6.4%**	**67.4%**
Battle	Surface	14,261	1.4%	3,759	1.2%	10,502	73.6%	1,354	1.1%	36.0%
	Groundwater	7,689	15.2%	4,439	17.8%	3,250	42.3%	1,377	12.7%	31.0%
	Total	**21,950**	**2.0%**	**8,198**	**2.0%**	**13,752**	**62.7%**	**2,731**	**2.0%**	**33.3%**
North Saskatchewan	Surface	158,476	15.4%	43,382	13.4%	115,094	72.6%	8,680	7.2%	20.0%
	Groundwater	5,925	11.7%	2,720	10.9%	3,204	54.1%	1,554	14.4%	57.1%
	Total	**164,401**	**15.2%**	**46,102**	**15.2%**	**118,298**	**72.0%**	**10,234**	**15.2%**	**22.2%**
Beaver	Surface	11,325	1.1%	2,077	0.6%	9,247	81.7%	663	0.6%	31.9%
	Groundwater	383	0.8%	204	0.8%	180	47.0%	87	0.8%	42.6%
	Total	**11,708**	**1.1%**	**2,281**	**1.1%**	**9,427**	**80.5%**	**750**	**1.1%**	**32.9%**
Athabasca	Surface	41,735	4.1%	7,023	2.2%	34,712	83.2%	3,903	3.3%	55.6%
	Groundwater	4,362	8.6%	1,885	7.5%	2,477	56.8%	1,605	14.9%	85.1%
	Total	**46,097**	**4.3%**	**8,907**	**4.3%**	**37,190**	**80.7%**	**5,508**	**4.3%**	**61.8%**
Peace	Surface	22,770	2.2%	6,507	2.0%	16,263	71.4%	538	0.4%	8.3%
	Groundwater	4,370	8.6%	1,800	7.2%	2,570	58.8%	919	8.5%	51.1%
	Total	**27,141**	**2.5%**	**8,307**	**2.5%**	**18,833**	**69.4%**	**1,457**	**2.5%**	**17.5%**
Hay	Surface	602	0.1%	602	0.2%	0	0.0%	272	0.2%	45.2%
	Groundwater	84	0.2%	17	0.1%	67	79.8%	9	0.1%	52.9%
	Total	**686**	**0.1%**	**619**	**0.1%**	**67**	**9.8%**	**281**	**0.1%**	**45.4%**
Liard	Surface	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.0%
	Groundwater	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.0%
	Total	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0**	**0.0%**	**0.0%**
Total	Surface	1,027,472	95.3%	324,211	92.8%	703,259	68.4%	120,059	91.7%	37.0%
	Groundwater	50,623	4.7%	24,975	7.2%	25,648	50.7%	10,807	8.3%	43.3%
	Total	**1,078,095**	**100.0%**	**349,185**	**100.0%**	**728,908**	**67.6%**	**130,865**	**100.0%**	**37.5%**

15.1.3 Licensed Water Use

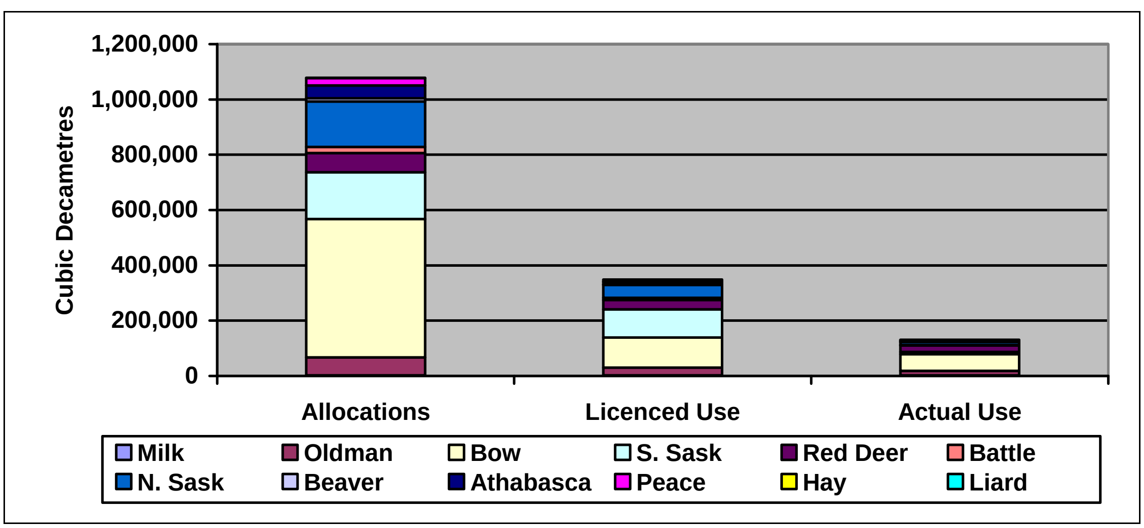
Under the terms of licences issued for municipal purposes, 32 percent of allocations can be consumed or lost (349,185 dam^3), with the remainder (68 percent or 728,908 dam^3) being returned. Return flow requirements vary from basin to basin, ranging from more than 80 percent in some of the northern basins to 40 to 60 percent for some of the southern basins.

15.1.4 Actual Water Use

Table 15-2 also contains estimates of actual municipal water use. These estimates must be used with some caution because most municipal licensees did not report on actual diversions or water use for 2005. The method of estimating actual water use varied from basin to basin, depending on how much information was available from AENV's Water Use Reporting System and Environment Canada's Municipal Water Use database. However, in general, the approach consisted of assuming that the rates of diversion and return flows reported by municipalities who did report were the same for all municipalities in the basin. For basins with large urban populations there was more information so the estimates are assumed to be more accurate than for smaller basins where there was less actual water use information. For example, the 69 licensees that did report their water diversions accounted for 82 percent of total municipal allocations, and they reported diverting about 39 percent of their maximum entitlement.

Using this approach it is estimated that municipalities used about 130,865 dam^3 of water in 2005. This reflects the difference between what municipalities are estimated to have withdrawn and what they are estimated to have returned. Almost half of the estimated actual water use (46 percent) occurred in the Bow River Basin. Other basins that accounted for more than five percent of municipal water use in Alberta included the Red Deer, Oldman and North Saskatchewan. Figure 15-2 shows the difference between allocations, licensed use and estimated actual use for the municipal sector.

Figure 15-2 Municipal Allocations, Licensed Use and Actual Use, Alberta

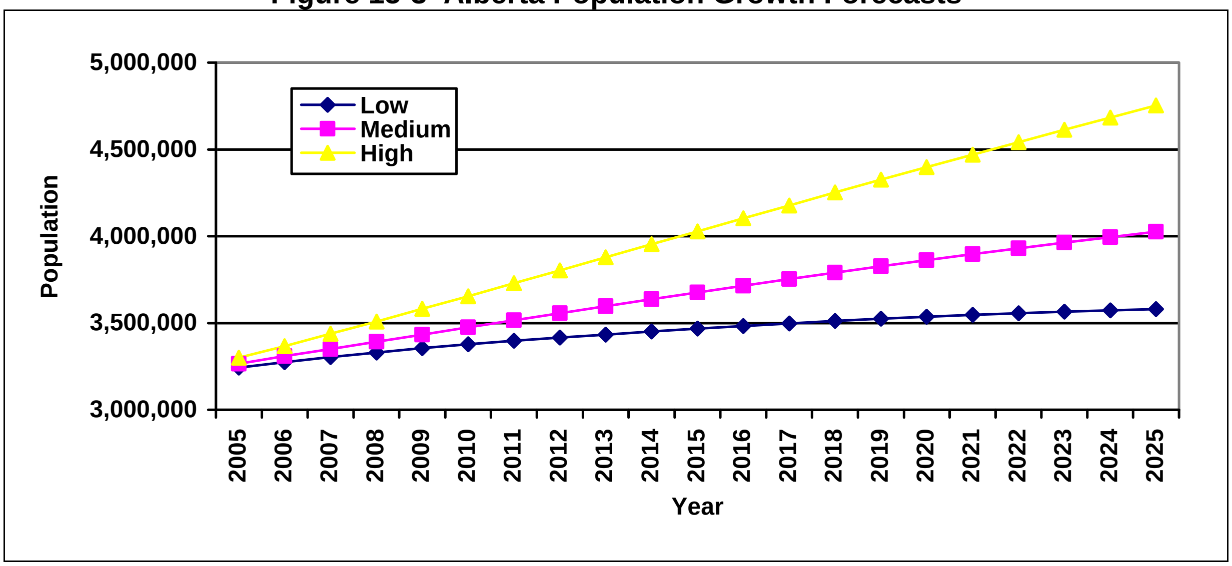


The water use estimates can also be used to calculate the extent to which current allocations are being utilized. These utilization rates are shown in Table 15-2, which shows that, on average, municipalities were using 38 percent of their entitlements. However, the utilization rates tended to be higher in southern Alberta, with the highest rate occurring in the Milk River Basin. Other basins with high licence utilization rates include the Red Deer, Athabasca, Oldman and Bow river basins. The lowest utilization rate was reported for the South Saskatchewan River Basin, but this may be attributed to the City of Medicine Hat which has a large licence and uses some of its allocation for thermal power production.

15.1.5 Forecasts of Future Water Use

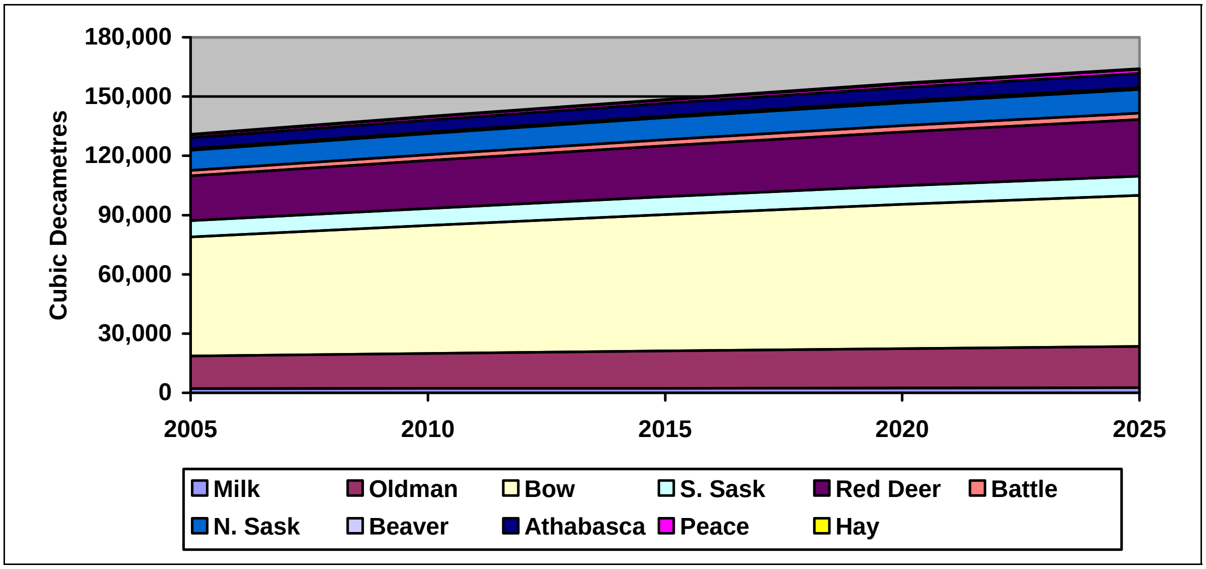
Figure 15-3 shows low, medium and high population projections for the province of Alberta as developed by Alberta Finance. These population forecasts have been used to predict municipal water use in each of the 12 basins.

Figure 15-3 Alberta Population Growth Forecasts



For Alberta, expected water use under the Medium Growth scenario will increase to 164,150 dam^3. This represents a 25 percent increase over current municipal water use. Figure 15-4 shows how this expected increase in water use will be distributed among the various river basins. It shows that the majority of the growth in municipal water use is expected in the Bow River Basin which, by 2025, would account for 47 percent of municipal water use in Alberta.

Figure 15-4 Alberta Municipal Water Use Forecasts, 2005-2025: Medium Growth Scenario



Under the Low Growth scenario, municipal water use in 2025 is projected to be 11 percent higher than in 2005. Under the High Growth scenario, the water use would be 42 percent higher in 2025 than in 2005

15.2 AGRICULTURAL SECTOR

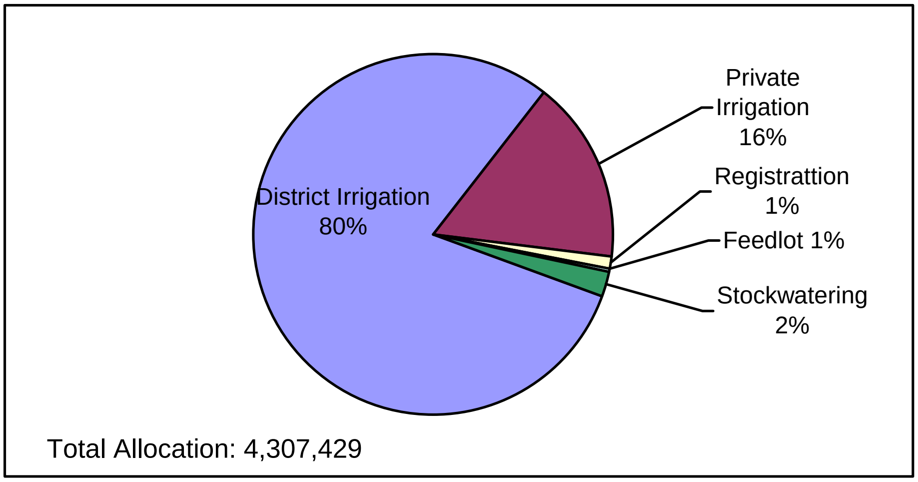
Water allocations for agricultural sector include registrations and licences issued for irrigation, feedlots and stockwatering. As of 2005, registrations and licences allow withdrawals of up to 4,307,429 dam^3, and this accounts for 45.3 percent of total water allocations in Alberta.

About 90,000 registrations had been issued in Alberta, and they allow up to 53,140 dam^3 of water to be diverted for agricultural purposes. Registrations make up about 0.6 percent of total water allocations in Alberta. Most of the registrations are in the Red Deer (25 percent), North Saskatchewan (21 percent) and Battle (18 percent) river basins, which together account for 64 percent of the allocations through registrations.

The majority of agricultural water allocation is authorized through 1,690 licences that allow diversion up to 4,254,289 dam^3 of water. Most allocations for agricultural use are in the Bow and Oldman basins, where the large irrigation districts are located.

Figure 15-5 shows how water allocations are distributed among the major agricultural activities for which licences and registrations are issued. The largest allocation is for district irrigation (80 percent). Private irrigation accounts for 16 percent of agricultural allocations while allocations for stockwatering, feedlots and registration together make up the remaining 4 percent. Overall, irrigation (district and private) accounts for 96 percent of total water allocation for the agricultural sector.

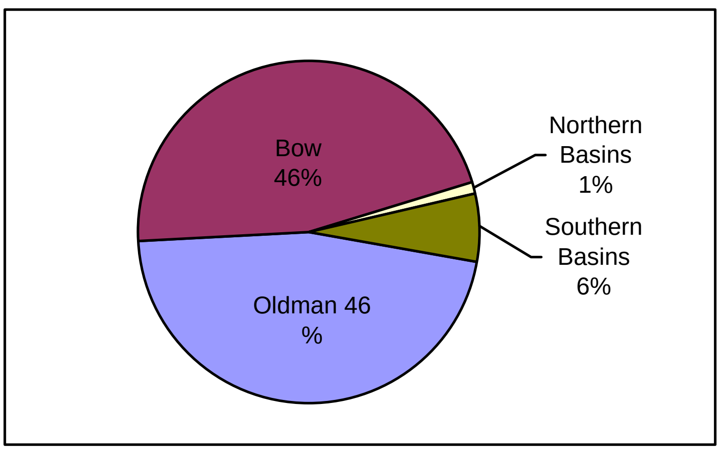
Figure 15-5 Water Allocation for Agricultural Activities in Alberta



15.2.1 Water Allocation

Figure 15-6 summarizes the distribution of agricultural water allocated among the river basins. Two basins, the Bow and the Oldman, together account for 92 percent of the allocation while the remaining southern basins account for six percent of allocation. Northern basins, which are located north of the Red Deer River Basin account for about one percent of the agricultural water allocations in Alberta.

Figure 15-6 Licensed Agricultural Allocations among River Basins in Alberta



A total of 54,745 registrations and 10,641 licences allow withdrawals of up to 4.32 million dam^3 of surface water; this accounts for 98 percent of all water allocated to the agricultural sector. Licences issued for groundwater account for two percent of allocations; 35,017 registrations and 6,289 licences have been issued to withdraw up to 66,042 dam^3 of groundwater.

15.2.2 Licensed Water Use

Table 15-3 shows that licences and registration allow withdrawals of up to 158,468 dam^3 for livestock watering. More than 99 percent of allocations for stockwatering can be used. There are no allowances for return flow in any of the groundwater allocations and only 1.2 percent of surface water allocations are to be returned.

Information on licences issued for irrigation and crop watering is provided in Table 15.4. This shows that up to 4,147,158 dam^3 of surface water and 647 dam^3 of groundwater can be used. There are no return flow requirements for any of the groundwater allocations but 6.5 percent of surface water withdrawals are to be returned. District irrigation accounts for 80 percent of licensed irrigation water use and is largely located in the Bow, Oldman and South Saskatchewan basins. Private irrigation accounts for the remaining 20 percent and occurs throughout the province but is concentrated in the southern basins.

15.2.3 Actual Water Use

Actual water use by livestock has been estimated based on animal populations in each basin in 2001, their daily water requirements and an allowance for evaporation and seepage from surface water sources. Using this approach it is estimated that livestock actually consumed 102,718 dam^3 of water in 2005; this represents 65 percent of licensed use. Licence utilization ranged from 22 percent (South Saskatchewan River Basin) to 3,320 percent (Hay River Basin[1]); however, these basins only accounted for three percent of cattle population in Alberta. The Red Deer River Basin accounted for nearly 26 percent of cattle population in Alberta in 2001, and the licence utilization was 72 percent. Other basins with large cattle populations included: the Oldman River Basin where 76 percent of licensed allocations were utilized; the North Saskatchewan River Basin (90 percent utilization); and the Battle River Basin (43 percent utilization). These three basins together account for 70 percent of cattle populations in Alberta and 45 percent of actual water use. As shown in Figure 15-7, average licence utilization for stockwatering in Alberta in 2005 was estimated to be 65 percent.

