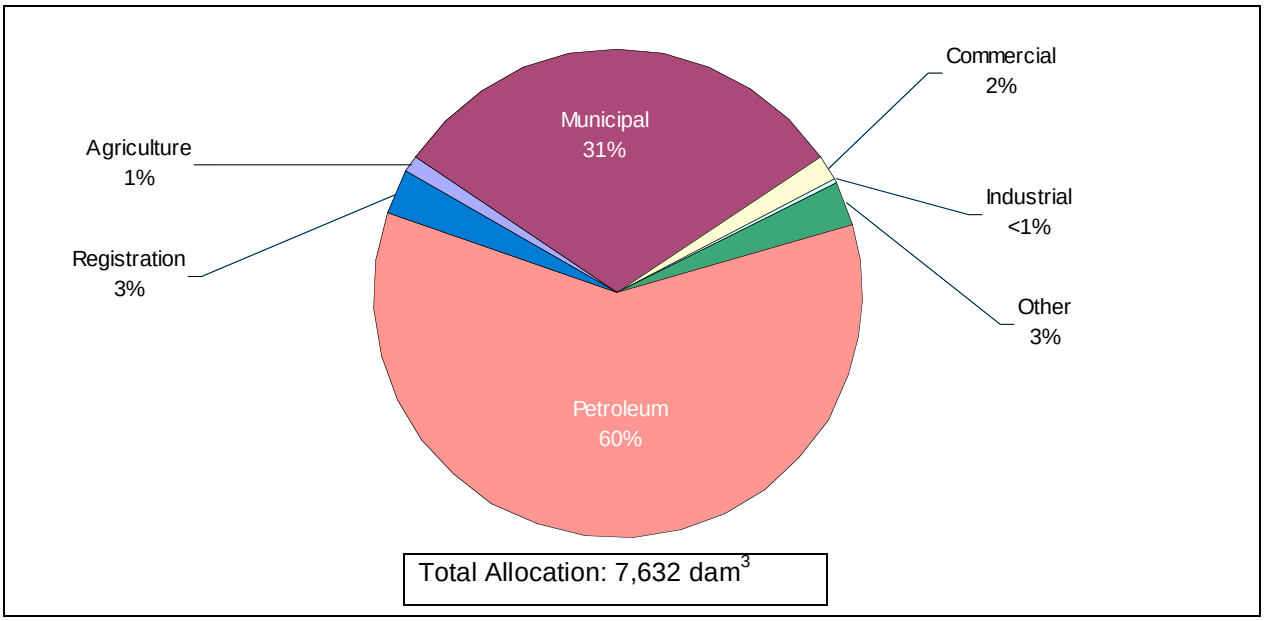
5.0 RAM

The Ram Sub-basin is about 6,200 km^2 in area and occupies approximately 11 percent of the North Saskatchewan Basin. In 2005, the sub-basin had a population of 14,270 people, which represents just over 1 percent of the Basin population, with a population density of 2.3 people per square kilometer. The Ram Sub-basin consists all or parts of one urban, two rural and three Aboriginal Settlements.

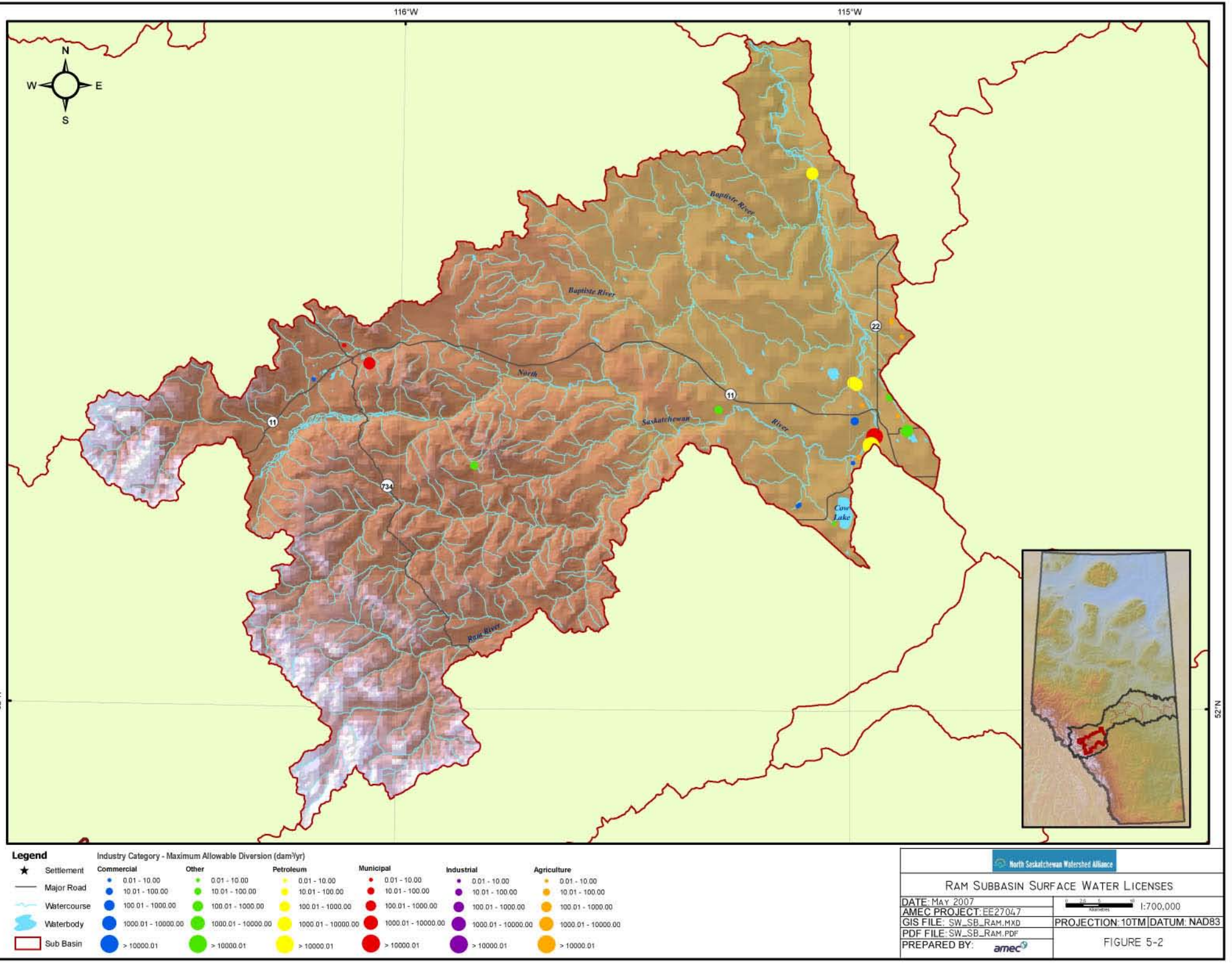
An overview of current surface and groundwater allocations is provided in Figure 5-1. It shows that the petroleum sector accounts for 60 percent of total allocations or 4,548 dam^3 in 2005. The municipal sector accounts for 31 percent of total allocation or 2,388 dam^3. The remaining allocations are for agricultural (including registrations), commercial, industrial and other sectors. Total allocations in the sub-basin in 2005 were 7,632 dam^3 of which 5890 dam^3 (77 percent) was for surface water.