In terms of water used for irrigation and crop watering, accurate estimates of diversions and return flow exist for the 13 irrigation districts, but there is no information on water used by private irrigators. The water use estimates in Table 15-4 assume that private irrigators used the full amounts allowed by their licences. Licensee utilization ranged from a low of 51 percent in the Oldman River Basin to 100 percent for most basins with only private irrigation. It is estimated that irrigators in the Bow River Basin used 54 percent of their allocation. It should be noted that actual diversions of water reported by the irrigation district varies considerable from year to year, depending on natural precipitation so, for purposes of this analysis, average

[1] The estimated livestock population in the Hay River Basin is very small and the estimated consumption of 295 dam^3 is much larger than the amount licensed for livestock (nine $dam^{3)}$.

diversion volumes were used for the calculations because 2005 was a “wet” year[2]. For Alberta, it is estimated that the licence utilization for irrigation was about 54 percent. The difference between allocations, licensed use, and actual use for irrigation is shown in Figure 15-7.

[2] Total volumes diverted by the 13 irrigation districts in 2005 amounted to 150775 dam$^{3 \text{ which}}$ was only 69 percent of average diversions and only 52 percent of diversion that occurred in 2000, which was considered a day year.

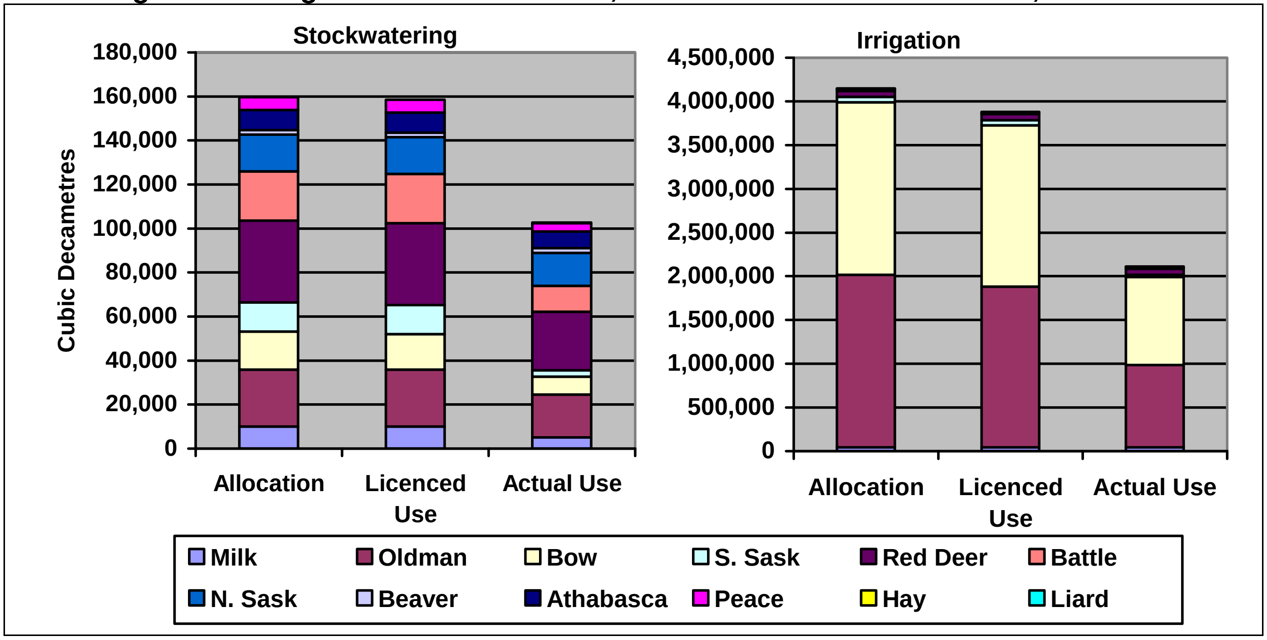
Table 15-3 Water Allocation and Use for Livestock Watering in Alberta

Basins	Water Type	Licensed Allocation and Use (dam^3)			Actual Use (dam^3)	Licence Utilization	Cattle population	Percent of animal population in AB	Actual Use (dam^3)	Percent Actual Use of AB
		Allocation	Licensed use	Return Flow						
Milk	Surface	9,259	9,217	42	4,781	51.9%	**278,384**	**4.2%**	5,051	3.2%
	Groundwater	804	804	0	270	33.6%				
	Total	**10,062**	**10,020**	**42**	**5,051**	**50.4%**				
Oldman	Surface	21,176	21,176	0	17,115	80.8%	**1,198,411**	**18.2%**	19,557	12.4%
	Groundwater	4,634	4,634	0	2,442	52.7%				
	Total	**25,810**	**25,810**	**0**	**19,557**	**75.8%**				
Bow	Surface	11,266	10,156	1,110	5,931	58.4%	**528,135**	**8.0%**	8,007	5.1%
	Groundwater	5,972	5,972	0	2,076	34.8%				
	Total	**17,243**	**16,133**	**1,110**	**8,007**	**49.6%**				
South Saskatchewan	Surface	12,497	12,497	0	2,842	22.7%	**168,350**	**2.6%**	2,960	1.9%
	Groundwater	800	800	0	118	14.7%				
	Total	**13,297**	**13,297**	**0**	**2,960**	**22.3%**				
Red Deer	Surface	17,084	17,081	4	15,066	88.2%	**1,682,444**	**25.5%**	26,562	16.9%
	Groundwater	20,046	20,046	0	11,496	57.3%				
	Total	**37,131**	**37,127**	**4**	**26,562**	**71.5%**				
Battle	Surface	9,525	9,525	0	4,029	42.3%	**746,350**	**11.3%**	9,593	6.1%
	Groundwater	12,925	12,925	0	5,564	43.2%				
	Total	**22,450**	**22,450**	**0**	**11,763**	**42.8%**				
North Saskatchewan	Surface	5,983	5,983	0	6,947	116.1%	**990,169**	**15.0%**	14,974	9.5%
	Groundwater	10,696	10,696	0	8,028	75.1%				
	Total	**16,680**	**16,680**	**0**	**14,974**	**89.8%**				
Beaver	Surface	788	788	0	1,098	139.3%	**159,904**	**2.4%**	2,214	1.4%
	Groundwater	1,228	1,228	1	1,116	90.9%				
	Total	**2,016**	**2,016**	**0**	**2,214**	**109.8%**				
Athabasca	Surface	3,051	3,051	0	3,052	74.6%	**569,205**	**8.6%**	6,829	4.3%
	Groundwater	6,071	6,071	0	4,553	75.0%				
	Total	**9,122**	**9,122**	**0**	**7,605**	**74.9%**				
Peace/Slave	Surface	3,556	3,556	0	2,635	74.1%	**249,116**	**3.8%**	3,730	2.4%
	Groundwater	2,249	2,249	0	1,095	48.7%				
	Total	**5,805**	**5,805**	**0**	**3,730**	**64.3%**				
Hay	Surface	5	5	0	206	3860.6%	**19,397**	**0.3%**	295	0.2%
	Groundwater	4	4	0	89	2509.1%				
	Total	**9**	**9**	**0**	**295**	**3320.0%**				
Total	Surface	94,191	93,035	1,156	63,702	68.5%	**6,589,865**	**100.0%**	**157,272**	**100.0%**
	Groundwater	65,429	65,429	0	36,847	56.3%				
	Total	**159,625**	**158,468**	**1,156**	**102,718**	**64.8%**				

Table 15-4 Water Allocation and Use for Crop Watering in Alberta

Basins	Water Type	Licensed Allocation and Use (dam^3)			Actual Use (dam^3)	Licence Utilization	Total Potential Acres *	% Acres of AB	Actual Use (dam^3)	% Actual use of AB
		Allocation	Licensed use	Return Flow						
Milk	Surface	44,641	43,178	1,463	43,178	100.0%	2,326,769	5.1%	43,178	2.1%
	Groundwater	0	0	0	0	N/A				
	Total	**44,641**	**43,178**	**1,463**	**43,178**	**100.0%**				
Oldman	Surface	1,972,752	1,837,160	135,592	942,619	51.3%	4,783,676	10.4%	942,701	44.8%
	Groundwater	191	191	0	82	43.0%				
	Total	**1,972,942**	**1,837,350**	**135,592**	**942,701**	**51.3%**				
Bow	Surface	1,969,960	1,846,562	123,399	1,005,609	54.5%	3,108,945	6.8%	1,005,794	47.8%
	Groundwater	249	249	0	184	74.0%				
	Total	**1,970,210**	**1,846,811**	**123,399**	**1,005,794**	**54.5%**				
South Saskatchewan	Surface	61,511	58,165	3,346	33,050	56.8%	2,467,922	5.4%	33,050	1.6%
	Groundwater	153	153	0	0	0.0%				
	Total	**61,664**	**58,317**	**3,346**	**33,050**	**56.7%**				
Red Deer	Surface	70,285	68,334	1,951	68,305.3	100.0%	11,017,227	23.9%	68,337	3.2%
	Groundwater	32	32	0	32.0	100.0%				
	Total	**70,317**	**68,366**	**1,951**	**68,337**	**100.0%**				
Battle	Surface	11,305	10,287	1,019	10,287	100.0%	5,074,622	11.0%	10,287	0.5%
	Groundwater	0	0	0	0	N/A				
	Total	**11,305**	**10,287**	**1,019**	**10,287**	**100.0%**				
North Saskatchewan	Surface	9,693	9,556	137	9,556	100.0%	6,869,097	14.9%	9,574	0.5%
	Groundwater	19	19	0	19	100.0%				
	Total	**9,712**	**9,574**	**137**	**9,574**	**100.0%**				
Beaver	Surface	183	153	30	153	100.0%	1,273,902	2.8%	153	0.0%
	Groundwater	0	0	0	0	N/A				
	Total	**183**	**153**	**30**	**153**	**100.0%**				
Athabasca	Surface	3,474	2,093	1,381	2,093	100.0%	3,418,694	7.4%	2,094	0.1%
	Groundwater	1	1	0	1	100.0%				
	Total	**3,475**	**2,094**	**1,381**	**2,094**	**100.0%**				
Peace/Slave	Surface	3,354	3,211	143	3,211	100.0%	4,838,888	10.5%	3,213	0.2%
	Groundwater	2	2	0	2	100.0%				
	Total	**3,356**	**3,213**	**143**	**3,213**	**100.0%**				
Hay	Surface	0	0	0	0	N/A	450,939	1.0%	0	0.0%
	Groundwater	0	0	0	0	N/A				
	Total	**0**	**0**	**0**	**0**	**N/A**				
Total	Surface	4,147,158	3,878,696	268,461	2,104,243	53.6%	**46,055,435**	**100.0%**	**2,104,563**	**100.0%**
	Groundwater	647	647	0	321	49.6%				
	Total	**4,147,805**	**3,879,343**	**268,461**	**2,104,563**	**53.5%**				

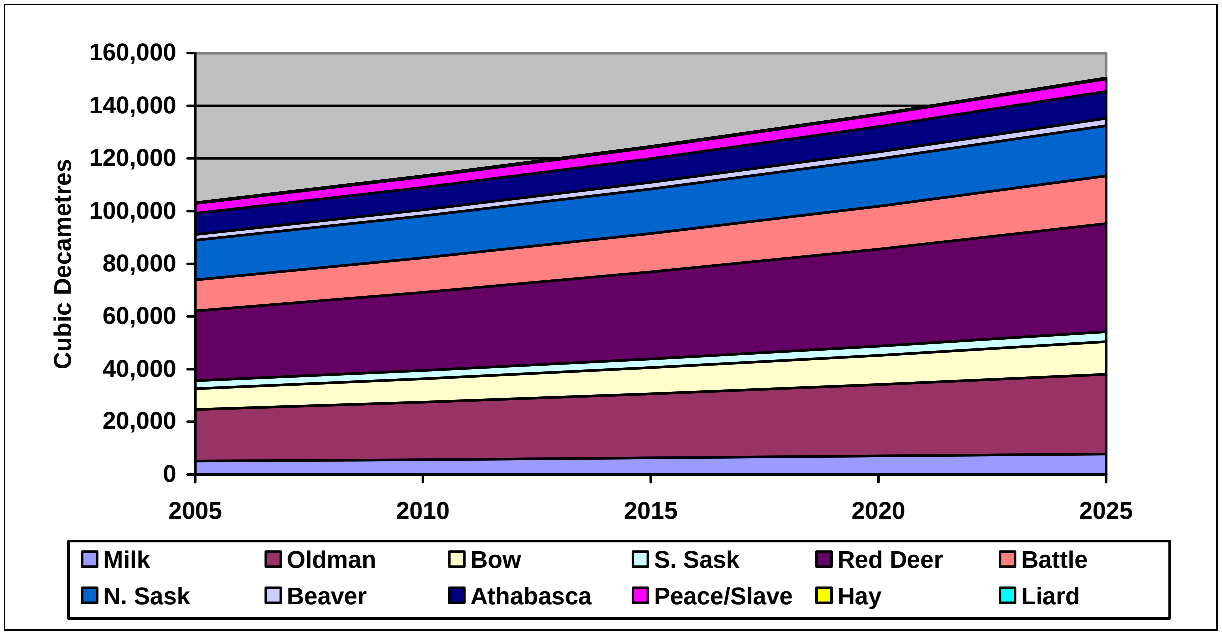
Figure 15-7 Agricultural Allocations, Licensed use and Actual Use, Alberta



15.2.4 Water Use Forecasts

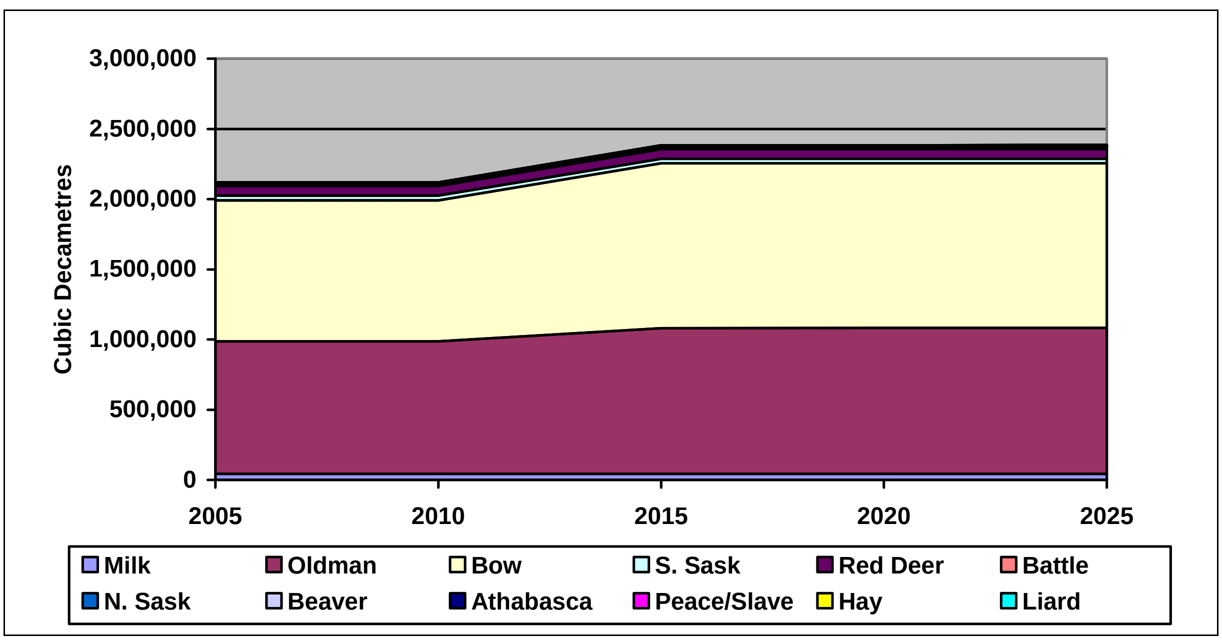
Forecasts of future water use for stockwatering were based on estimated increases in cattle populations in each river basin. Based on assessments completed by AAFRD (Section 2.3), the potential for the development of intensive cattle operations varies among river basins, based on differences in landscape, silage supplies and water availability. The potential for increased livestock population was also assessed based on the number of applications to the NRCB for intensive livestock development. Based on this information, it was estimated that livestock populations and water demand will increase annually at rates of between 0.5 percent and 2.2 percent per year. The higher rate represents the annual average increase in cattle population in Alberta between 1958 and 2005. Water use forecast for stockwatering under the Medium Growth Scenario is shown in Figure 15-8. Under this scenario, livestock water use in 2025 is projected be 150,488 dam^3, which represents an increase of 46 percent from 2005 and coincides with current allocations. The forecast assumes that the current distribution of groundwater (36 percent) and surface water (64 percent) will remain the same over the forecast period. Livestock populations in four basins (the Red Deer, Oldman, North Saskatchewan and Battle) are expected to account for 72 percent of livestock water use by 2025, which is a slight increase from 2005.

Figure 15-8 Projected Water Use for Stockwatering to 2025 in Alberta



Future water demand for irrigation water use is related to demand for forage, specialty and cereal crop production. With the expansion of livestock populations and increasing demands for forage, water use for irrigation is expected to increase, especially for private irrigators. However, the irrigation districts will continue to be the major water users. Projected water use forecast for crop watering under Medium Base Growth Scenario is shown in Figure 15-9.

Figure 15-9 Projected Water Use for Irrigation and Crop Watering to 2025 in Alberta



This forecast assumes that irrigated acres in the districts will expand to the limit specified by the *1991 South Saskatchewan Basin Water Allocation Regulation* and, with improved crop and farm water management, water use is expected to be 2.2 million dam^3 by 2025. This use is equivalent to 96 percent of their current licensed entitlements. Private and district irrigation water use combined is expected to be 2.3 million dam^3 by 2025; this is a 13 percent increase over water use in 2005. Irrigation in the Bow and the Oldman river basins will continue to account for the majority of water use for irrigation and crop watering.

15.3 COMMERCIAL SECTOR

A total 1,430 licences have been issued for commercial purposes and they allow diversions of up to 88,627 dam^3 of water. These allocations account for less than one percent of total water allocation in Alberta.

15.3.1 Water Allocations

Water allocations for the commercial sector include a variety of activities. As shown in Figure 15-10 the most important activities in terms of water allocations include parks and recreation (33 percent of allocations), golf courses (23 percent), food processing (19 percent), and aggregate washing (11 percent). Allocations for these purposes together account for 86 percent of commercial allocations.