Figure 5-1 Distribution of Active Water Allocations in the Ram Sub-basin



Figures 5-2 and 5-3 show the location, allocation and sector of all active water licences in the Ram Sub-basin. The locations of registrations issued in this sub-basin are provided in Figure 5-4.

Figure 5-2 Ram Sub-basin Surface Water Licences


116°W
115°W
52°N
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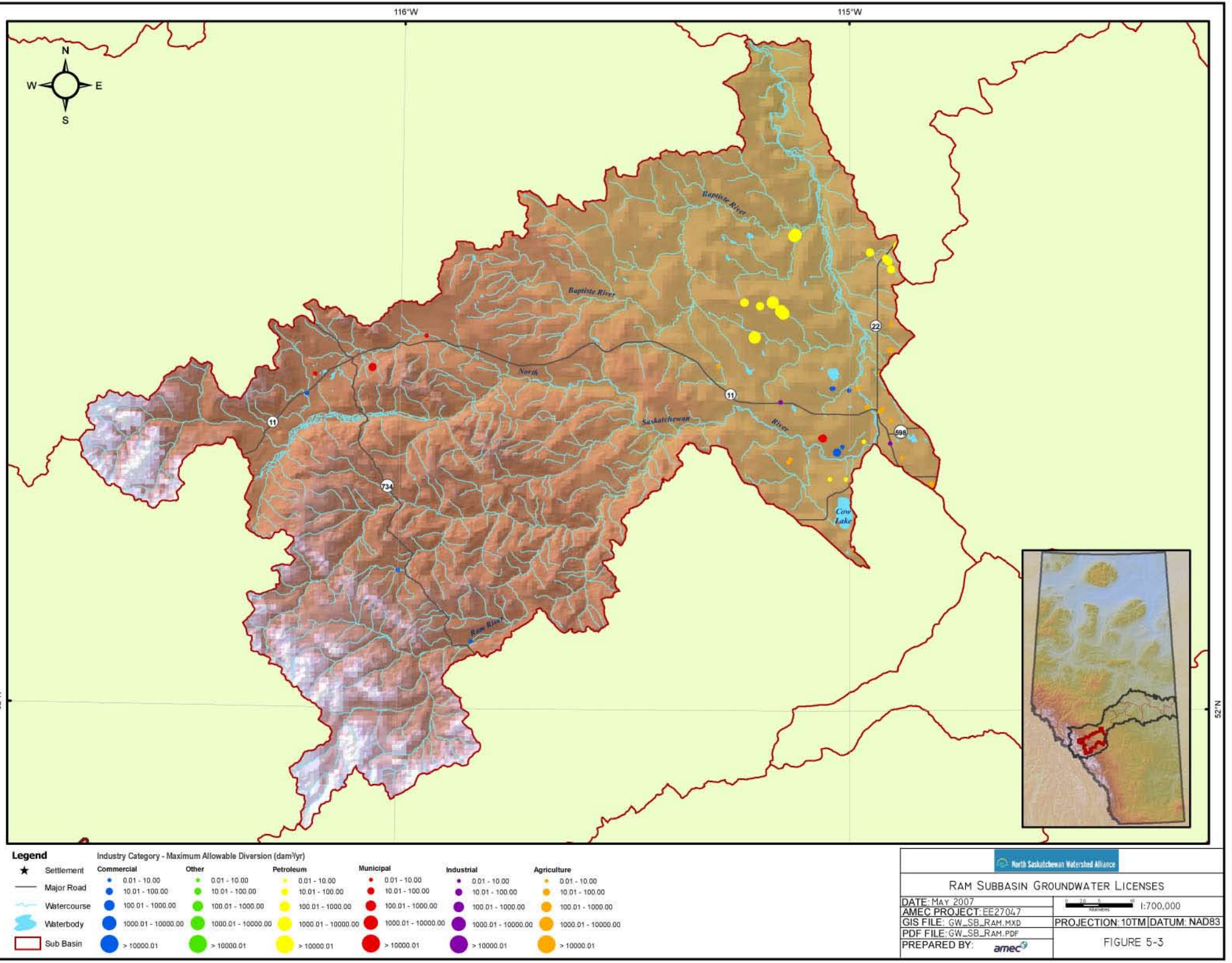
W
E
S
Baptiste River
Baptiste River
North
Saskatchewan
River
Cow
Lake
Ram River
22
11
11
734
Legend
Settlement
Major Road
Watercourse
Waterbody
Sub Basin
Industry Category - Maximum Allowable Diversion (dam³/yr)
Commercial
Other
Petroleum
Municipal
Industrial
Agriculture
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
North Saskatchewan Watershed Alliance
RAM SUBBASIN SURFACE WATER LICENSES
DATE: MAY 2007
AMEC PROJECT: EE27047
GIS FILE: SW_SB_RAM.MXD
PDF FILE: SW_SB_RAM.PDF
PREPARED BY: amec
1:700,000
PROJECTION: 10TM | DATUM: NAD83
FIGURE 5-2