Figure 15-10 Water Allocation by Volume for Commercial Sector Activities in Alberta

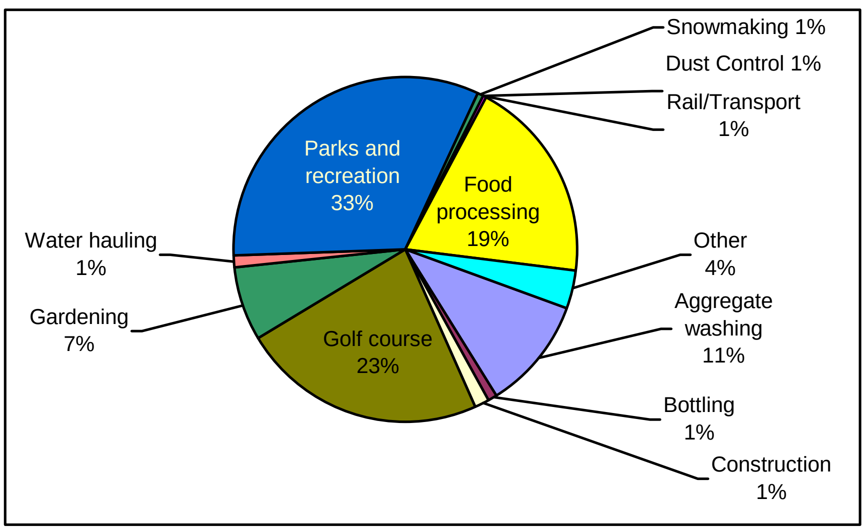
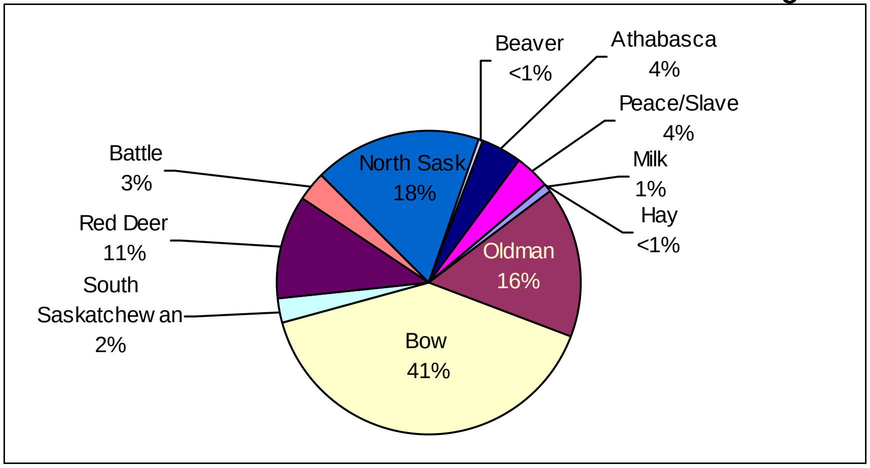


Figure 15-11 shows how commercial water allocations are distributed among the river basins. Three basins account for 75 percent of total commercial allocations. These include the Bow River Basin (which accounts for 41 percent of commercial allocations), the North Saskatchewan River Basin (18 percent) and the Oldman River Basin (16 percent).

Figure 15-11 Distribution of Commercial Water Allocation Among River Basins



Most allocations of water for commercial purposes (83 percent) are for surface water. There are 856 surface water licences that allow diversions of up to 73,168 dam^3. Groundwater accounts for 17 percent (15,458 dam^3) of allocations for commercial purposes. Table 15-5 provides a summary of water licences issued for commercial purposes for each of the basins, while Table 15-6 shows the licence information for individual commercial activities.

15.3.2 Licensed Water Use

Under the terms of licences issued for commercial purposes, 75 percent of withdrawals are expected to be used and the remainder to be returned. The return flow allowances (25 percent) are nearly identical for surface and groundwater licences. However, return flow allowances are generally much higher for commercial allocations in the southern basins than in the northern basins. Return flow allowances are less than two percent of allocations for commercial licences issued in the Beaver, Hay, Milk, Peace/Slave, Athabasca, and Battle river basins. Return flow allowances exceed 20 percent for the other basins (North Saskatchewan, Oldman, South Saskatchewan and Bow, and are 33 percent for commercial licences in the Red Deer basin.

15.3.3 Actual Water Use

None of the commercial operations with water licences reported their actual water use in 2005. Thus, for purposes of estimating total water use in Alberta, it was assumed that commercial licensees were withdrawing and using their full entitlements. While this assumption may overstate actual water use in Alberta, the error will be relatively small because allocations to this sector account for less than one percent of total allocations. Table 15-5 shows that estimated water use by the commercial sector amounted to 66,736 dam^3. Because of the regional differences in return flow requirements, the distribution of actual commercial water use among river basins is slightly different than the distribution of commercial allocations. As shown in Figure 15-12, the Bow River Basin accounts for a smaller percentage of actual water use. Overall, actual water use by the commercial sector is estimated to be 75 percent of total allocations.

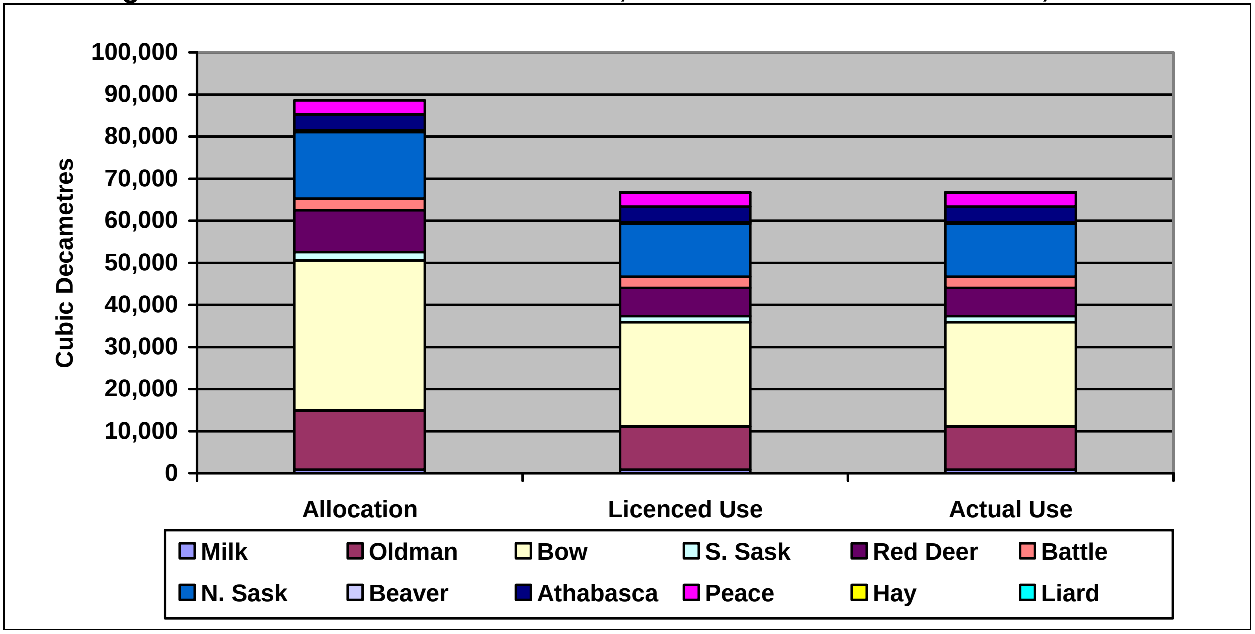
Table 15-5 Water Allocation and Use for the Commercial Sector by River Basin in Alberta

Basins	Water Type	Licensed Allocation and Use (dam^3)			Estimated Actual Use (dam^3)	Licence Utilization	Percent of Alberta Use
		Allocation	Licensed use	Return Flow			
Milk	Surface	775	775	0	775	100.0%	**1.2%**
	Groundwater	35	35	0	35	100.0%	
	Total	**809**	**809**	**0**	**809**	**100.0%**	
Oldman	Surface	13,463	9,705	3,758	9,705	100.0%	**15.5%**
	Groundwater	631	626	5	626	100.0%	
	Total	**14,094**	**10,330**	**3,764**	**10,330**	**100.0%**	
Bow	Surface	26,249	19,092	7,157	19,092	100.0%	**37.1%**
	Groundwater	9,399	5,650	3,748	5,650	100.0%	
	Total	**35,648**	**24,742**	**10,906**	**24,742**	**100.0%**	
South Saskatchewan	Surface	1,916	1,389	527	1,389	100.0%	**2.2%**
	Groundwater	119	62	56	62	100.0%	
	Total	**2,034**	**1,451**	**583**	**1,451**	**100.0%**	
Red Deer	Surface	8,696	5,469	3,227	5,469	100.0%	**10.0%**
	Groundwater	1,251	1,222	30	1,222	100.0%	
	Total	**9,948**	**6,691**	**3,256**	**6,691**	**100.0%**	
Battle	Surface	1,625	1,575	49	1,575	100.0%	**4.0%**
	Groundwater	1,104	1,098	6	1,098	100.0%	
	Total	**2,729**	**2,674**	**55**	**2,674**	**100.0%**	
North Saskatchewan.	Surface	14,354	11,084	3,270	11,084	100.0%	**18.8%**
	Groundwater	1,480	1,480	0	1,480	100.0%	
	Total	**15,834**	**12,563**	**3,270**	**12,563**	**100.0%**	
Beaver	Surface	294	294	0	294	100.0%	**0.5%**
	Groundwater	28	28	0	28	100.0%	
	Total	**323**	**323**	**0**	**323**	**100.0%**	
Athabasca	Surface	2,771	2,736	35	2,736	100.0%	**5.6%**
	Groundwater	1,031	1,014	17	1,014	100.0%	
	Total	**3,801**	**3,749**	**52**	**3,749**	**100.0%**	
Peace/Slave	Surface	3,006	3,006	0	3,006	100.0%	**5.1%**
	Groundwater	377	372	5	372	100.0%	
	Total	**3,383**	**3,378**	**5**	**3,378**	**100.0%**	
Hay	Surface	20	20	0	20	100.0%	**0.0%**
	Groundwater	5	5	0	5	100.0%	
	Total	**25**	**25**	**0**	**25**	**100.0%**	
Total	Surface	73,168	55,145	18,024	55,145	100.0%	**100.0%**
	Groundwater	15,458	11,591	3,867	11,591	100.0%	
	Total	**88,627**	**66,736**	**21,891**	**66,736**	**100.0%**	

Table 15-6 Water Allocation and Use for the Commercial Sector by Activity in Alberta

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Use (dam^3)	Licence Utilization	Percent of Sector
			Allocation	Water Use	Return			
Aggregate Washing	Surface	78	8,040	5,286	2,754	5,286	100.0%	7.9%
	Groundwater	41	1,295	1,249	46	1,249	100.0%	1.9%
	Total	**119**	**9,335**	**6,535**	**2,800**	**6,535**	**100.0%**	**9.8%**
Bottling	Surface	18	341	341	0	341	100.0%	0.5%
	Groundwater	27	398	391	7	391	100.0%	0.6%
	Total	**45**	**739**	**732**	**7**	**732**	**100.0%**	**1.1%**
Construction	Surface	14	1,198	819	379	819	100.0%	1.2%
	Groundwater	11	202	202	0	202	100.0%	0.3%
	Total	**25**	**1,400**	**1,021**	**379**	**1,021**	**100.0%**	**1.5%**
Dust Control	Surface	182	40	40	0	40	100.0%	0.1%
	Groundwater	1	1	1	0	1	100.0%	0.0%
	Total	**183**	**41**	**41**	**0**	**41**	**100.0%**	**0.1%**
Food Processing	Surface	17	12,663	9,386	3,277	9,386	100.0%	14.0%
	Groundwater	29	3,058	3,057	1	3,057	100.0%	4.6%
	Total	**46**	**15,722**	**12,443**	**3,278**	**12,443**	**100.0%**	**18.6%**
Gardening	Surface	107	5,822	5,822	0	5,822	100.0%	8.7%
	Groundwater	69	258	258	0	258	100.0%	0.4%
	Total	**176**	**6,080**	**6,080**	**0**	**6,080**	**100.0%**	**9.1%**
Golf Courses	Surface	194	18,169	16,913	1,256	16,913	100.0%	25.3%
	Groundwater	70	2,477	2,477	0	2,477	100.0%	3.7%
	Total	**264**	**20,646**	**19,390**	**1,256**	**19,390**	**100.0%**	**29.0%**
Parks and Recreation	Surface	187	22,940	13,194	9,746	13,194	100.0%	19.7%
	Groundwater	227	5,779	2,259	3,520	2,259	100.0%	3.4%
	Total	**414**	**28,719**	**15,453**	**13,266**	**15,453**	**100.0%**	**23.1%**
Rail/Transport	Surface	2	189	189	0	189	100.0%	0.3%
	Groundwater	9	194	83	112	83	100.0%	0.1%
	Total	**11**	**383**	**272**	**112**	**272**	**100.0%**	**0.4%**
Snow Making	Surface	6	289	289	1	289	100.0%	0.4%
	Groundwater	1	10	10	0	10	100.0%	0.0%
	Total	**7**	**299**	**299**	**1**	**299**	**100.0%**	**0.4%**
Water Hauling	Surface	0	0	0	0	0	N/A	N/A
	Groundwater	29	1,070	1,070	0	1,070	100.0%	1.6%
	Total	**29**	**1,070**	**1,070**	**0**	**1,070**	**100.0%**	**1.6%**
Other	Surface	52	3,618	3,006	612	3,006	100.0%	4.5%
	Groundwater	57	707	525	182	525	100.0%	0.8%
	Total	**109**	**4,325**	**3,531**	**794**	**3,531**	**100.0%**	**5.3%**
Total	Surface	857	73,308	55,284	18,024	55,284	100.0%	82.7%
	Groundwater	571	15,450	11,582	3,867	11,582	100.0%	17.3%
	Total	**1,428**	**88,758**	**66,867**	**21,891**	**66,867**	**100.0%**	**100.0%**

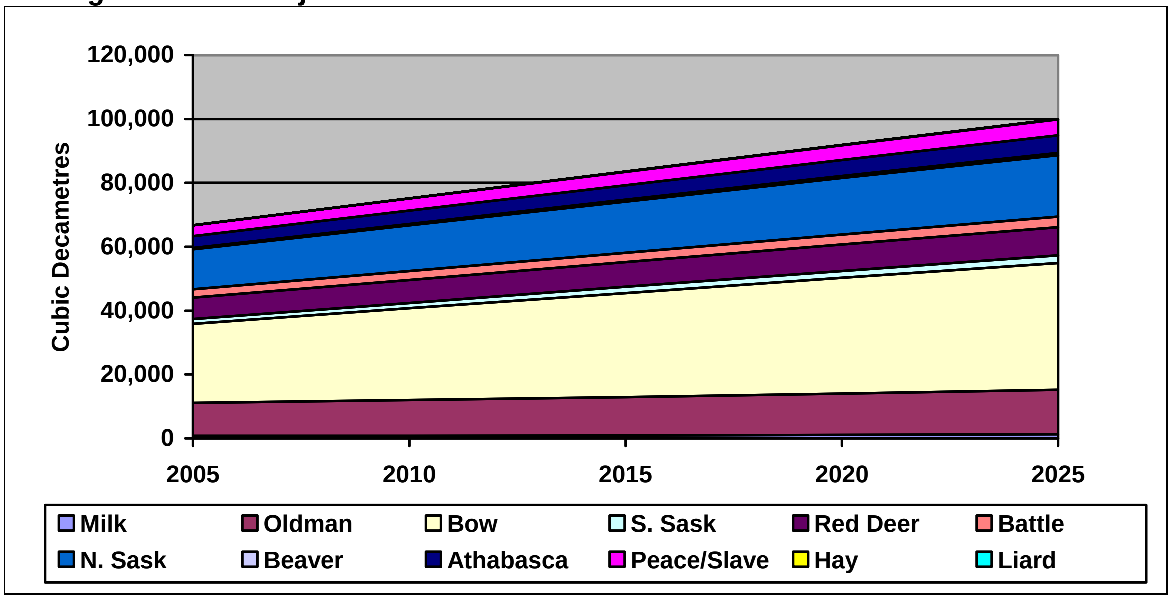
Figure 15-12 Commercial Allocations, Licensed use and Actual Use, Alberta



15.3.4 Forecasts of Future Water Use

The assumptions used to forecast future water use by the commercial sector are different for each basin and reflect the mix of commercial activities in each basin. For some activities, such as golf courses and parks and recreation, the forecasts are tied to population growth rates. For other sectors, such as food processing and aggregate washing, projections are based on expected economic growth rates, which tend to be slightly higher than population growth. Annual growth in water use by the commercial sector is predicted to range from 0 to 3.2 percent per year. However, even at the highest rate of growth, the resulting increases in water use by the commercial sector will not appreciably affect water use in Alberta because the commercial sector currently accounts for less than one percent of total allocation. Future water use forecast for the commercial sector under Medium Growth scenario is shown in Figure 15-13. By 2025 water use is expected to be 99,968 dam^3; this is an increase of 50 percent over current licensed use and exceeds existing allocations by about 10,000 dam^3. This forecast assumes that current distribution of ground and surface water allocations would be the same over the forecast period. The Bow, Oldman and North Saskatchewan River basins are expected to continue to account for the majority of water use for the commercial sector in Alberta.

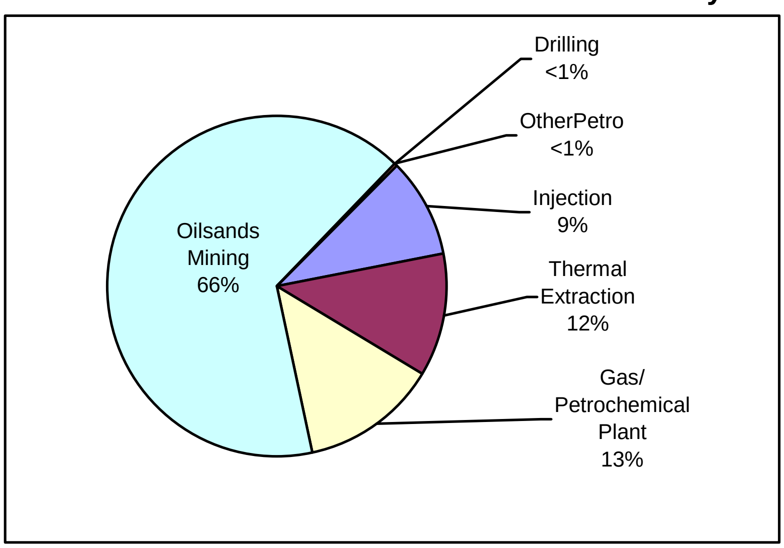
Figure 15-13 Projected Water Use for Commercial Sector to 2025 in Alberta



15.4 PETROLEUM SECTOR

In 2005, water licences issued to the petroleum sector in Alberta allow up to 780,106 dam^3 to be withdrawn for use. This sector accounts for eight percent of total water allocations in the province. The majority of allocations for the petroleum industry (87 percent) are for surface water. The petroleum sector includes water allocations for oilfield injection, thermal extraction, oilsands mining, gas and petrochemical plants, drilling, and various other activities. As shown in Figure 15-14, the majority of allocations are for oilsands mining (66 percent).

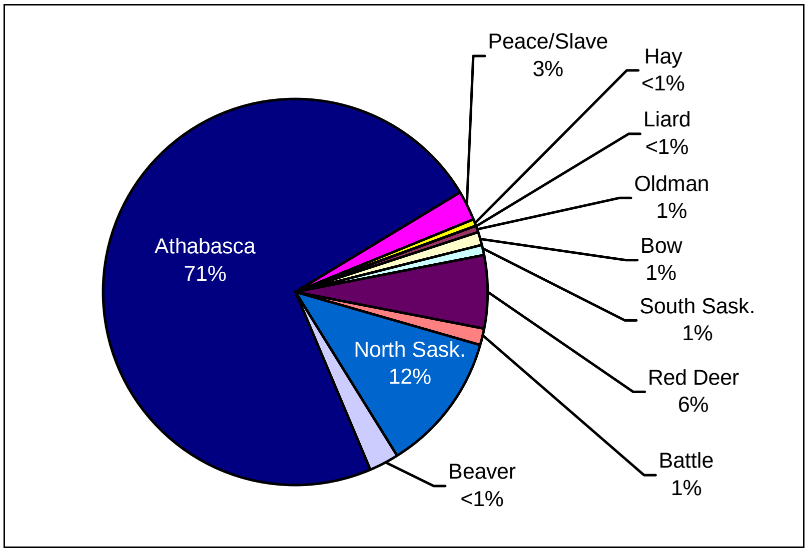
Figure 15-14 Petroleum Water Allocations in Alberta by Activity



15.4.1 Water Allocations

Figure 15-15 shows how water allocations for the petroleum sector are distributed among the various basins. It shows that 71 percent of water allocations for the petroleum sector are in the Athabasca where all oilsands mining is located. Other basins where large amounts of water have been allocated to the petroleum sector include the North Saskatchewan River Basin (12 percent) and the Red Deer River Basin (six percent). Relatively small amounts of water have also been allocated to the petroleum sector in the Bow, Battle, Hay, Oldman, South Saskatchewan, Beaver, Liard and Peace/Slave basins.

Figure 15-15 Petroleum Water Allocation in Alberta by Basin



Most allocations of water to the petroleum sector (87 percent) are for surface water. There are 270 surface water licences that allow diversions of up to 801,620 dam^3. Groundwater accounts for 13 percent (100,214 dam^3) of allocations. Table 15-7 provides a summary of water licences issued to the petroleum sector for each of the basins. Table 15-8 shows the water licence information for each of the activities within the sector.

15.4.2 Licensed Water Use

Under the terms of licences issued to the petroleum sector, 92 percent of withdrawals are expected to be used. The remainder is to be returned. Return flow allowances range from 8.8 percent of surface diversions to 0.2 percent for groundwater withdrawals. The return flow allowances are generally consistent among the river basins, but vary slightly according to the activity. Return flow allowances were one percent for water used for oilfield injection, six percent of water used for thermal extraction, seven percent for oilsands mining and 17 percent for gas/petrochemical plants. The difference between allocations and licensed water use is shown in Figure 15-16.

Table 15-7 Water Allocation and Use for the Petroleum Sector by River Basin in Alberta

Basin	Water Type	Licensed Allocation and Use (dam^3)			Estimated Use (dam^3)	Licence Utilization	Percent of Alberta Use
		Allocation	Licensed use	Return Flow			
Milk	Surface	0	0	0	0	0.0%	0.0%
	Groundwater	0	0	0	17	0.0%	0.0%
	Total	**0**	**0**	**0**	**17**	**0.0%**	**0.0%**
Oldman	Surface	4,267	3,527	740	822	19.3%	0.3%
	Groundwater	3	3	0	171	5700.0%	0.1%
	Total	**4,270**	**3,530**	**740**	**993**	**23.3%**	**0.3%**
Bow	Surface	9,414	9,290	123	1,245	13.2%	0.4%
	Groundwater	142	142	0	164	107.0%	0.0%
	Total	**9,556**	**9,432**	**123**	**1,409**	**14.6%**	**0.4%**
South Saskatchewan	Surface	6,869	6,097	772	4271	62.2%	1.3%
	Groundwater	11	11	0	172	1563.6%	0.1%
	Total	**6,880**	**6,108**	**772**	**4,443**	**64.6%**	**1.4%**
Red Deer	Surface	46,240	41,876	4,364	18,158	39.3%	5.6%
	Groundwater	2,781	2,781	0	3,159	113.6%	1.0%
	Total	**49,021**	**44,657**	**4,364**	**21,317**	**43.5%**	**6.5%**
Battle	Surface	7,378	7,237	141	475	6.4%	0.1%
	Groundwater	2,711	2,711	0	340	12.5%	0.1%
	Total	**10,089**	**9,948**	**141**	**815**	**8.1%**	**0.2%**
North Saskatchewan.	Surface	88,828	77,568	11,260	29,158	32.8%	8.9%
	Groundwater	4,517	4,517	0	1,680	37.2%	0.5%
	Total	**93,345**	**82,084**	**11,260**	**30,838**	**33.0%**	**9.5%**
Beaver	Surface	8,490	8,453	37	3,636	42.8%	1.1%
	Groundwater	12,622	12,622	0	5,547	43.9%	1.7%
	Total	**21,112**	**21,075**	**37**	**9,183**	**43.5%**	**2.8%**
Athabasca	Surface	511,093	470,068	41,026	166,732	32.6%	63.8%
	Groundwater	70,698	70,501	197	16,933	24.0%	6.5%
	Total	**581,792**	**540,569**	**41,223**	**183,664**	**31.6%**	**70.3%**
Peace/Slave	Surface	11,201	10,246	955	5,117	45.7%	1.6%
	Groundwater	9,385	9,385	0	1,798	19.2%	0.6%
	Total	**20,586**	**19,631**	**955**	**6,915**	**33.6%**	**2.1%**
Hay	Surface	4,356	4,356	0	1,348	30.9%	0.4%
	Groundwater	562	562	0	252	44.8%	0.1%
	Total	**4,918**	**4,918**	**0**	**1,600**	**32.5%**	**0.5%**
Liard	Surface	50	50	0		0.0%	0.0%
	Groundwater	0	0	0	80		0.0%
	Total	**50**	**50**	**0**	**80**	**160.0%**	**0.0%**
Total	Surface	698,186	638,768	59,418	230,960	33.1%	88.4%
	Groundwater	103,432	103,235	197	30,301	29.3%	11.6%
	Total	**801,619**	**742,002**	**59,615**	**261,260**	**32.6%**	**100.0%**

Table 15-8 Water Allocation and Use for the Petroleum Sector by Activity in Alberta

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Use (dam^3)	Licence Utilization	Percent of Sector
			Allocation	Water Use	Return			
Injection	Surface	122	67,872	67,370	502	5,578	8.2%	2.1%
	Groundwater	146	8,271	8,271	0	2,480	30.0%	0.9%
	Total	**268**	**76,143**	**75,641**	**502**	**8,058**	**10.6%**	**3.1%**
Thermal	Surface	54	56,443	52,634	3,810	15,403	27.3%	5.9%
	Groundwater	321	37,280	37,280	0	10,464	28.1%	4.0%
	Total	**375**	**93,723**	**89,914**	**3,810**	**25,867**	**27.6%**	**9.9%**
Oilsands Mining	Surface	**22**	471,273	433,065	38,208	158,077	33.5%	60.5%
	Groundwater	**27**	52,418	52,148	0	12,224	23.3%	4.7%
	Total	**49**	**523,691**	**485,483**	**38,208**	**170,301**	**32.5%**	**65.2%**
Gas/Petrochemical Plant	Surface	62	99,509	82,611	16,898	48,815	49.1%	18.7%
	Groundwater	146	5,329	5,132	197	5,011	94.0%	1.9%
	Total	**208**	**104,838**	**87,743**	**17,095**	**53,826**	**51.3%**	**20.6%**
Drilling (developing oil/gas well)	Surface	1	1	1	0	1	100.0%	0.0%
	Groundwater	1	9	9	0	9	100.0%	0.0%
	Total	**2**	**10**	**10**	**0**	**10**	**100.0%**	**0.0%**
Other Petroleum	Surface	10	3,087	3,087	0	3,087	100.0%	1.2%
	Groundwater	20	124	124	0	124	100.0%	0.0%
	Total	**30**	**3,211**	**3,211**	**0**	**3,211**	**100.0%**	**1.2%**
Total	Surface	271	698,185	638,768	59,418	230,961	33.1%	88.4%
	Groundwater	661	103,431	103,234	197	30,301	29.3%	11.6%
	Total	**932**	**801,619**	**742,002**	**59,615**	**261,243**	**32.6%**	**100.0%**

15.4.3 Actual Water Use

Estimates of actual water use for the petroleum sector came from various sources. Water use information for oilfield injection and thermal extraction were based on estimates prepared by Geowa based on EUB data. According to the Geowa report, 8,058 dam^3 of fresh water was diverted for injection purposes in 2005, including 5,578 dam^3 of surface water and 2,480 dam^3 of groundwater, and 25,867 dam^3 of fresh water was diverted for thermal extraction, including 15,403 dam^3 of surface water and 10,464 dam^3 of groundwater. This information suggests that the petroleum sector was only using 27 percent of their entitlement for oilfield injection and 15 percent of their entitlements for thermal extraction.

Detailed estimates of water used for oilsands mining were provided by AENV and indicate that about 173,301 dam^3 of fresh water was diverted for oilsands mining, consisting of 150,877 dam^3 of surface water and 12,224 dam^3 of groundwater. While this suggest that oilsands operators were only using about 33 percent of their entitlements, it should be noted that only three of the six major oilsands projects that have licences were actually operating in 2005. The other three plants have yet to come on-stream. Actual water use by the three plants that were operating amounted to 90 percent of their licensed water use and about 68 percent of the sector's allocations.

Water use information for gas/petrochemical plants was based on information from AENV's WURS database. The database has information for 83 of 208 water licences and these 82 licences account for 61 percent of licensed use. Estimates of water use were developed using the assumption that the water use practices reported by the major gas/petrochemical plants applied to all gas/petrochemical plants. Based on this assumption, the total water use by gas/petrochemical plants in 2005 is estimated to be 53,826 dam^3, consisting of 48,815 dam^3 of surface water and 5,011 dam^3 of groundwater.

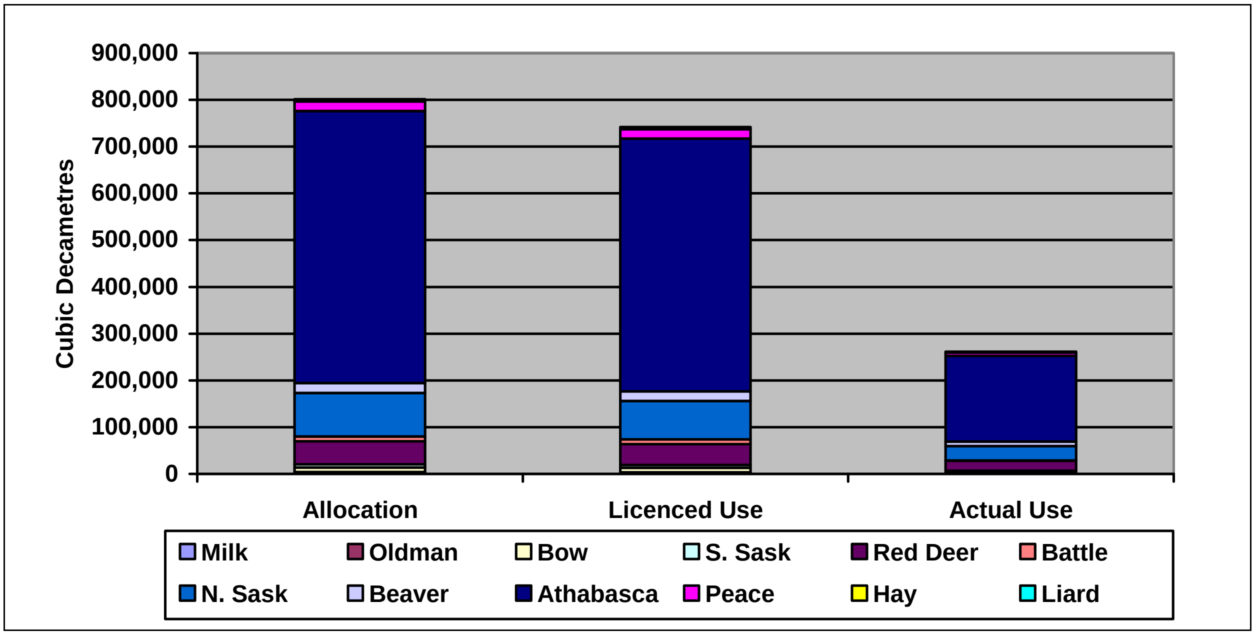
There was no information on water use for drilling or other petroleum activities so it was assumed that these activities were using the full amounts allowed in their licences.

Estimates of water use for each of the river basins are provided in Table 15-7. It shows that activities in the Athabasca River Basin accounted for 70 percent of all water use by the petroleum sector, and this is largely attributable to water use by the oilsands mines. The only other basins where large amounts of water are being used by the petroleum industry include the North Saskatchewan River Basin (12 percent of the provincial total) and the Red Deer River Basin (eight percent).

The data in Table 15-7 suggest that the overall licence utilization rate was only 33 percent but, as noted above, this is largely due to only three of six oilsands mines actually operating in 2005. Outside the Athabasca River Basin, the average utilization was only 38 percent and this reflects very low use of entitlements in the Battle and the Bow where water use for injection has been declining as oilfields age and production drops. It should be noted that estimated use of groundwater in some basins actually exceeded licensed allocations. The reasons for this are

unclear but may reflect differences in how water use data are collected for the oil and gas industry (the location of the well rather than by water licence number). The difference between licensed use and actual use is shown in Figure 15-16.

Figure 15-16 Allocations, Licensed use and Actual Use for the Petroleum Sector, Alberta



15.4.4 Forecasts of Future Water Use

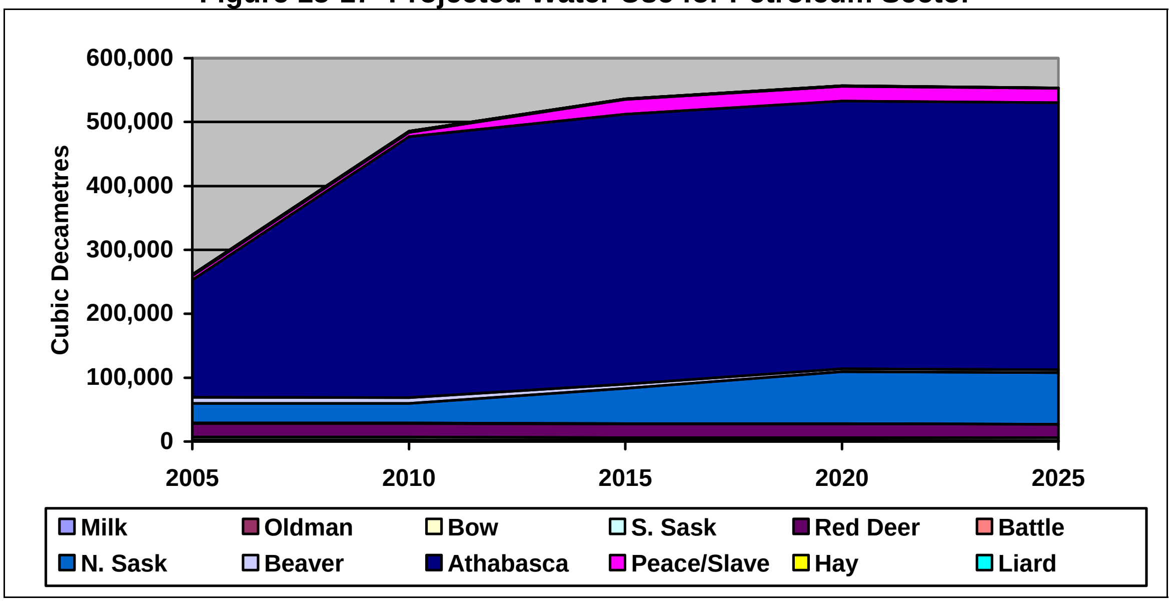
Future water uses for the petroleum sector is expected to rise significantly in the next few years as new oilsands mines start operating and as new upgraders are constructed to process extracted bitumen. Estimates of future water used for the oilsands mines were provided by AENV and suggest that water use will continue to increase until at least 2015 and then decrease slightly. These forecasts include allocations for the proposed Sycrude, Imperial, Deer Creek, and Synenco projects, but do not include any new applications that may be submitted in the future. There are currently plans to construct as many as five new upgraders in the North Saskatchewan basin and at least one in the Athabasca River Basin. Once completed, the six bitumen upgraders will process approximately 1.5 million barrels of heavy oil per day and may require approximately 60,000 dam^3 of water per year.

The amounts of water used for thermal extraction are also expected to increase. Recent forecast from the EUB and CAPP have bitumen production increasing: the EUB forecasts that in situ crude bitumen production (thermal) in 2015 will be 140 percent higher than in 2005. Water use for thermal extraction is expected to follow a similar pattern. On the other hand, with conventional crude oil production declining as existing fields mature and there are fewer new finds, water use for injection purposes will decline. The most recent forecast from the EUB and CAPP have oil production decreasing by between 30 and 38 percent between 2005 and 2015,

and a further decline of about 23 percent by 2020, and it is expected that water use will decline by the same amount.

Estimates of future water use by the petroleum sector in Alberta are shown in Figure 15-17. It shows the projections under the Medium Growth scenario, and suggests the overall demand for water in the Alberta will more than double over the period until 2015 and then remains fairly constant thereafter. Estimated water use in 2015 is estimated to be 536,457 dam^3. Figure 15-17 shows that most of the increase will be in the Athabasca River Basin as a result of future oilsands mines. However, it also shows that there will be a small increase in the North Saskatchewan River Basin due to development of bitumen upgraders.

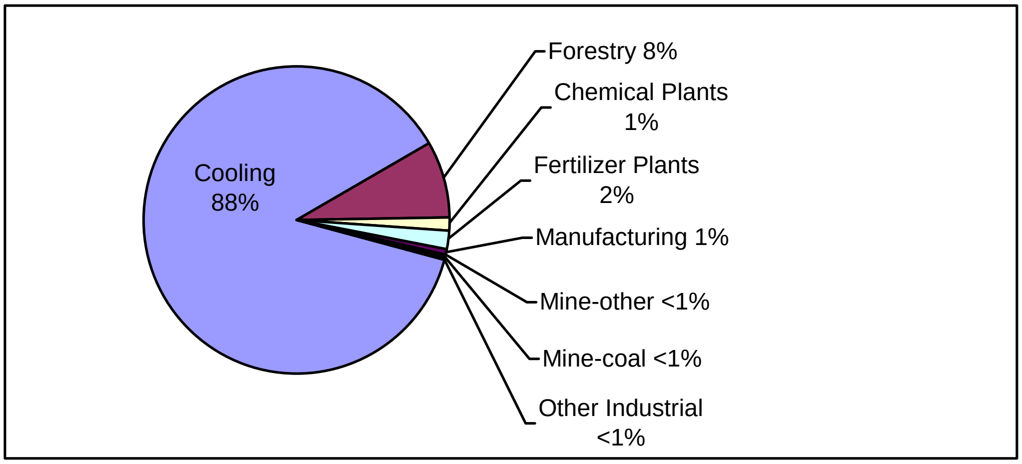
Figure 15-17 Projected Water Use for Petroleum Sector



15.5 INDUSTRIAL SECTOR

Industrial water licences account for 28 percent of the provincial water allocations. In Alberta, 215 water licences have been issued for industrial use and these allow withdrawals of up to 2,664,746 dam^3. Just over half of all water allocations for the industrial sector (52 percent) are for surface water (2,654,284 dam^3). As shown in Figure 15-18, the industrial sector includes water allocations for cooling, forestry, chemical plants, fertilizer plants, manufacturing, mining other than coal, coal mining, hydroelectricity, and other industrial activities. It shows that 88 percent of allocations are for cooling (power plants), and eight percent of allocations are to the forestry industry. Allocations for all other industrial sectors each account for two percent or less of industrial allocations.