Figure 5-3 Ram Sub-basin Groundwater Licences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North
Saskatchewan
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Cow
Lake
Ram River
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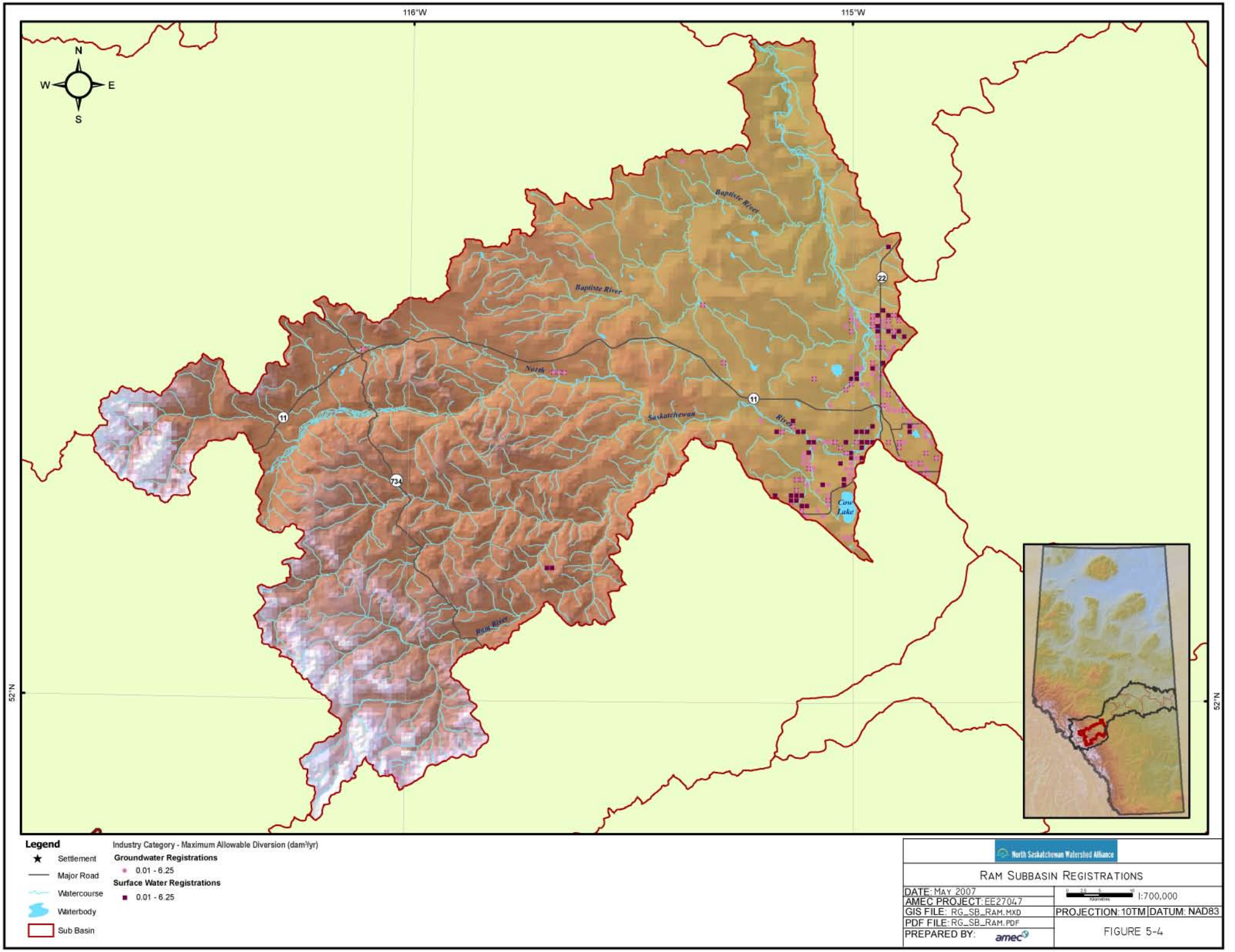
22
598
734
Legend
Settlement
Major Road
Watercourse
Waterbody
Sub Basin
Industry Category - Maximum Allowable Diversion (dam³/yr)
Commercial
Other
Petroleum
Municipal
Industrial
Agriculture
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
North Saskatchewan Watershed Alliance
RAM SUBBASIN GROUNDWATER LICENSES
DATE: MAY 2007
AMEC PROJECT: EE27047
GIS FILE: GW_SB_RAM.MXD
PDF FILE: GW_SB_RAM.PDF
PREPARED BY: amec
1:700,000
PROJECTION: 10TM | DATUM: NAD83
FIGURE 5-3