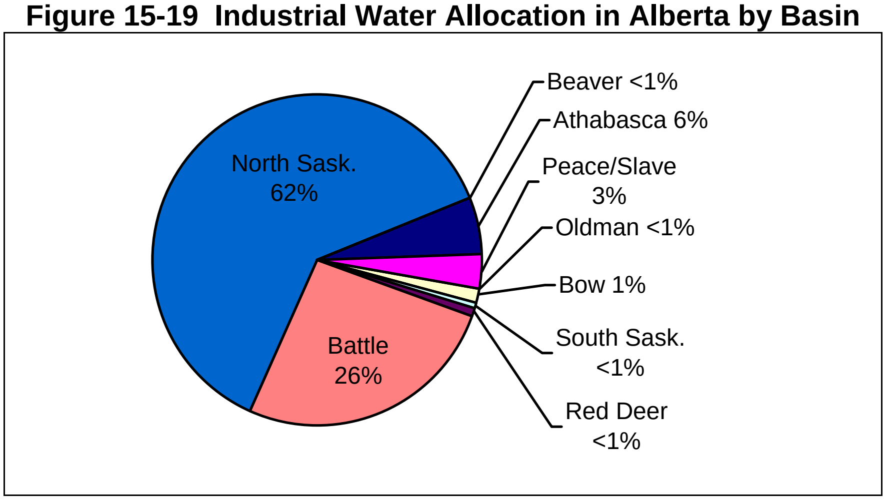
Figure 15-18 Industrial Water Allocations in Alberta by Activity



15.5.1 Water Allocations

As illustrated in Figure 15-19, most of the water allocations for the industrial sector are in the North Saskatchewan River Basin (62 percent) or the Battle River Basin (26 percent). Another six percent of allocations are for the Athabasca River Basin. Small amounts of water have been issued for industrial purposes in the Peace/Slave, South Saskatchewan, Bow, and Red Deer river basins. No industrial water licences have been issued for the Hay, Liard, or Milk River basins. Details of the industrial licences for each of the river basins are provided in Table 15-9.

Figure 15-19 Industrial Water Allocation in Alberta by Basin



The table shows that 88 percent of the allocations are for cooling purposes for thermal power generation or cooling such as air conditioning and that nearly 77 percent of this is for surface water. The majority of these thermal power plants are in the North Saskatchewan River Basin, but there are also plants in the Battle and Athabasca river basins. Another eight percent of allocations are for the forestry industry, specifically the pulp mills in the Athabasca and Peace/Slave basins, and more than 99 percent of these allocations are for surface water.

Table 15-9 Water Allocation and Use for the Industrial Sector by River Basin in Alberta

Basins	Water Type	Licensed Allocation and Use (dam^3)			Estimated Use (dam^3)	Licence Utilization	Percent of Alberta Use
		Allocation	Licensed use	Return Flow			
Milk	Surface	0	0	0	0		0.0%
	Groundwater	0	0	0	0		0.0%
	Total	**0**	**0**	**0**	**0**	**!**	**0.0%**
Oldman	Surface	0	0	0	0		0.0%
	Groundwater	11	11	0	11	100.0%	0.0%
	Total	**11**	**11**	**0**	**11**	**100.0%**	**0.0%**
Bow	Surface	30,312	20,230	10,082	20,230	100.0%	11.0%
	Groundwater	3,788	695	3,093	695	100.0%	0.4%
	Total	**34,100**	**20,925**	**13,175**	**20,925**	**100.0%**	**11.3%**
South Saskatchewan	Surface	18,894	17,167	1,727	17,167	100.0%	9.3%
	Groundwater	909	182	727	182	100.0%	0.1%
	Total	**19,803**	**17,349**	**2,454**	**17,349**	**100.0%**	**9.3%**
Red Deer	Surface	22,210	13,823	8,388	13,823	100.0%	7.6%
	Groundwater	105	70	35	70	100.0%	0.0%
	Total	**22,315**	**13,893**	**8,422**	**13,893**	**100.0%**	**7.5%**
Battle	Surface	691,860	13,864	677,996	7,706	55.6%	4.2%
	Groundwater	26	26	0	26	100.0%	0.0%
	Total	**691,886**	**13,890**	**677,996**	**7,732**	**55.7%**	**4.2%**
North Saskatchewan.	Surface	1,659,880	206,980	1,452,901	92,744	44.2%	49.5%
	Groundwater	694	614	80	614	100.0%	0.3%
	Total	**1,660,575**	**207,594**	**1,452,981**	**93,358**	**45.0%**	**50.2%**
Beaver	Surface	0	0	0	0		0.0%
	Groundwater	3	3	0	3	100.0%	0.0%
	Total	**3**	**3**	**0**	**3**	**100.0%**	**0.0%**
Athabasca	Surface	140,699	22,288	118,411	20,838	93.5%	11.3%
	Groundwater	4,665	1,729	2,937	1,729	100.0%	0.9%
	Total	**145,364**	**24,017**	**121,348**	**22,567**	**94.0%**	**12.1%**
Peace/Slave	Surface	90,429	20,633	69,796	9,787	47.4%	5.3%
	Groundwater	261	163	99	163	100.0%	0.1%
	Total	**90,690**	**20,796**	**69,895**	**9,950**	**47.8%**	**5.4%**
Hay	Surface	0	0	0	0		0.0%
	Groundwater	0	0	0	0		0.0%
	Total	**0**	**0**	**0**	**0**		**0.0%**
Total	Surface	2,654,284	314,984	2,339,300	182,294	57.5%	98.1%
	Groundwater	10,462	3,494	6,971	3,494	100.0%	1.9%
	Total	**2,664,747**	**318,478**	**2,346,271**	**185,788**	**58.3%**	**100.0%**

Table 15-10 Water Allocation and Use for the Industrial Sector by Activity in Alberta

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Use (dam^3)	Licence Utilization	Percent of Sector
			Allocation	Licensed Water Use	Return			
Cooling	Surface	36	2,322,617	199,104	2,123,513	95,656	48.0%	52.5%
	Groundwater	11	2,191	50	2,141	50	100.0%	1.4%
	Total	**47**	**2,324,808**	**199,154**	**2,125,654**	**95,706**	**48.1%**	**51.5%**
Forestry	Surface	9	213,441	25,291	188,150	19,902	78.7%	10.9%
	Groundwater	15	607	517	90	517	100.0%	14.8%
	Total	**24**	**214,048**	**25,809**	**188,239**	**20,419**	**79.1%**	**11.0%**
Chemical Plants	Surface	9	39,634	30,322	9,312	12,910	42.6%	7.1%
	Groundwater	5	67	67	0	67	100.0%	1.9%
	Total	**14**	**39,701**	**30,389**	**9,312**	**12,977**	**42.7%**	**7.0%**
Fertilizer Plants	Surface	11	52,973	48,102	4,871	43,198	89.8%	23.7%
	Groundwater	8	223	189	35	189	100.0%	5.4%
	Total	**19**	**53,196**	**48,291**	**4,905**	**43,387**	**89.8%**	**23.4%**
Manufacturing	Surface	5	12,236	1,401	10,835	1,401	100.0%	0.8%
	Groundwater	18	1,257	529	727	529	100.0%	15.2%
	Total	**23**	**13,493**	**1,931**	**11,562**	**1,931**	**100.0%**	**1.0%**
Mine-other	Surface	7	9,225	6,604	2,621	1,207	18.3%	13.1%
	Groundwater	12	439	439	0	439	100.0%	100.0%
	Total	**19**	**9,664**	**7,043**	**2,621**	1,646	23.4%	17.0%
Mine-coal	Surface	14	3,560	3,560	0	3,560	100.0%	2.0%
	Groundwater	18	4,140	1,195	2,946	1,195	100.0%	34.2%
	Total	**32**	**7,700**	**4,755**	**2,946**	**4,755**	**100.0%**	**2.6%**
Hydro	Surface	7	0	0	0	0	100.0%	0.0%
	Groundwater	0	0	0	0	0		
	Total	**7**	**0**	**0**	**0**	**0**	**100.0%**	**0.0%**
Other Industrial	Surface	8	599	599	0	599	100.0%	0.3%
	Groundwater	22	1,537	505	1,032	505	100.0%	14.5%
	Total	**30**	**2,136**	**1,104**	**1,032**	**1,104**	**100.0%**	**0.6%**
Total	Surface	106	2,654,284	314,983	2,339,301	182,294	56.6%	6.7%
	Groundwater	109	10,462	3,492	6,970	3,492	100.0%	33.4%
	Total	**215**	**2,664,746**	**318,475**	**2,346,271**	**185,786**	**57.1%**	**6.8%**

The other five percent of industrial allocations are for chemical and fertilizer plants, manufacturing, mining and hydroelectric power generation. About 96 percent of these allocations are for surface water.

15.5.2 Licensed Water Use

Water licences issued for industrial purposes include allowances for up to 318,475 dam^3 of water to be lost or consumed. Allowances for return flow account for the vast majority of withdrawals (2,346,271 dam^3 or 88 percent). Return flow allowances are highest for the cooling sector. Although power plants are licensed for very large amounts of water, most of the water should be returned to the watershed: 91 percent of surface water allocations and 98 percent of groundwater allocations are to be returned. Licences issued for forestry also have high return flows allowances: 88 percent for surface water licences and 85 percent for groundwater.

Most other industrial activities, for example, chemical plants are assumed to use all of their groundwater licences and 77 percent of surface water diversions. Similarly, licences issued to fertilizer plants assume that 84 percent of groundwater withdrawals and 91 percent of surface water allocations to be consumed. Licences issued to manufacturing are based on the expectation that 88 percent of surface water diversions and 42 percent of groundwater will be consumed. Overall, licences issued for these other industrial activities have return flow allocations of 23 percent for surface water and 62 percent for groundwater. The difference between industrial allocations and licensed water use is shown in Figure 15-20.

15.5.3 Actual Water Use

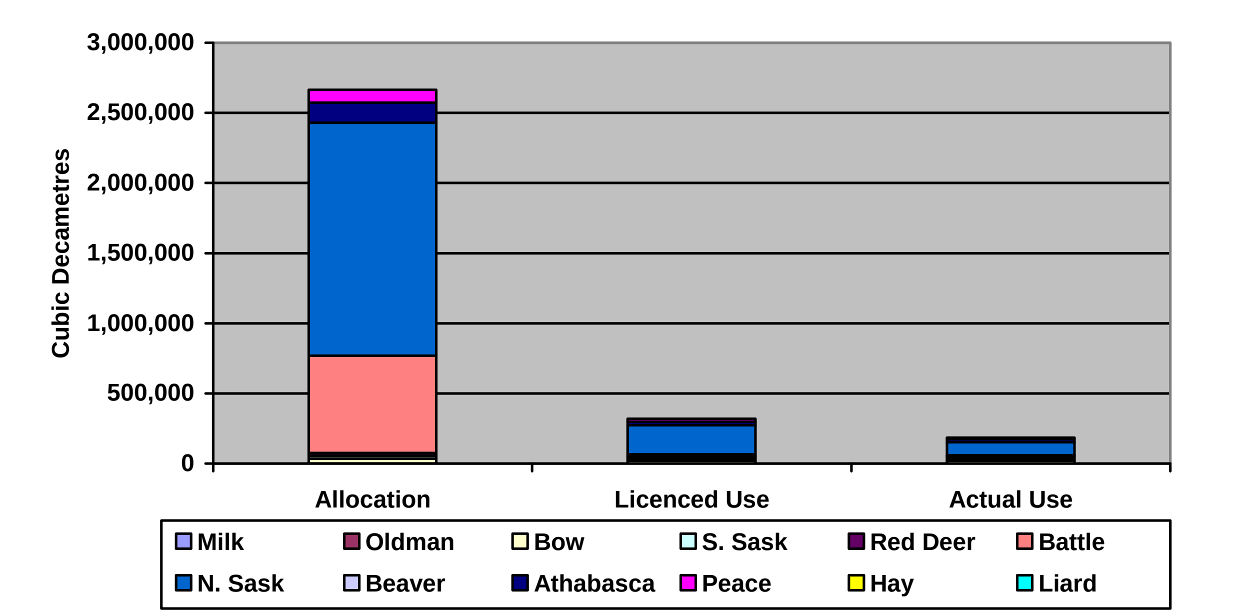
Information on actual water use came from a variety of sources. Estimates of water used for thermal power plants were taken from AENV’s WURS database which includes information for 24 of 47 water licences. The licensees who reported accounted for 99 percent of the licensed water use, and they reported using an average of 42 percent of the water that they are allowed to consume. The WURS database also had water use information for five of nine licences issued for chemical plants, 13 of 19 licences for fertilizer plants, and five of the seven surface water licences issued for mining other than coal. Available information showed that chemical plants with surface water allocations were using an average of 18 percent of their licensed water use, fertilizer plants used an average of 44 percent of the amounts allowed in licences surface water entitlements, and mines other than coal reported using 18 percent of their licensed use.

Water use for the forestry sector was based on WURS data as well as information provided by the AFPA for 2004 for pulp mills. The mills reported actually using 92 percent of their licence entitlements. The WURS database did not include enough information on actual water use by industries using groundwater or for other industries that used surface water. For these uses, it was assumed that licensees were using the full amounts of water that they were licensed to use.

Based on the available information and the assumptions noted above, it is estimated that actual industrial water amounted to 185,786 dam^3, including 182,294 dam^3 of surface water and 3,492 dam^3 of groundwater. Actual water use amounted to 57 percent of licensed use.

For the Oldman, Bow, South Saskatchewan, Red Deer and Beaver River basins, industrial water users were assumed to be using the amounts of water allowed in their licences, minus any allowances for return flows, because there was no actual water use for industries in this basin. For the other basins where actual water use was reported for the major industrial activities, licence utilization rates were typically in the range of 44 percent (North Saskatchewan River Basin) to 56 percent (Battle River Basin), although industrial activities in the Athabasca River Basin reported using about 94 percent of their licence entitlements.

Figure 15-20 Allocations, Licensed use and Actual Use for the Industrial Sector, Alberta



15.5.4 Forecasts of Future Water Use

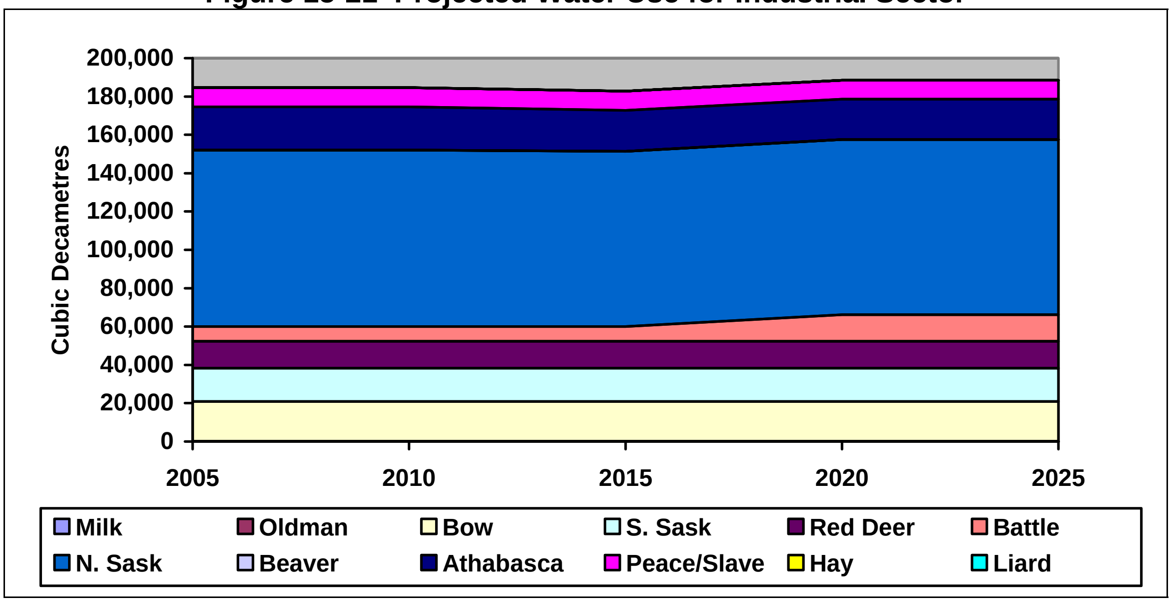
Over the next 20 years the water demand for cooling activity is expected to increase slightly as water use by two new plants in the Red Deer and Bow river basins will offset reduced water use resulting from the retirement of one plant (Wabamun) and renovations of existing plants that will improve water use efficiency (Clover Bar, Sundance, and Keephills). Estimates of water use for cooling were based on discussions with companies and power demand forecasts provided by the Alberta Electric System Operator which suggests that power production will increase by 3280 MW between 2005 and 2015, and by 3100 MW between 2015 and 2025.

For the forestry sector it is expected that water use will decrease over time due to improved operating efficiencies. Very little information is available for all other industrial activities, so it

assumed that water use by chemical plants, fertilizer plants, mining, and manufacturing will remain constant over the period to 2025.

Estimates of future water use by the industrial sector in Alberta under the Medium Growth scenario are shown in Figure 15-21. Under this scenario, industrial water use is expected to remain relatively constant over time with the improved operating efficiencies in the forest industry offsetting increased water use for thermal power production. Estimated water use in 2025 is estimated to be 188,502 dam^3; this is a two percent increase over current use. Figure 15-21 shows that most of the increase will be in the Battle River Basin while water use in the Athabasca River Basin is expected to decline slightly.