Figure 5-4 Ram Sub-basin Registrations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North
Saskatchewan
River
Cow
Lake
Ram River
22
11
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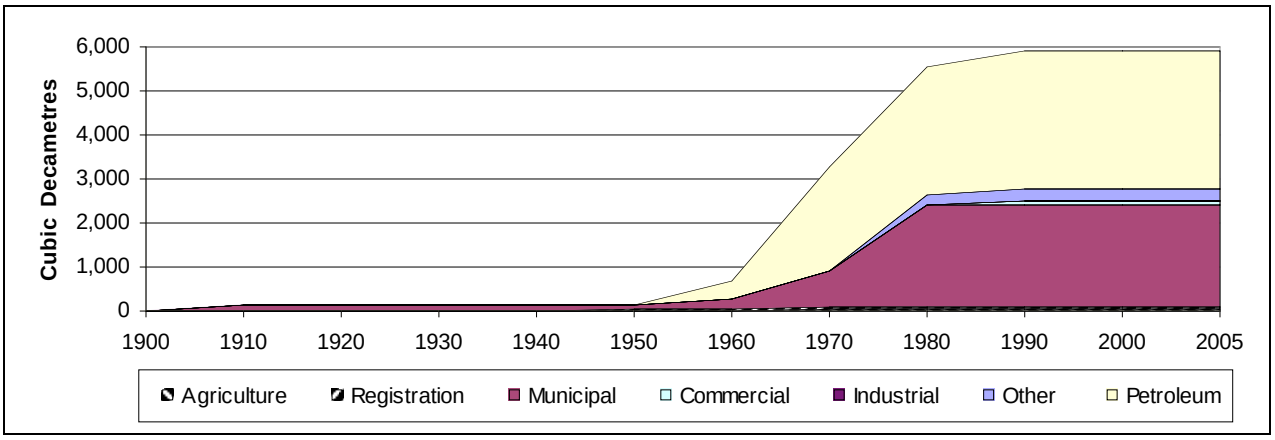
734
Legend
Settlement
Major Road
Watercourse
Waterbody
Sub Basin
Industry Category - Maximum Allowable Diversion (dam³/yr)
Groundwater Registrations
0.01 - 6.25
Surface Water Registrations
0.01 - 6.25
North Saskatchewan Watershed Alliance
RAM SUBBASIN REGISTRATIONS
DATE: MAY 2007
AMEC PROJECT: EE27047
GIS FILE: RG_SB_RAM.MXD
PDF FILE: RG_SB_RAM.PDF
PREPARED BY: amec
1:700,000
PROJECTION: 10TM | DATUM: NAD83
FIGURE 5-4

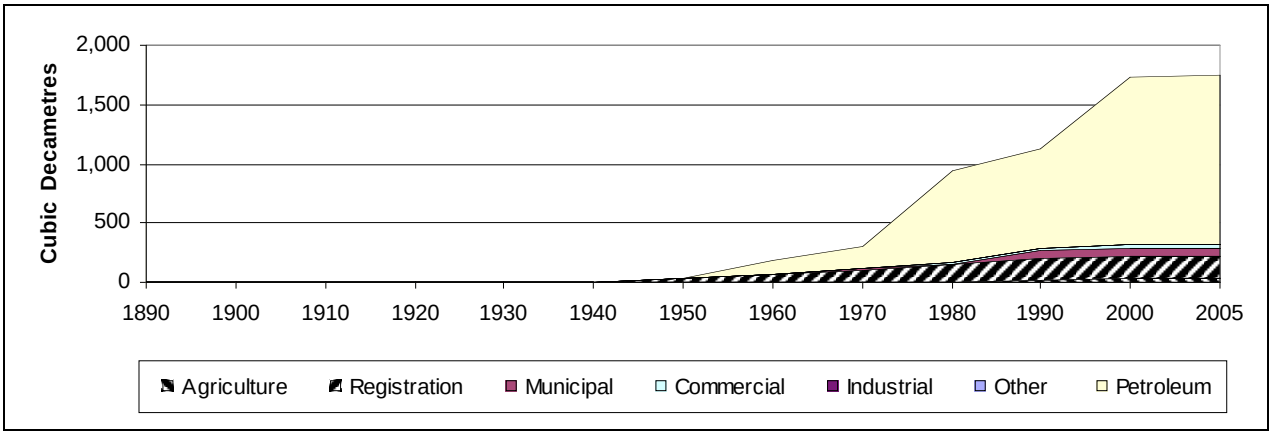
An historical perspective on water allocated among the sectors is provided in Figure 5-5 (surface water) and Figure 5-6 (groundwater). The two largest allocations for surface water in the Ram Sub-basin are the petroleum and the municipal sectors. Allocations for the petroleum sector were first issued in the 1950s and increased substantially but since the 1990s allocations have remained relatively stable. Allocations for the municipal sector were first issued in the 1900s but remained relatively unchanged until the 1950s when the allocations increased substantially until the 1980s. Since that time municipal sector allocations have remained unchanged. Agriculture, registration, commercial and other sectors are also allocated surface water in the sub-basin and some of these allocations were first issued in the 1900s.

Figure 5-5 Historical Trends in Surface Water Allocation in the Ram Sub-basin



The largest allocations for groundwater are for the petroleum sector. The allocations were first issued in the 1950s and since that time allocations have grown substantially, however, since 2005, the allocations have remained unchanged. Agriculture, registration, commercial, municipal and industrial sectors are also allocated groundwater in the sub-basin and some of these allocations were first issued in the early 1900s.

Figure 5-6 Historical Trends in Groundwater Allocation in the Ram Sub-basin



5.1 Municipal and Residential Sector

5.1.1 Population

The population of Ram Sub-basin is primarily split between rural and urban municipalities, with a small proportion living in Aboriginal settlements. As shown in Table 5-1, 48 percent of the basin population in 2006 lived in rural and urban municipalities, respectively, and four percent lived on reserves and in Métis settlements. The urban population is growing quite quickly in Ram Sub-basin, at almost 11 percent in the inter-censal period from 2001 to 2006. With three percent growth over the inter-censal period, rural municipalities are growing slowly, while the Aboriginal settlement population is falling rapidly.

Table 5-1 Population Distribution and Growth in the Ram Sub-basin

	2006		2001	2001 to 2006 Population Change
	Population	**Percent**	**Population**	**Percent**
Urban Municipality	6,874	48.2%	6,208	10.7%
Rural Municipality	6,888	48.3%	6,701	2.8%
First Nations and Métis Settlements	512	3.6%	576	-11.1%
Total	**14,273**	**100.0%**	**13,485**	**5.8%**

Table 5-1 lists all municipalities situated in the Ram Sub-basin, their estimated 2006 sub-basin populations, and a summary of their water licence information. The major population centre is the Town of Rocky Mountain House (6,874 residents). Of the two rural municipalities, Clearwater County holds virtually all of the population (6,887 residents). O'Chiese Band has the highest population among the Aboriginal settlements (450 residents).