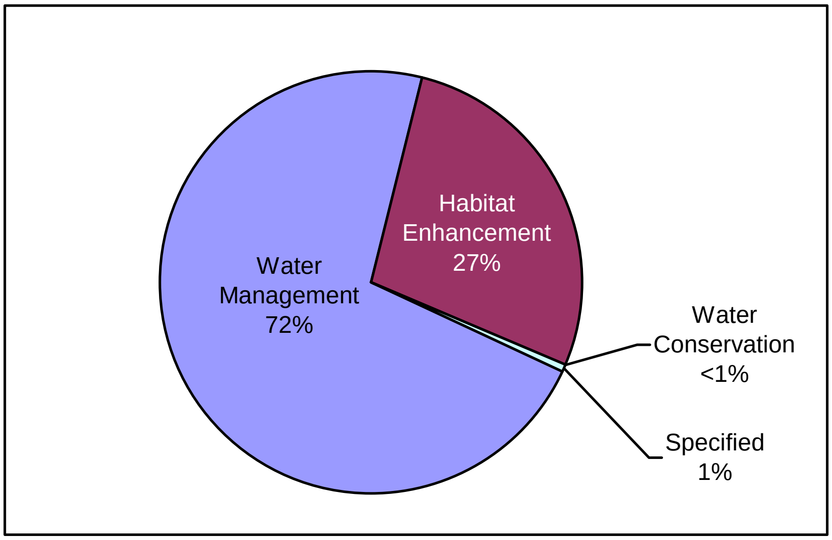
Figure 15-21 Projected Water Use for Industrial Sector



15.6 OTHER SECTOR

In Alberta, 1,197 water licences have been issued for other purposes. These licences allow withdrawals of up to 622,300 dam^3. This allocation to the other sector accounts for about seven percent of licensed water use in all of Alberta. As shown in Figure 15-22, the majority of allocations to the other sector are for water management for flood control and lake stabilization; these account for 72 percent of total allocations for the other sector. This sector also includes allocations for fish, wildlife and habitat enhancement (27 percent), and for water conservation and uses specified by a director with AENV. The majority (90 percent) of allocations to the other sector is for surface water (557,058 dam^3). It should be noted that the majority of licences for water management and habitat enhancement have been issued to Alberta Environment and Ducks Unlimited. Although these two uses have been analyzed separately, there may actually be no significant differences between these two categories of licences.

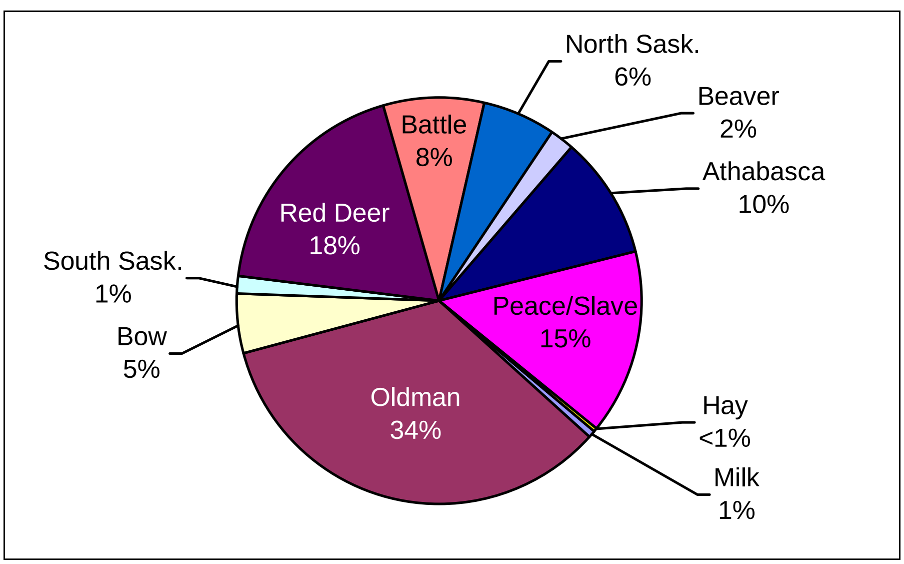
Figure 15-22 Other Sector Water Allocations in Alberta by Activity



15.6.1 Water Allocations

Figure 15-23 shows that more water has been allocated for other purposes in the Oldman River Basin than in any other basin. The Oldman River basin accounts for 34 percent of allocations for other purposes. Other river basins with large allocations of water for other purposes include the Red Deer (18 percent), and Peace/Slave (15 percent), Athabasca (10 percent), Battle (eight percent), North Saskatchewan (six percent) and Bow (five percent) river basins. Very small amounts of water have been allocated to this sector in the Beaver, South Saskatchewan, Milk and Hay River basins. No water licences have been allocated to the other sector in the Liard river basin.

Figure 15-23 Other Water Allocation in Alberta by Basin



Details of the licences issued to the other sector in Alberta are provided in Table 15-11 for each river basin and for each activity in Table 15-12. Overall, groundwater accounts for about 10 percent of allocations for other purposes. However, with the exception of two basins, groundwater typically accounts for at most six percent of allocations for other purposes. Allocations of groundwater were much higher in the Oldman and Bow river basins where groundwater comprises between 24 and 25 percent of total allocations for other purposes. Groundwater accounted for 10 percent of allocations for water management, but 90 percent of director-specified activities.

15.6.2 Licensed Water Use

Table 15-12 shows that licences issued for water management purposes allow about 76 percent of surface water allocations and three percent of groundwater allocations to be used. The other 24 percent of surface water and 97 percent of groundwater are expected to be returned after use. Licences issued for habitat enhancement purposes require that 15 percent of surface water withdrawals and 97 percent of groundwater withdrawals be returned. There are no return flow requirements in licences issued for water conservation purposes or for allocations of surface water for director–specified activities. However, 44 percent of groundwater withdrawals are to be returned. Licences allow up to 441,252 dam^3 to be used, consisting of 437,656 dam^3 of surface water and 3,596 dam^3 of groundwater. The difference between allocation and licensed use for licences issued to the other sector are shown in Figure 15-24.

Figure 15-24 Allocations, Licensed use and Actual Use for the Other Sector, Alberta

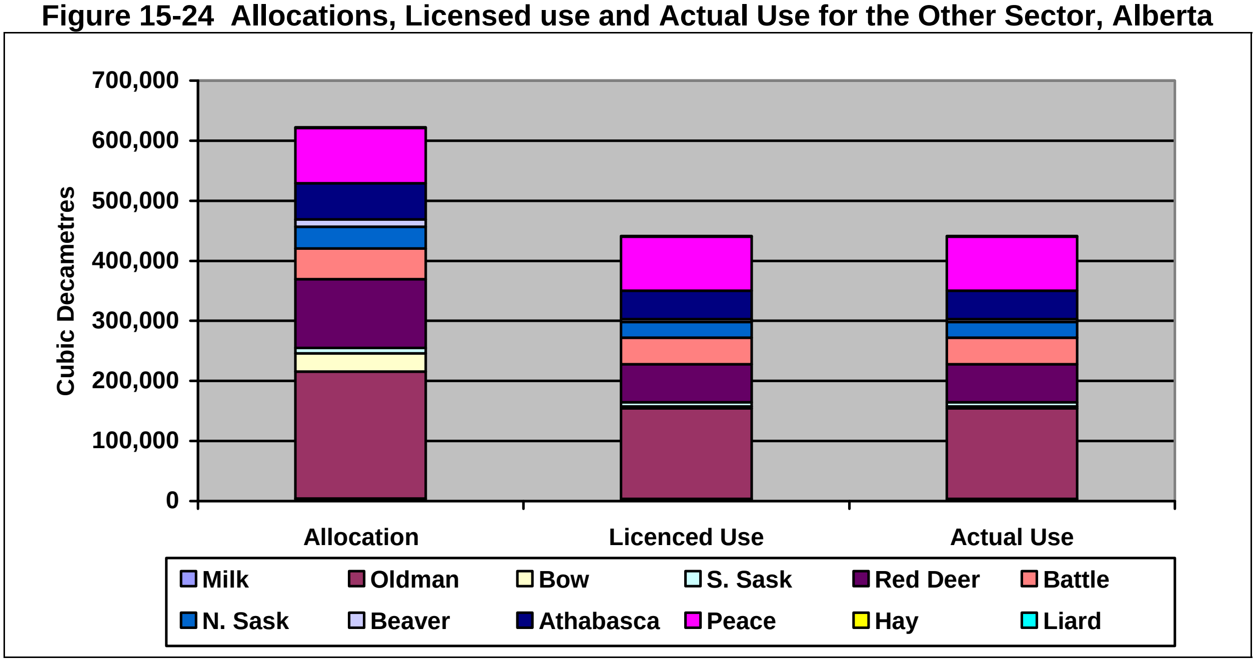


Table 15-11 Water Allocation and Use for the Other Sector by River Basin in Alberta

Basins	Water Type	Licensed Allocation and Use (dam^3)			Estimated Use (dam^3)	Licence Utilization	Percent of Alberta Use
		Allocation	Licensed use	Return Flow			
Milk	Surface	4,310	3,744	566	3,744	100.0%	0.8%
	Groundwater	0	0	0	0	N/A	0.0%
	Total	**4,310**	**3,744**	**566**	**3,744**	**100.0%**	**0.8%**
Oldman	Surface	161,243	149,426	11,817	149,426	100.0%	33.9%
	Groundwater	49,881	1,395	48,485	1,395	100.0%	0.3%
	Total	**211,124**	**150,821**	**60,302**	**150,821**	**100.0%**	**34.2%**
Bow	Surface	22,945	2,742	20,203	2,742	100.0%	0.6%
	Groundwater	7,721	170	7,551	170	100.0%	0.0%
	Total	**30,666**	**2,912**	**27,754**	**2,918**	**100.0%**	**0.7%**
South Saskatchewan	Surface	8,680	7,021	1,659	7,021	100.0%	1.6%
	Groundwater	0	0	0	0	N/A	0.0%
	Total	**8,680**	**7,021**	**1,659**	**7,021**	**100.0%**	**1.6%**
Red Deer	Surface	111,636	61,687	49,948	61,687	100.0%	14.0%
	Groundwater	3,004	1,673	1,331	1,673	100.0%	0.4%
	Total	**114,640**	**63,360**	**51,279**	**63,360**	**100.0%**	**14.4%**
Battle	Surface	51,351	43,993	7,358	43,993	100.0%	10.0%
	Groundwater	22	1	21	1	100.0%	0.0%
	Total	**51,373**	**43,994**	**7,379**	**43,994**	**100.0%**	**10.0%**
North Saskatchewan.	Surface	33,914	25,899	8,014	25,899	100.0%	5.9%
	Groundwater	2,095	184	1,911	184	100.0%	0.0%
	Total	**36,009**	**26,083**	**9,926**	**26,083**	**100.0%**	**5.9%**
Beaver	Surface	12,110	5,012	7,098	5,012	100.0%	1.1%
	Groundwater	4	4	0	4	100.0%	0.0%
	Total	**12,114**	**5,016**	**7,098**	**5,016**	**100.0%**	**1.1%**
Athabasca	Surface	57,473	47,339	10,133	47,339	100.0%	10.7%
	Groundwater	2,516	169	2,347	169	100.0%	0.0%
	Total	**59,988**	**47,508**	**12,480**	**47,208**	**100.0%**	**10.7%**
Peace/Slave	Surface	92,436	89,833	2,603	89,833	100.0%	20.4%
	Groundwater	1	0	0	0	100.0%	0.0%
	Total	**92,436**	**89,833**	**2,603**	**89,833**	**100.0%**	**20.4%**
Hay	Surface	960	960	0	960	100.0%	0.2%
	Groundwater	0	0	0	0	N/A	0.0%
	Total	**960**	**960**	**0**	**960**	**100.0%**	**0.2%**
Total	Surface	557,058	437,656	119,399	437,656	100.0%	99.2%
	Groundwater	65,244	3,596	61,646	3,596	100.0%	0.8%
	Total	**622,300**	**441,252**	**181,046**	**441,252**	**100.0%**	**100.0%**

Table 15-12 Water Allocation and Use for the Other Sector by Activity in Alberta

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Use (dam^3)	Licence Utilization	Percent of Sector
			Allocation	Water Use	Return			
Water Management	Surface	370	394,880	299,246	95,634	299,246	100.0%	67.8%
	Groundwater	34	52,821	1,572	51,249	1,572	100.0%	0.4%
	Total	**404**	**447,702**	**300,818**	**146,883**	**300,818**	**100.0%**	**68.2%**
Habitat	Surface	712	161,594	137,827	23,766	137,827	100.0%	31.2%
	Groundwater	58	9,401	280	9,120	280	100.0%	0.1%
	Total	**770**	**170,994**	**138,108**	**32,887**	**138,108**	**100.0%**	**31.3%**
Water Conservation	Surface	5	229	229	0	229	100.0%	0.1%
	Groundwater	0	0	0	0	0		0.0%
	Total	**5**	**229**	**229**	**0**	**229**	**100.0%**	**0.1%**
Director-Specified Activities	Surface	13	354	354	0	354	100.0%	0.1%
	Groundwater	5	3,020	1,743	1,277	1,743	100.0%	0.4%
	Total	**18**	**3,374**	**2,097**	**1,277**	**2,097**	**100.0%**	**0.5%**
Total	Surface	1100	557,058	437,656	119,399	437,656	100.0%	99.2%
	Groundwater	97	65,242	3,596	61,646	3,596	100.0%	0.8%
	Total	**1197**	**622,300**	**441,252**	**181,046**	**441,252**	**100.0%**	**100.0%**

15.6.3 Actual Water Use

There is no information on actual water diversions and consumption for any of the licences issued to the other sector. The lack of information for the other sector makes it very difficult to interpret actual water use, especially in those basins where significant volumes of water have been allocated to this sector. For purposes of this analysis, it is assumed that licensees are using their full entitlement. Given the types of projects in the other sector, this assumption likely overestimates actual water use. The collection of more detailed water information for these projects was beyond the scope of this study.

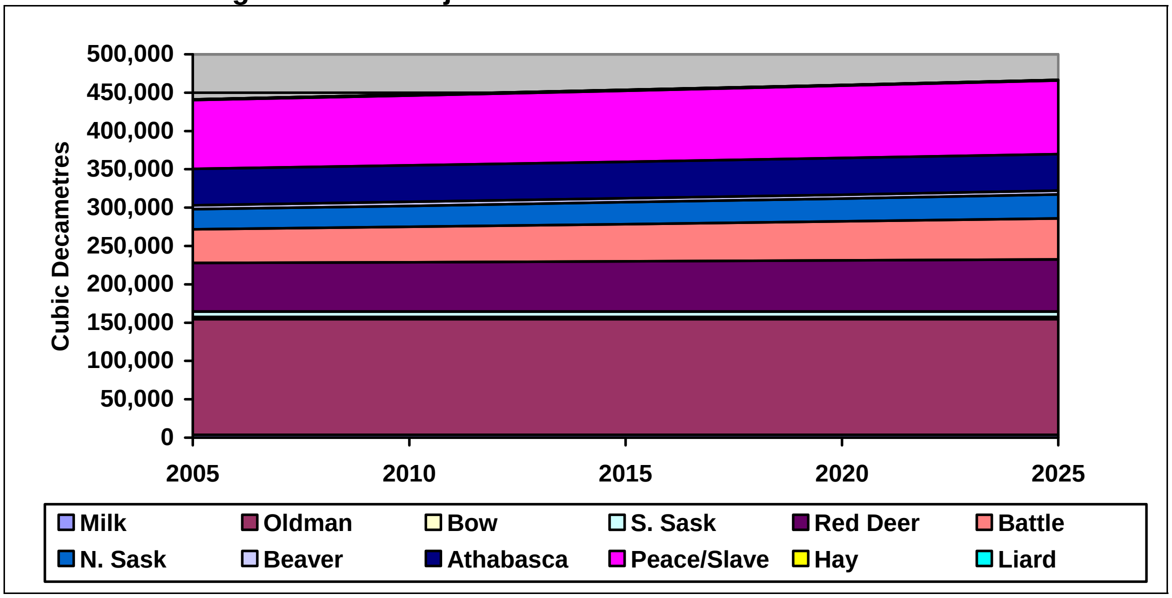
15.6.4 Forecasts of Future Water Use

Forecasts of future water use by the other sector are based on consultations with the two large licence holders: Ducks Unlimited and Alberta Environment. Neither organization has formal forecasts of their future water needs. Ducks Unlimited indicated that although there will be an increased emphasis on restoring drained wetlands to pre-drainage or natural conditions, it may undertake as may as two new water management projects per year with each requiring about 300 dam^3. These projects will likely be developed in the Battle and the North Saskatchewan river basins, and another project requiring 600 dam^3 may be developed in the Red Deer River Basin. Ducks Unlimited indicated that it might undertake six new habitat enhancement projects per year, likely in the Battle and the North Saskatchewan river basins with one project in another basin, such as the Peace/Slave, Athabasca or Red Deer river basins. These projects would also require allocations of 300 dam^3 each.

Water use by Alberta Environment is not expected to change over the forecast period. In the absence of information about water conservation or director-specified activities, it is assumed that water use by these components of the other sector will remain constant for the forecast period.

Estimates of future water use by the other sector in Alberta are shown in Figure 15-25 for the Medium Growth scenario. Under this scenario, water use for water management and habitat enhancement projects is expected to increase gradually while water use for water conservation and director-specified activities will remain constant. Figure 15-25 shows that most of the increase in water use will occur in the central and northern river basins, notably the Battle and North Saskatchewan river basins. Estimated water use in 2015 is estimated to be 466,779 dam^3; this is nearly a six percent increase over current use. Under the Low Growth and High Growth scenarios, water use for the other sector could increase by between three and 25 percent by 2025

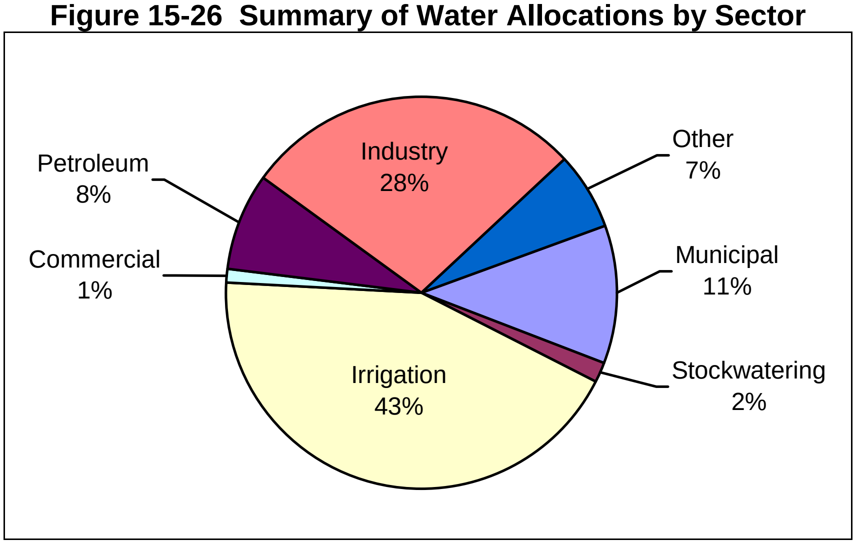
Figure 15-25 Projected Water Use for the Other Sector



15.7 SUMMARY

As of 2005, Alberta had allocated a total of 9,563,218 dam^3 of water for various purposes. The irrigation sector is allocated the most water (43 percent of the total). The industrial sector accounts for the next highest allocation (28 percent), followed by the municipal sector (11 percent), petroleum sector (8 percent), the other sector (7 percent), stockwatering (2 percent) and the commercial sector (1 percent).