5.1.2 Allocations

As of 2005, there were 12 active municipal water licences for seven licensees in Ram Sub-basin. These licences allow maximum withdrawals of 2,388 dam^3 per year. As shown in Figure 5-1 municipal water uses account for 31 percent of all licensed water allocations in the basin. About 92 percent of the municipal allocation is for Rocky Mountain House.

Surface water licences account for 97 percent of total municipal water allocations. The maximum amount of surface water that can be withdrawn in Ram Sub-basin by the municipal sector is 2,316 dam^3. Urban municipal licences account for the majority of surface water allocations (2,353 dam^3). In contrast, surface water allocations for rural municipal uses amounted to only 21 dam^3 and allocations for other municipal uses totaled 14 dam^3.

Groundwater licences represent three percent of total municipal water allocations. Licences allow withdrawals of up to 72 dam^3, of which urban users can withdraw up to 40 dam^3. Rural

users can withdraw up to 21 dam^3 of groundwater and other users are allocated withdrawals of 11 dam^3.

Licensees that are not municipalities but have municipal water use licences within the Ram Sub-basin are shown in Table 5-2.

Table 5-2 Municipal Populations and Water allocations within Ram Sub-basin

Municipal Name		2006 Population	Source	2005 Allocation (dam^3)
Urban	Town of Rocky Mountain House	6,874	Surface	2188.2
Rural	Clearwater County	6,887	Groundwater	40.5
	Brazeau County	1		
Aboriginal	O'Chiese Band	450		
	SUNCHILD FIRST NATION	47		
	STONEY BAND	14		

5.1.3 Allocations

As of 2005, there were 12 active municipal water licences held by seven licensees in Ram Sub-basin. These licences allow maximum withdrawals of 2,388 dam^3 per year. As shown in Figure 5-1, municipal water uses account for 31 percent of all licensed water allocations in the basin. About 92 percent of the municipal allocation is for Rocky Mountain House.

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Groundwater licences represent three percent of total municipal water allocations. Licences allow withdrawals of up to 72 dam^3, of which urban users can withdraw up to 40 dam^3. Rural users can withdraw up to 21 dam^3 of groundwater and other users are allocated withdrawals of 11 dam^3.

Licensees that are not municipalities but have municipal water use licences within the Ram Sub-basin are shown in Table 5-3.

Table 5-3 Additional Municipal Water Use Licensees in the Ram Sub-basin

Licensee	Water Source	Allocation (dam^3)
ALBERTA INFRASTRUCTURE AND TRANSPORTATION	SURFACE	124.6
S & LYDIA WAGNER	GROUNDWATER	12.3
DEVON CANADA CORPORATION	GROUNDWATER	8.6
GOLDEYE FOUNDATION SOCIETY	GROUNDWATER	8.5
SHUNDA CREEK HOSTEL	SURFACE	3.7
ALBERTA INFRASTRUCTURE AND TRANSPORTATION	GROUNDWATER	2.0

5.1.4 Licensed Water Use

Table 5-4 summarizes licensed water use for the municipal sector in the Ram Sub-basin. Under the terms of these licences, a maximum of 326 dam^3 is assigned for use (i.e. 14 percent of allocations can be consumed and/or lost) with the remainder (86 percent or 2,062 dam^3) assigned to be returned. Designated return flow for urban surface water licences is 88 percent of allocations whereas there is no return flow requirement for urban groundwater, rural and other municipal uses.

5.1.5 Actual Water Use

Water use data from the MWWS is available for the Town of Rocky Mountain House, the primary municipal licensee in the Ram Sub-basin. The total allocation for Rocky Mountain House in 2005 was 2,188 dam^3; this represents 92 percent of all municipal allocations in the Ram Sub-basin. Based on the population growth rate from the 2004 MWWS data year to the 2006 Census year, Rocky Mountain House diverted an estimated 1,294 dam^3 of water during 2005. This represents 59 percent of the maximum entitlement.

With respect to return flow, Rocky Mountain House returned an estimated 828 dam^3 in 2005, 42 percent of the licensed return flow. Rocky Mountain House, therefore, used an estimated 467 dam^3 of water in 2005, which is more than twice as much as its licensed use. Given that Rocky Mountain House represents 92 percent of municipal allocations in the Ram Sub-basin, it was deemed reasonable to use the diversion to allocation ratio for Rocky Mountain House to estimate water diversion among the licensees representing the remaining 8 percent of Ram Sub-basin municipal allocations. Rocky Mountain House's actual to licensed return ratio was used to estimate water use among the other urban surface water licensees, while no return flow was assumed for other types of municipal uses that have no licensed return flow requirements.

The estimated water use among sub-basin municipal water licensees is calculated to be 546 dam^3, of which surface water use represents 504 dam^3 and groundwater use represents 43 dam^3.[1] This estimate, however, does not take into account water use by residents of the sub-basin who are not serviced under municipal water licences. If one were to assume that residents of Ram sub-basin whose water use is not associated with a municipal water licence use water at the same per capita rate as residents of Rocky Mountain House do, then the sub-basin municipal water use estimate would increase in proportion to the population represented by unlicensed users. It should be noted, however, that rural residents not covered by a municipal water licence would not have the same per capita water use profile as an urban area such as Rocky Mountain House because commercial and industrial users within an urban municipality are also serviced by the municipal licence, which drives up per capita use. Therefore, if one wishes to account for rural unlicensed residential use, the residential component of urban municipal use should be utilized.

[1] These values are not distinguishable in Table 5-4 because the table shows estimates combining licensed and unlicensed municipal use.

Based on analysis of MWWS water and wastewater flow data, Rocky Mountain House had an estimated residential water use of 176 dam^3 during 2005, and a population of 6,874 people, for a per capita residential water use of 26 m^3 per year. The population within the sub-basin not serviced under a municipal water licence is 7,399. Estimated water use among unlicensed residents of the basin is therefore 190 dam^3. Although the proportions of groundwater and surface water use are not known among unlicensed municipal users in Ram Sub-basin, it was assumed that 75 percent of unlicensed rural residents use groundwater and 25 percent use surface water, given that the majority is likely to be drawing from private wells. Thus, the total municipal water use estimate for Ram Sub-basin including licensed municipal and unlicensed residential use is 736 dam^3, as shown in Table 5-4.

Table 5-4 Licensed Municipal Allocations and Use and Actual Use, Ram Sub-basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Actual Water Use (dam3)		
			Allocation	Water Use	Return Flow	Diversion	Estimated Use	Return Flow
Urban*	Surface	4	2,312.8	250.4	2,062.4	1,368	501	867
	Groundwater	1	40.5	40.5	0.0	24	24	0
	Subtotal	**5**	**2,353.3**	**290.9**	**2,062.4**	**1,392**	**525**	**867**
Rural**	Surface	0	N/A	N/A	N/A	125	45	75
	Groundwater	2	21.0	21.0	0.0	375	134	226
	Subtotal	**2**	**21.0**	**21.0**	**0.0**	**501**	**179**	**301**
Other***	Surface	1	3.7	3.7	0.0	3.0	8	0.0
	Groundwater	4	10.5	10.5	0.0	8.0	24	0.0
	Subtotal	**5**	**14.2**	**14.2**	**0.0**	**11.0**	**32.0**	**0.0**
Total	Surface	5	2,316.5	254.1	2,062.4	1,496.0	554	942
	Groundwater	7	72.0	72.0	0.0	408	182	226
	Total	**12**	**2,388.4**	**326.1**	**2,062.4**	**1,904**	**736**	**1,168**

* 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

5.1.6 Future Water Use Forecasts

Figure 5-7 shows low, medium and high population projection scenarios for Ram Sub-basin based on Alberta Finance Census Division projections. The population forecasts in Figure 5-7 have been used to predict future municipal surface and groundwater use. The resulting forecasts of water use are provided in Table 5-5, and are based on the estimated per capita water use in 2005.

Figure 5-7 Ram Sub-basin Population Growth Forecasts

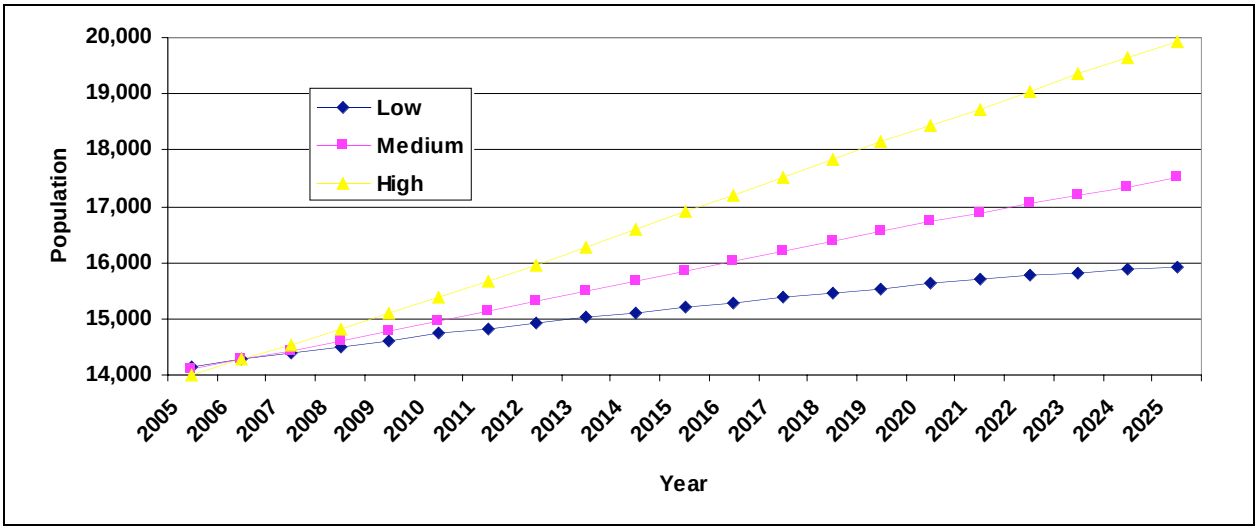


Table 5-5 Projected Municipal Water Use in the Ram Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Population Growth	Surface	554	578	596	613	625
	Groundwater	182	189	195	201	205
	Total	**736**	**767**	**791**	**814**	**830**
Medium Population Growth	Surface	554	588	623	658	688
	Groundwater	182	193	204	215	226
	Total	**736**	**781**	**827**	**873**	**914**
High Population Growth	Surface	554	609	668	729	788
	Groundwater	182	199	219	239	258
	Total	**736**	**808**	**887**	**968**	**1,046**