Figure 15-26 Summary of Water Allocations by Sector



While allocations are a measure of the amount of surface and groundwater that can be withdrawn, many licences, especially for surface water, include an allowance for some water to

be returned after use. Thus, some licences assumed that actual use will be less than the total allocations, and this difference varies from activity to activity. As shown in Figure 15-27, the return flow allowance of licences issued for stockwatering, irrigation and the petroleum sector is very low. For these sectors, actual use is expected to be 99 percent, 94 percent and 92 percent of total allocations respectively. Licences issued for the commercial and other sectors assume that 75 and 71 percent of withdrawals will be consumed. The highest return flow allowances are in licences issued to the municipal and industrial sectors. Municipal licences assume that 32 percent of withdrawals will be consumed, and 68 percent will be returned. The highest return flow allowances are in licences issued to the industrial sector where an average of 88 percent of withdrawals will be returned. Overall, 62 percent used. Thus, current licences and registrations assume that 5,933,707 dam^3 of water will be used.

Figure 15-27 Licensed Allocation and Use and Actual Water by Activity

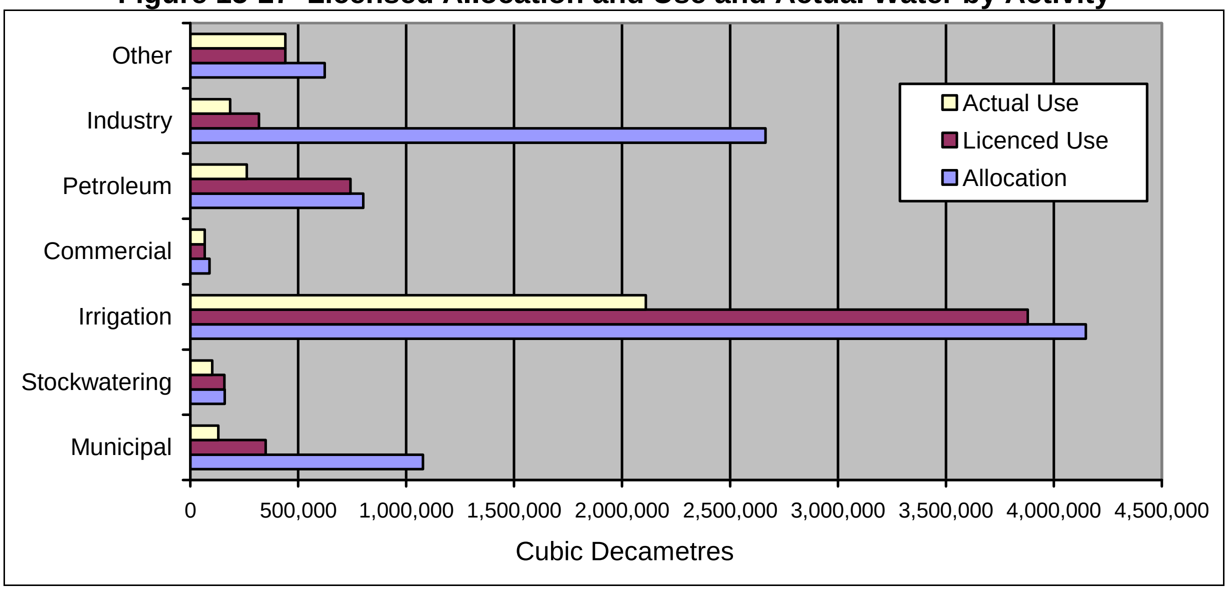


Table 15-13 shows the allocations and licensed use for each of the sectors. It shows that although the irrigation sector accounted for 44 percent of allocations, it can account for 65 percent of total licensed water consumption. And, while the industrial sector accounts for 28 percent of allocations, it accounts for only five percent licensed water use due to the very high return flow requirements.

Based on available information on actual water use in 2005 and various assumptions about water use by licensees who did not report their use, it is estimated that licensees only used 57 percent of the amounts of water that they are expected to use. It is estimated that water users in Alberta actually used 3,297,876 dam^3 of water. Table 15-13 also shows the licence utilization rates for each of the sectors. It shows that the highest utilization occurred in the commercial and other sectors, but this reflects the assumption that, in the absence of any actual information, licensees were using their full entitlement. The next highest utilization rate is for stockwatering (65 percent). While available information suggests that the petroleum sector has a 35 percent utilization rate, the data include water licence information for a number of large

oilsands mines that are not yet operating. Thus, the real utilization rate for the petroleum sector is actually much higher. The utilization rate for the irrigation sector was 54 percent, and was based on long-term average water use by the irrigation districts; 2005 was a wet year and below-average utilization rates were reported. The difference between actual water use and licensed water use is also shown in Figure 15-27.

Table 15-13 Summary of Allocation and Use by Sector in Alberta

Sector	Allocation		Licensed use		Return Flow	Estimated Actual Use		Licence Utilization
	dam^3	Percent	dam^3	Percent	dam^3	dam^3	Percent	
Municipal	1,078,095	11.3%	349,185	5.9%	728,908	130,865	3.9%	37.5%
Stockwatering	159,624	1.7%	158,468	2.7%	1,156	102,719	3.1%	64.8%
Irrigation	4,147,805	43.5%	3,879,343	65.4%	268,461	2,110,017	62.8%	54.4%
Commercial	88,629	0.9%	66,735	1.1%	21,891	66,736	2.0%	100.0%
Petroleum	801,618	8.4%	742,002	12.5%	59,615	261,243	7.9%	35.2%
Industry	2,665,149	27.9%	318,609	5.4%	2,346,539	184,565	5.5%	57.9%
Other	622,299	6.5%	441,252	7.4%	181,047	441,252	13.1%	100.0%
Total	**9,563,218**	**100.0%**	**5,955,594**	**100.0%**	**3,607,617**	**3,297,876**	**100.0%**	**55.4%**

Overall, groundwater accounts for 3.2 percent of total water allocations in Alberta in 2005. Licences and registrations allow up to 308,287 dam^3 of groundwater to be withdrawn for use and, of this, 95,320 dam^3 (31 percent) is to be returned. As shown in Table 15-14, the proportion of groundwater licensed to each of the sectors varies considerably. About 41 percent of allocations for stockwatering are for groundwater, while very little groundwater is used for irrigation. Other sectors that are heavily reliant on groundwater include the commercial sector (17 percent of allocations), the petroleum sector (13 percent) and the other sector (11 percent).

It should be noted that the estimates in Table 15-14 do not include groundwater used for household purposes, the number of household uses and the volume of groundwater they use is not known, but could be significant in some of the river basins.

Table 15-14 Summary of Groundwater Allocation and Use by Sector in Alberta

Sector	Allocation		Licensed use			Estimated Actual Use		
	dam^3	Percent of Sector	dam^3	Percent of Sector	Percent of Alberta	dam^3	Percent of sector	Percent of Alberta
Municipal	47,623	4.4%	24,975	7.2%	11.7%	10,813	8.3%	11.2%
Stockwatering	65,427	41.0%	65,427	41.3%	30.7%	36,909	35.8%	38.2%
Irrigation	648	0.0%	648	0.0%	0.3%	322	0.0%	0.3%
Commercial	15,461	17.4%	11,593	17.4%	5.4%	11,257	16.9%	11.6%
Petroleum	103,432	12.9%	103,235	13.9%	48.5%	30,284	11.6%	31.3%
Industrial	10,452	0.4%	3,493	1.1%	1.6%	3,493	1.9%	3.6%
Other	65,244	10.5%	3,596	0.8%	1.7%	3,596	0.8%	3.7%
Total	**308,287**	**3.2%**	**212,967**	**3.6%**	**100.0%**	**96,674**	**2.9%**	**100.0%**

The petroleum sector accounts for 48 percent of total licensed groundwater use and also accounted for 31 percent of actual water use in 2005. Stockwatering only accounted for 34 percent of total groundwater use. Although the municipal sector only accounted for four percent of groundwater allocations, it is estimated to have been responsible for 10 percent of all groundwater use. Overall, groundwater use accounted for only 3.2 percent of total water use in Alberta in 2005. It should be noted that, based on estimated usage, about 58,000 dam^3 of groundwater was withdrawn and returned, typically to surface water uses. Most of this return flow comes from the other and municipal sectors, and effectively increases the availability of surface water in some river basins.

Actual water use over the next 20 years is predicted to increase by about 21 percent. The Medium Growth forecast is shown in Figure 15-28. It shows that irrigation water is expected to increase in the short run and then stabilize once the irrigation districts are operating at capacity. There will also be a significant increase in water use in the petroleum sector as additional oilsands mines begin operations and upgraders are constructed to process bitumen. While water use in the other sectors is also expected to increase, these changes will be fairly small compared to the irrigation and industrial sectors.

Figure 15-28 Projected Water Use by Sector

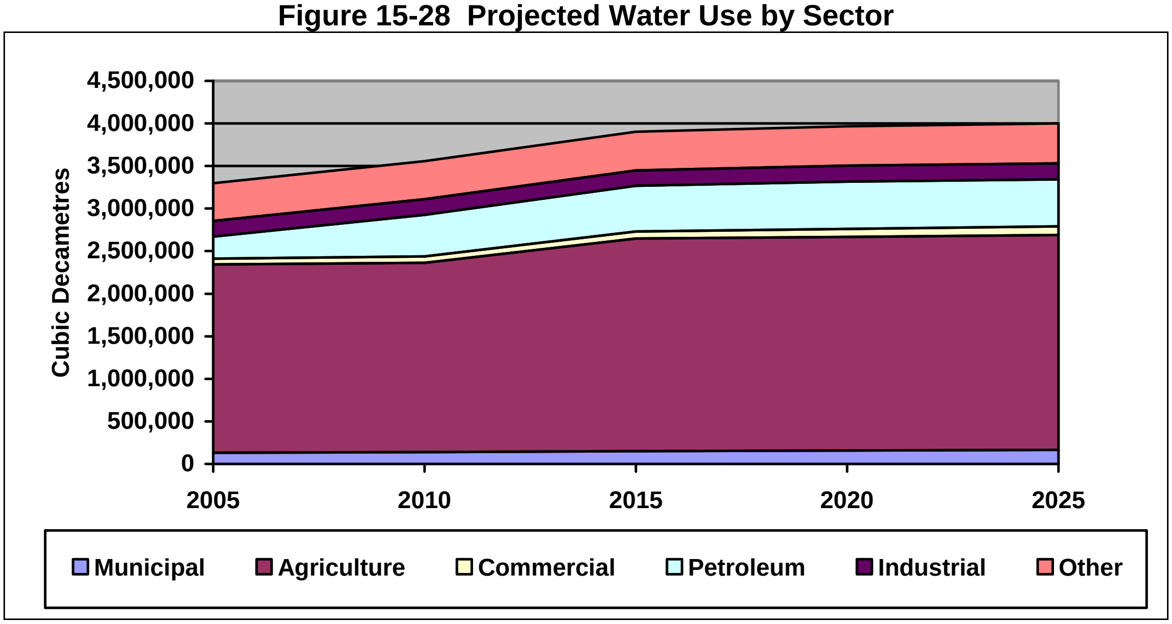


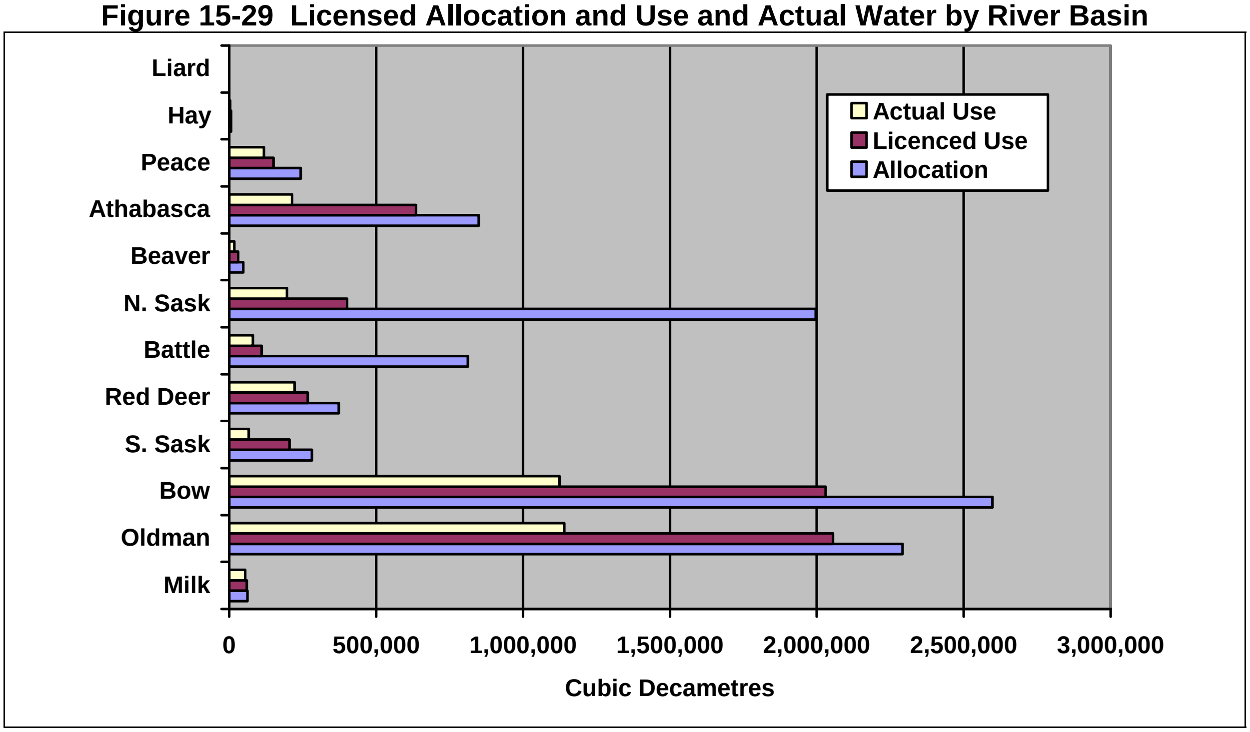
Table 15-15 shows the differences between water allocations, licensed water use and actual water use in 2005 for each of the river basins. It shows that the majority of allocations, licensed use , and actual water use occur in the Oldman and Bow river basins, where 12 of the 13 irrigation districts are located. Together, these two basins account for 67 percent of all water use in Alberta in 2005. Another 10 percent of actual water use occurred in the Athabasca River Basin, which is the location of the oilsands plants, many thermal extraction projects and the majority of the pulp mills in Alberta. The only other river basins that account for a significant amount of actual water use in Alberta are the Red Deer River Basin (seven percent) and the North Saskatchewan River Basin (six percent).

Table 15-15 Summary of Allocation and Use by River Basin in Alberta

Sector	Allocation		Licensed use		Return Flow	Actual Use		Licence Utilization
	dam^3	Percent	dam^3	Percent	dam^3	dam^3	Percent	
Milk	62,361	0.7%	59,946	1.0%	2,415	54,842	1.6%	91.5%
Oldman	2,292,401	24.0%	2,055,620	34.6%	236,778	1,140,982	33.9%	55.5%
Bow	2,597,894	27.2%	2,030,257	34.2%	567,636	1,124,096	33.4%	55.4%
S. Sask.	281,971	3.0%	205,316	3.5%	76,655	66,112	2.0%	32.2%
Red Deer	372,829	3.9%	267,947	4.5%	104,882	223,031	6.6%	83.2%
Battle	811,782	8.5%	111,440	1.9%	700,342	79,996	2.4%	71.8%
N. Sask.	1,996,839	20.9%	400,695	6.8%	1,596,141	196,298	5.8%	49.0%
Beaver	47,457	0.5%	30,865	0.5%	16,592	17,642	0.5%	57.2%
Athabasca	849,639	8.9%	635,965	10.7%	213,674	273,144	8.3%	42.9%
Peace	243,398	2.6%	150,962	2.5%	92,435	118,476	3.5%	78.5%
Hay	6,598	0.1%	6,531	0.1%	67	3,161	0.1%	48.4%
Liard	50	0.0%	50	0.0%	0	80	0.0%	160.0%
Total	**9,563,218**	**100%**	**5,955,594**	**100%**	**3,607,617**	**3,297,876**	**100%**	**55.4%**

Figure 15-29 also shows the differences between allocations, licensed water use and actual water use for each of the river basins. The largest differences occur in the North Saskatchewan and Battle river basins because water allocations in these basins are currently dominated by thermal power plants which have large return flows and actually account for very little actual water use. Figure 15-29 also shows the importance of the Bow and Oldman river basins in terms of provincial allocations and water use.

Figure 15-29 Licensed Allocation and Use and Actual Water by River Basin



The Beaver, Athabasca and Red Deer river basins were more reliant on allocations of groundwater that the rest of the province. Overall, groundwater allocations accounted for 3.2 percent of licences and registrations in Alberta, but accounted for more than 30 percent of allocations in the Beaver River Basin. Groundwater also accounted for about 10 percent of allocations in both the Athabasca and Red Deer river basins. The basins with the lowest reliance on groundwater allocations include the North and South Saskatchewan and Bow River basins. Under the terms of licences and registrations, it is expected that 209,748 dam^3 will be used and the remainder is returned. Table 15-16 shows that 37 percent of all licensed groundwater use occurs in the Athabasca River Basin, most likely for the petroleum sector. The volumes of groundwater that can be used in the Red Deer and Battle river basins account for 15 and 10 percent of total licensed groundwater use, respectively.