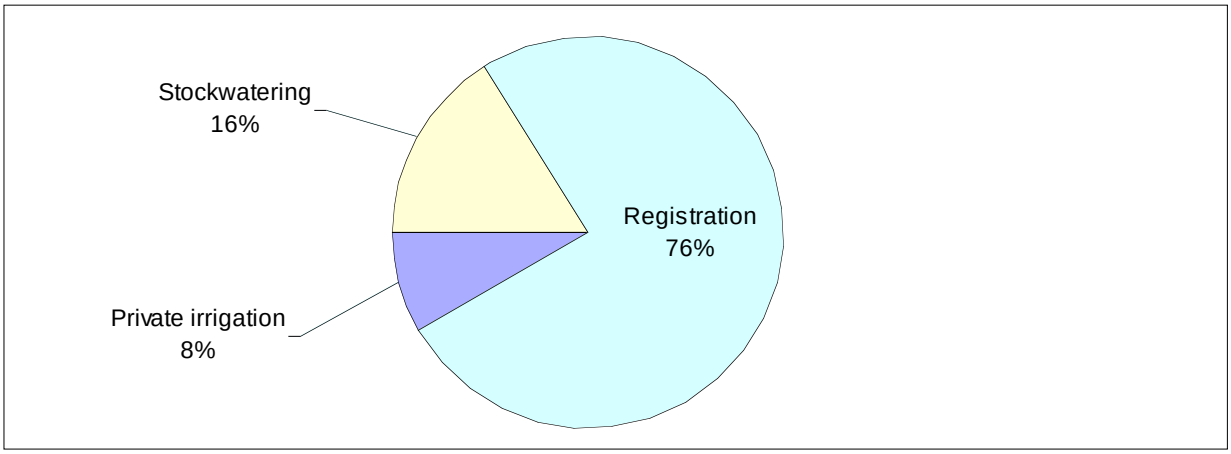
Under the Low Population Growth scenario, municipal water use in 2025 is expected to be 13 percent greater than at present and actual water use will be 254 percent of the licensed use amount. Under the High Population Growth scenario, water use will increase by 42 percent over current levels and water use is expected to be 321 percent of licensed use.

5.2 Agriculture Sector

As of December 2005 a total of 322 dam^3 had been allocated to the agricultural sector in the Ram Sub-basin. This includes 390 registrations representing 243 dam^3 and 28 licences representing 79 dam^3 of water. Water allocated to agriculture, including registration, accounts for four percent of all allocation in the Ram Sub-basin.

Figure 5-8 shows how this water is distributed among the different agricultural activities in the sub-basin. The largest allocation is for registration (76 percent). Stockwatering accounts for 16 percent and private irrigation accounts for eight percent of total allocations.

Figure 5-8 Water Allocation for Agricultural Activities in the Ram Sub-basin, 2005



A total of 165 registrations and seven licences allow withdrawal of up to 106 dam^3 of surface water; this accounts for 33 percent of water allocations for the agricultural sector. Groundwater accounts for the other 67 percent of allocations, with 216 dam^3 being allocated through 21 licences and 225 registrations.

5.2.1 Overview of Agriculture

Based on information from the 2001 Census of Agriculture, there were about 414 farms in the Ram Sub-basin (3.4 percent of North Saskatchewan total) with an average size of 625 acres. At the North Saskatchewan Basin level there are about 12,300 farms with an average size of 625 acres. Farms in the Ram Sub-basin cover an area of nearly 260,000 acres; this is equivalent to about 1,048 km^2 or about 17 percent of the sub-basin. As shown in Table 5-6, 26 percent of the land in the basin is used to raise crops. About 57 percent of agricultural land is pasture. The rest of the lands are in summer fallow or other uses.

Table 5-6 Agricultural Land Use in the Ram Sub-basin, 2001

Land Use	Acres	Percent
Crop Land	66,374	26
Summerfallow	3,416	1
Tame/Seeded Pasture	43,659	17
Natural Pasture	116,710	45
Other	28,776	11
Total	**258,935**	**100%**

The types of farming activity vary within the sub-basin. Table 5-7 shows the classification of farms based on the commodity groups that accounted for 51 percent or more of total gross farm receipts. The table shows that the Ram Sub-basin accounts for 3.4 percent of total farms in the North Saskatchewan. About 67 percent of the farms in the sub-basin raise beef cattle and about 14 percent are speciality farms. Field crop farms make up about 10 percent of the farms. Like the North Saskatchewan, cattle (beef) farms are the most common type of farm in the sub-basin, however, beef farms account for proportionately higher share. The general mix of other

types of farms is different for both Ram and North Saskatchewan with most of the farms in the sub-basin focused on cattle, speciality and field crops.

Table 5-7 Classifications of Farms in the Ram Sub-basin and North Saskatchewan, 2001

Farm Type (Farms with Gross Receipts >$2,500)	Percent of Farms in the Sub-basin	Percent Share of North Saskatchewan	North Saskatchewan Farm Type (Percent)
Dairy Farms	2.4%	4.1%	1.9%
Cattle (beef) Farms	66.9%	4.9%	45.8%
Hog Farms	0.8%	2.0%	1.4%
Poultry & Egg Farms	0.3%	1.1%	1.1%
Wheat Farms	0.2%	0.1%	4.2%
Grain & Oilseed Farms	2.2%	0.4%	19.6%
Field Crop Farms	10.4%	4.1%	8.6%
Fruit Farms	0.0%	0.1%	0.2%
Misc. Specialty Farms	14.0%	3.7%	12.9%
Sum of Livestock Comb. Farms	1.4%	1.8%	2.6%
Sum of Vegetable Farms	0.0%	0.0%	0.1%
Sum of Other Comb Farms	1.5%	3.5%	1.5%
Total	**100%**	**3.4%**	**100%**

5.2.2 Stockwatering

As noted in Table 5-7 about 70 percent of farms in the Ram Sub-basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species are provided in Table 5-8. The table shows that there are about 44,000 cattle and calves which, together, accounted for about 65 percent of the livestock population. Other livestock in the sub-basin included poultry, pigs, sheep and lamb, horses and ponies, bison, deer and elk.

Table 5-8 Estimated Livestock Populations in the Ram Sub-basin, 2001

Livestock Species	Ram	North Saskatchewan	% North Saskatchewan
Hens and Chicken	17,986	3,090,930	0.6%
Turkey	42	41,519	0.1%
Cattle	32,073	990,169	3.2%
Calves	12,544	365,725	3.4%
Pigs	3,977	232,169	1.7%
Sheep and Lamb	959	55,204	1.7%
Horse and Ponies	1,484	35,172	4.2%
Bison	279	18,906	1.5%
Deer	56	2,864	1.9%
Elk	202	6,426	3.2%

5.2.2.1 Water Allocation

Overall, 416 licences and registrations have been issued for livestock watering with total allocation amounting to 298 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 sub-basin is not known. Furthermore, the numbers of "exempted agricultural" users are also not known in the sub-basin.