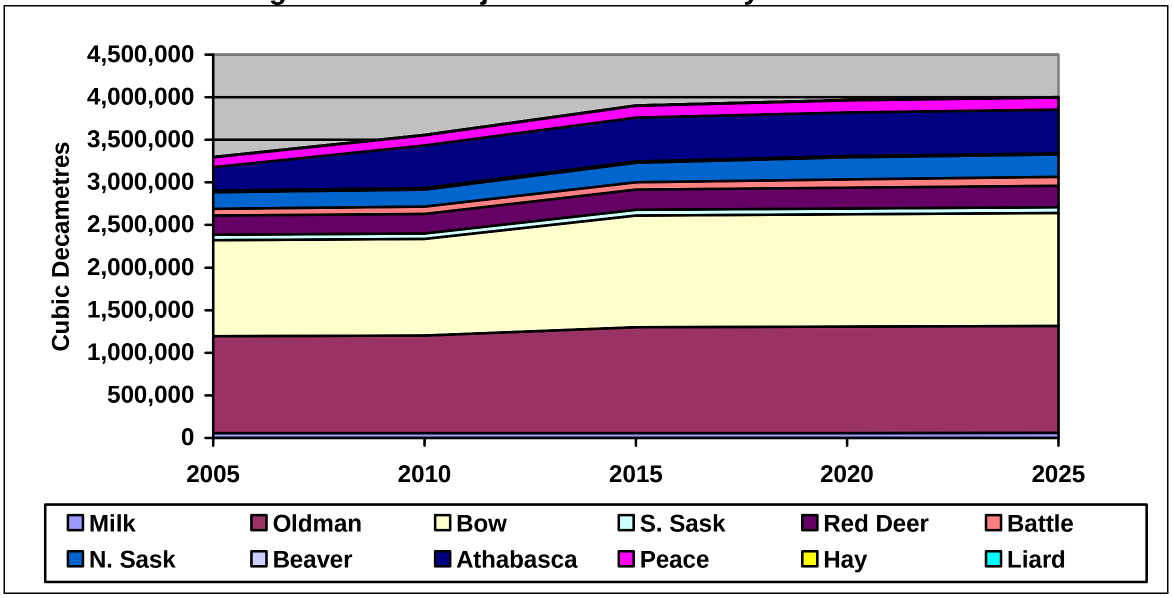
Table 15-16 Summary of Groundwater Allocation and Use by River Basin in Alberta

Basin	Allocation		Licensed use			Actual Use		
	dam^3	Percent of Sector	dam^3	Percent of Sector	Percent of Alberta	dam^3	Percent of sector	Percent of Alberta
Milk	1,428	2.3%	1,428	2.4%	0.7%	942	1.7%	1.0%
Oldman	61,075	2.7%	10,239	0.5%	4.8%	6,448	0.6%	6.7%
Bow	36,540	1.4%	15,882	0.8%	7.5%	10,368	0.9%	10.7%
S. Sask.	4,103	1.5%	1,860	0.9%	0.9%	698	1.1%	0.7%
Red Deer	37,324	10.0%	32,108	12.0%	15.1%	19,014	8.5%	19.7%
Battle	24,477	3.0%	21,200	19.0%	10.0%	8,406	10.5%	8.7%
N. Sask.	22,427	1.1%	20,231	5.0%	9.5%	13,559	6.9%	14.0%
Beaver	14,268	30.1%	14,089	45.6%	6.6%	6,785	38.5%	7.0%
Athabasca	89,344	10.5%	81,370	12.8%	38.2%	26,004	9.5%	26.9%
Peace/Slave	16,646	6.8%	13,972	9.3%	6.6%	4,015	3.4%	4.2%
Hay	655	9.9%	588	9.0%	0.3%	355	11.2%	0.4%
Liard	0	0.0%	0	0.0%	0.0%	80	100.0%	0.1%
Total	**308,287**	**3.2%**	**212,967**	**3.6%**	**100.0%**	**96,674**	**2.9%**	**100.0%**

In 2005 it is estimated that 96,674 dam^3 were actually used in Alberta. Most of this use occurs in the Athabasca River Basin (27 percent) and the Red Deer River basin (20 percent). Even though groundwater only accounts for 1.1 percent of total allocations in the North Saskatchewan River Basin, the estimated use of groundwater in this basin accounted for 14 percent of all groundwater use in Alberta.

Projections of future water use in Alberta under the Medium Growth scenario are provided in Figure 15-30 for each of the river basins. It shows that, in the near future, most of the increased use will occur in the Athabasca River Basin as the oilsands mines commence operations. Between 2010 and 2015 water use in the Bow and Oldman river basins is expected to increase due to agricultural expansion. However, after 2015, water use is expected to level off as generally population-based increases in water use are offset be continuing decreases in water use for injection purposes and as various industries improve their operating efficiencies.

Figure 15-30 Projected Water Use by River Basin



Conclusions and Recommendations

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16.0 CONCLUSIONS AND RECOMMENDATIONS

One of the challenges in undertaking this study is related to the availability of comprehensive and reliable information on actual water use. Although AENV maintains a detailed listing of all licences and registrations, allowing accurate assessments of water allocations and licensed use, its Water Use Reporting System (WURS) contains very few reports on actual water use. This lack of comprehensive, current and reliable information on actual water use will create significant problems for water management because, without knowing how water is actually being used, it will very difficult for Watershed Planning and Advisory Councils (WPAC's) develop effective or accurate basin management plans; it will be impossible to measure any the effects of efficiency or conservation programs; and, it is impossible to correctly determine natural flows, which are calculated as the sum of observed flows and estimated consumption. Consequently, to develop the information required to better understand actual water use, the following recommendations identify initiatives for each water use sector.

16.1 MUNICIPAL SECTOR

The WURS database currently contains withdrawal information for most of the large municipal licence holders in some basin but, as shown in Table 16-1, actual withdrawals were reported by licensees that allocated for 40 percent of allocations for municipal purposes. While withdrawal data is fairly reliable for communities in the Bow, South Saskatchewan and North Saskatchewan river basins, it is almost non-existent for communities in the Oldman, Battle and Peace river basins.

Table 16-1 Reporting of Municipal Water Withdrawals by Percent of Allocations

River Basin	Allocation (dam^3)	Percent of Allocations
Milk	10,020	67%
Oldman	64,149	5%
Bow	16,133	94%
South Saskatchewan	13,297	96%
Red Deer	37,127	41%
Battle	22,450	8%
North Saskatchewan	16,680	92%
Beaver	2,016	64%
Athabasca	9,122	73%
Peace	5,805	13%
Hay	9	0%
Liard	0	N/A
Total	**196,807**	**40%**

To determine actual water use, it is necessary to subtract return flows from withdrawals. However, information on return flows from municipal water users is also almost non-existent. The main readily available information source was Environment Canada's

Municipal Water Use database which was last updated in 2001. The problem is that, while reporting withdrawals is a requirement under the *Water Act,* the reporting of return flows (treated municipal effluent) is a requirement of the Alberta *Environmental Protection and Enhancement Act*. As the two databases are not linked and each uses different identification numbers for licensees, it is not possible to easily develop estimates of actual water use. The only way of determining actual water use is by reviewing the paper copies of the two types of reports submitted to Alberta Environment and calculating net water use manually. This approach was used in Watrecon(2005) for the Battle River and was very time consuming. However, without this information is simply not possible to develop reliable estimates of municipal water use. With a move toward of regional water systems, this task may become even more challenging in the future.

One solution to this problem would be to undertake a detailed comprehensive survey of municipal water use, such as was done in 1992 by Reid Crowther, entitled "*Technical Review of Water Conservation Options for Alberta Municipalities".* Reid Crowther gathered data from seven sources[1] to assess Alberta municipal water use patterns in detail and also identified the key factors that influence municipal water use, including the use of water meters, climate (aridity index[2]), the proportion of non-residential to residential water use in the community, and billing rates, as well as other factors such as source limitations, commercial and institutional uses, system leakage, water main breaks, sale of water outside the municipality, treating of wastewater from outside the municipality and partial distribution systems. The information contained in this report is invaluable for assessing water use efficiency and the potential benefits of conservation, but is now 15 years old and needs updating.

Due to the current policy environment, Alberta's rapid population growth and the limitations of water supplies <u>a thorough and up-to date assessment of municipal water use in Alberta is recommended</u>. The study should adopt the Reid Crowther approach where possible, and the resulting information should be integrated into WURS in order to provide a reliable assessment of municipal water use for at least one year. It is suggested that the study differentiates municipal water use among river basins and captures inter-basin and groundwater to surface water transfers. Such a study would provide an information resource for managing and communicating municipal water demand in Alberta for years to come, and could be used as a useful baseline until all municipalities are voluntarily submitting annual water use information to WURS and the return flow information is also readily available and can be used to develop reliable estimates of actual municipal water use.

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1 Official population list 1990; AB hamlets 1991 (Municipal Services Branch, Municipal Affairs); AB Water and Wastewater Facilities Survey 1990 (AENV Standards and Approvals Division, Municipal Branch); Water treatment plant operating reports (AENV Standards and Approvals Division, Municipal Branch); Economics and water use data (AENV Planning Division); Residential Property Survey 1986 including utilities charges and rate structure (Municipal Affairs); Water license database (now called EMS)

2 Aridity index in the Reid Crowther report is the depth to which the soil must be watered to grow a reference crop, although the most common current definition is that of the UNEP, which states that the aridity index is precipitation / potential evapotranspiration.

Another limitation of this study was that the analysis of municipal water use was based on 2001 Census information which, considering Alberta's recent population growth, could be quite inaccurate. The 2001 Census was the only reliable and comprehensive information source available at the time the study was undertaken. However, the results of the 2006 Census are currently being released and this data could be used to provide more accurate estimates of current water use as well as projections of future water use that are tied to population growth. It is recommended that this assessment of current and future water use be updated to reflect the results of the 2006 Census.

16.2 AGRICULTURAL SECTOR

Agricultural sector is divided into three main activities, district irrigation, private irrigation and stockwatering, each with its own specific data availability and reliability issues. For district irrigation the quality of available information through WURS and AAFRD is generally good, although it would be helpful to have information on allocations, diversions and return flow available from one source. In reviewing the WURS data, however, it appears that the use data was entered in terms of cubic decametres, rather than metres, but the correct numbers were used in this analysis.

Neither AENV nor AAFRD have any information regarding water use by private irrigators, even though they account for 17 percent of agricultural allocations and seven percent of total allocations in Alberta. In some southern basins, particularly the Bow and the Oldman, private irrigators account for an even greater proportion of total allocations. For purposes of this analysis, it was assumed that private irrigators were using their full licence entitlements. Given that the southern basins are "capped", with no further surface water allocations and limited groundwater availability, it would be advantageous to know the extent to which private irrigators are exercising their entitlements, how they are using water, the crops they raise, the irrigation technology they employ, and any water-related issues they face. Consequently, it sis recommended that a thorough assessment of water use by private irrigators be undertaken, especially since efficiency improvements by this group could have a significant effect on future water use in the southern river basins.

There is no actual water use information for stockwatering. For this assessment, water use estimates have been derived based on livestock population numbers, specifically cattle from 2001 Census. Given that the cattle industry has gone through significant changes since 2001, an update based on the latest available Census data from 2006 would provide a more current water use estimates. Consequently, it is recommended that the estimates of water use by livestock be updated once the 2006 Census of Agriculture is available. Other information for the other agricultural data used in this analysis could also be updated. It is expected that comprehensive Census information on farms and operator data will be available on May 16, 2007, and the Agricultural Community Profiles will be released in the fall of 2007.

16.3 COMMERCIAL SECTOR

WURS contains very limited water use information for the commercial sector. This was not considered to be an issue in this assessment because allocations for the commercial sector are so small, accounting for less than one percent of total allocations in Alberta. However, commercial sector allocations are of more importance in some basins than others and, to improve the overall reliability of water use estimates. It is recommended that further study be undertaken by the Bow, Oldman and North Saskatchewan, where most of the commercial sector activities occur. The water use assessments in this report do not specifically identify water use by commercial enterprises that obtain their water from municipalities. It is expected that this use will increase overtime as municipalities grow. To understand this aspect of water use, municipalities should be asked to provide specific estimates of the water they supply to their commercial customers. Environment Canada currently has some information on this use as part of its most current version of the Municipal Use Database. This could be done by requiring that all commercial licensees submit annual water use reports to WURS, or by undertaking a survey of a sample of commercial enterprises to determine the extent to which they are using their available entitlements and what factors are affecting water use.

16.4 PETROLEUM SECTOR

All of the information for injection and thermal activities in this report related to the petroleum sector is based on the results of a recent assessment by Geowa Technologies of water use information submitted to the EUB. While the EUB has comprehensive information on petroleum-related water use, this information is reported by operator and legal land description, not by water licence, and extensive effort is required to marry the water licence and water use databases to provide water use estimates for individual river basins. Fortunately, Gewoa undertook this exercise fairly recently so summarizing information for individual basins did not require significant effort. Had the Geowa report not been available, a detailed analysis of water use information by basin would have been impossible given the budget available for this study.

Assuming that detailed assessments of water use will be required again in the future, it is recommended that AENV work with the EUB to determine a methodology that would allow water use data provided to the EUB to be readily migrated into the WURS data base on an ongoing basis. This would allow water use assessments to be prepared without the significant effort that is currently required to match information from the two databases.

Given that oilsands mining accounts for 64 percent of petroleum water allocations, reliable estimates of water use in the northern basins will require better information on their actual use. Currently, the only information available for some oilsands mining operations is water withdrawal rates: no actual water use data is available. It is recommended that additional effort taken to determine how much water is actually being

used by oilsands mining projects and to monitor how the adoption of new technologies is affecting their actual water use.

Throughout the report, petroleum water forecasts have assumed that water use for injection and thermal extraction will continue to use the same mix of surface and groundwater. This assumption likely overstates future surface water use because, under the 2006 Water Conservation and Allocation Policy for Oilfield Injection Policy, petroleum operators are expected to use non-potable water sources. However, as noted earlier the overall effects of they policy are not yet evident. It is expected that the effects of the Policy will be most important in the water short areas of Alberta (the South Saskatchewan, Milk and Battle River Basins) where the conditions for using potable water for oilfield injection are most struggling. It is recommended that AENV monitor and report water use for oilfield injection to measure the success of the Policy.

16.5 INDUSTRIAL SECTOR

Estimates of water use for the industrial sector are considered to be fairly reliable because water use information for cooling and forestry activities, which account for 95 percent of the industrial water allocation in the province, was available in WURS or through discussions with major water holders. For the remaining five percent of industrial water allocations WURS contained some information for chemical plants, fertilizer plants, and mines for other than coal but very little information for coal mining, manufacturing, hydroelectricity and other industrial activities. Allocations for these activities are relatively small on a provincial basis therefore the lack of information is not expected to significantly affect estimates of total water use. However, better information for these activities would provide a better assessment of industrial water use in the individual river basins. It is recommended that ENV encourage all industrial water users, especially the larger ones, to report their water withdrawals and use to WURS. It should be added that some industries obtain their water from municipalities and do not have their own licences to fully understand industrial water use; municipalities should be asked to provide separate estimates of the amount of water they provide to industrial customers. Many municipalities now report this information to Environment Canada as part of its municipal use database.

16.6 OTHER SECTOR

Current allocations to the other sector account for about seven percent of water allocations in Alberta, yet there is no information about actual water use. The majority of licensees in the other sector have been issued for water management and habitat enhancement, primarily to Alberta Environment and Ducks Unlimited. However, neither of these organizations have reported their annual water use. For purposes of this analysis, it was assumed that all licensees in the other sector were using their full entitlement. While this may not have a significant effect on total water use estimates for Alberta, the accuracy of water use estimates becomes suspect in those basins where the other sector accounted for a significant portion of estimated water use. These

include the Peace (76 percent of estimated total water use), the Battle (55 percent), the Hay (30 percent), the Red Deer (29 percent) and even the Oldman (13 percent).

A review of licences issued to Alberta Environment for other purposes suggests that there may be some double counting of water allocations. For example, water diverted from the Highwood River to the Little Bow River under the terms of a licence issued to Alberta Environment may be withdrawn by users in the Little Bow Basin who may have their own licences. This would result in double-counting because allocations for the same water would show up for two different basins and purposes within EMS, even though the licensed use information is correct. This problem may also exist for other types of licences issued to AENV. For example, AENV is licensed to divert 270,803 dam^3 province-wide under licences assigned to the agricultural sector, primarily for crops. Most of this is for Bow River Basin (246,715 dam^3), with much of the remainder for Red Deer River Basin (22,205 dam^3). It is not clear whether irrigators are then issued licences that allow them to use this water. The extent of this problem is uncertain, but <u>it is recommended that AENV undertake a review of all licences issued to itself to ensure that there is no double counting of allocations or water use</u>

16.7 OTHER RECOMMENDATIONS

Based on the experience of preparing this study, there are a number of issues that relate to more than one water use sector and need to be addressed if reliable estimates of water use are to be developed on a regular basis.

A first issue is that there are some inconsistencies among river basins or administrative regions regarding how licences are described in terms of their purpose or activity. These problems are most apparent for the petroleum sector (observed differences between allocations for injection and thermal extraction projects may be incorrect), the other sector (Ducks Unlimited has licences for water management and habitat enhancement, even though the projects are nearly identical), and the commercial sector, (often used as a catch-all for any use that does not fit within any other category). <u>It is recommended that AENV develop and use a consistent list of licence and water use categories that will support future water management initiatives</u>. For example, if productivity or efficiency targets are established for specific sectors or activities, it is important to ensure that the same types of uses are included in each sector for each river basin.

A second issue is that there appears to be some potential for duplication of water licences or allocations. It was noted that some licences issued for petroleum purposes have been issued to the same company and have the same priority number, allocation, and legal land description and it is not clear whether this is one allocation that allows a specified volume to be withdrawn from a combination of groundwater wells or whether each licence is unique. In addition, some companies have licences that allow them to switch from one source to another (surface or groundwater) depending on surface water availability, so counting each licence separately may also overstate allocations.

Potential situations of duplication should be identified and reviewed and the EMS database revised to ensure that there is no double counting of allocations.

The third general problem is that, for WURS to be truly effective, there needs to be better linkages between EMS licence information, the EUB water use data, the return flow information collected under AEPEA, and WURS. Ideally, WURS should be the single source of information on water withdrawals and use, and this will not occur without linkages to these other datasets. To make WURS more effective it is also recommended that:

- the format of WURS entries be standardized (sometimes an entry will have the withdrawal information, sometimes it has withdrawal and return information),
- a quality control process be implemented to ensure the accuracy of WURS data (the dataset contains a number of typos or mistakes, including entries that use the wrong measurement units – dam^3 instead of m^3)
- all major licence holders be required or strongly encouraged to report their water use. While this may not be practical for all licensees, AENV needs to develop a strategy that identifies the water use sectors of greatest importance for water management and then works to obtain reliable annual water use information for the individual licensees within these sectors.

A fourth issue in this report water use has been reported on an annual basis, even though use may actually vary significantly from season to season, month to month, or even day to day. Given that better information is now required for water management in capped basins and to ensure that minimum flows are being respected, it is recommended that AENV pursue developing seasonal water use estimates for the various sectors in different parts of the province.

Fifth, some licensees have been issued for mixed use purposes and it is very difficult to determine, based on available information, exactly how water is being used. For example, water withdrawn by EPCOR for the North Saskatchewan River is treated and sent to many municipalities, including the City of Edmonton; some of the waste water is sent to water treatment facilities and returned to the North Saskatchewan basin; but some treated wastewater is provided to industries who use, treat and return some of the water and some treated wastewater may be return to the Battle River basin. There are also examples of complex industrial licences. In these cases a true understanding of water use will require a collaborative approach among water users (licensed and otherwise) and it is recommended that AENV provide more specific reporting requirements that correctly capture the various uses of water for complex licences.

Finally, not all water users are licensed and there is no information on this use. This includes people who obtain their water for household purposes or as exempted agricultural use. Household use of groundwater is believed to be significant in some basins but, without more information on actual use, this perception and the relative importance of unlicensed users can not be confirmed. It is recommended that AENV

conduct a study of unlicensed uses in out least some basins so that this aspect of water use can be better understood.

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