Table 5-9 summarizes current water licences and registrations issued for livestock according to the water source. It shows that surface water accounts for about 27 percent of allowable diversions for livestock and that registrations account for 83 percent of the allocations.

5.2.2.2 Licensed Water Use

Table 5-9 shows that licenses do not include an allowance for return flow. Licenses expected that all water diverted will be used. There is no return flow; the entire allocations can be used.

5.2.2.3 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 Ram Sub-basin. However, a reasonable estimate of water use can be derived using the actual animal population in the basin as shown in Table 5-8. Based on livestock populations for the Ram Sub-basin in 2001, the total water required for livestock was estimated to be 386 dam^3, or about 130 percent of the licensed allocation.[2] The calculations for this estimate are provided also in Table 5-10 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".[3] In terms of water requirements by species, cattle accounts for about 90 percent of the total, about 3 percent is required by pigs, and all other species accounted for the remaining 7 percent.

[2] 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.

[3] http://www3.gov.ab.ca/env/water/Legislation/Approvals_Licences/CalculationChart.doc.

Table 5-9 Summary of Water Licences and Registrations Issued for Livestock Watering in the Ram Sub-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)
Registration	Surface	165	65.1	65.1	0.0	0	N/A
	Groundwater	225	178.1	178.1	0.0	0	N/A
	Subtotal	390	243.2	243.2	0.0	**0**	**N/A**
Stockwatering	Surface	**5**	**13.6**	**13.6**	**0.0**	0	N/A
	Groundwater	21	37.9	37.9	0.0	0	N/A
	Subtotal	26	51.5	51.5	0.0	**0**	**N/A**
Total	Surface	170	78.7	78.7	0.0	0	N/A
	Groundwater	246	216.0	216.0	0.0	0	N/A
	Total	**416**	**294.7**	**294.7**	**0.0**	**0**	**N/A**

Table 5-10 Estimated Livestock Water Requirements for 2001

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chickens	17,986	0.045	1.3
Turkey	42	0.15	0.0
Bulls	704	9.0	10.5
Milk Cows	305	30.0	15.2
Beef Cows	14,168	9.0	211.5
Heifers	3,191	6.0	31.7
Steers	1,160	6.0	11.5
Calves	12,544	3.0	62.4
Boars	17	6.5	0.2
Sows and Gilts - Breeding	379	6.5	4.1
Nursing and Weaner Pigs	1,573	0.5	1.3
Grower and Finishing Pigs	2,009	1.5	5.0
Sheep and Lambs	959	2.0	3.2
Horse and Ponies	1,484	10.0	24.6
Bison	279	2.0	0.9
Deer	56	10.0	0.9
Elk	202	3.5	1.2
Total			**385.6**

The estimated actual consumption (386 dam^3) based on livestock populations shown in Table 5-10 does 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 73 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 441 dam^3 would be required to support the animal populations in Table 5-10. This water requirement is about 150 percent of the water allocation through licences and registrations. Consequently, it is assumed that actual water use is greater than the amount of water licensed for livestock. It is also expected that most 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

Future water use is dependent on future livestock population in the sub-basin. Information from the NRCB indicates that, as of December 31, 2005, there had been no applications from farmers throughout the sub-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 cattle. Figures 2-3 and 2-4 in Section 2.3 show areas where there is capability for supporting a 5,000-head back grounding operation and a 20,000-head operation. The figures show that there are no townships that meet all of the criteria for both types of operations. For townships that meet some of the criteria, limiting factors include groundwater, landscape and silage for backgrounding operations. For finishing operations limiting factors include silage. Based on Alberta Agriculture's assessment, it would appear that livestock expansion in the Ram Sub-

basin is unlikely. Consequently, livestock water use is expected to remain unchanged at 441 dam^3 for the duration of the forecast period across all growth scenarios (Table 5-11).

Table 5-11 Projected Water Use for Livestock in the Ram Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low, Medium, High Growth	Surface	158	158	158	158	158
	Groundwater	283	283	283	283	283
	Total	**441**	**441**	**441**	**441**	**441**

5.2.3 Irrigation

The other major use of water for agricultural purposes is irrigation or crop watering. 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 five acres of land in the Ram Sub-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 22 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.

5.2.3.1 Water Allocation

There are two licences that allocate approximately 27 dam^3 for irrigation purposes. All of this allocation is from surface water.

5.2.3.2 Licensed Use

Table 5-14 shows that licenses issued for irrigation assume that there will be no return flow; the entire allocations is expected to be used.

5.2.3.3 Actual Water Use

Neither Alberta Agriculture nor Alberta Environment have 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 actual stockwatering use in the sub-basin (441 dam^3) is 16 times the amount of water used for crop watering.

5.2.3.4 Forecasts of Future Irrigation Water Use

With no expansion of livestock, additional demand for forage is not expected. Irrigation water use is projected to remain at 27 dam^3 over the forecast period (Table5-12).

Table 5-12 Projected Water Use for Irrigation in the Ram Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low, Medium, High Growth	Surface	27	27	27	27	27
	Groundwater	0	0	0	0	0
	Total	**27**	**27**	**27**	**27**	**27**

5.2.4 Summary

In summary, current agricultural water use in the Ram Sub-basin is estimated to be about 468 dam^3, of which 94 percent is for stockwatering and six percent is for irrigation. Agricultural water demand in the basin is expected to remain unchanged over the forecast period. A summary of future agricultural water demand is provided in Table 5-13.

Table 5-13 Projected Water Use for Agriculture in the Ram Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low, Medium, High Growth	Surface	185	185	185	185	185
	Groundwater	283	283	283	283	283
	Total	**468**	**468**	**468**	**468**	**468**

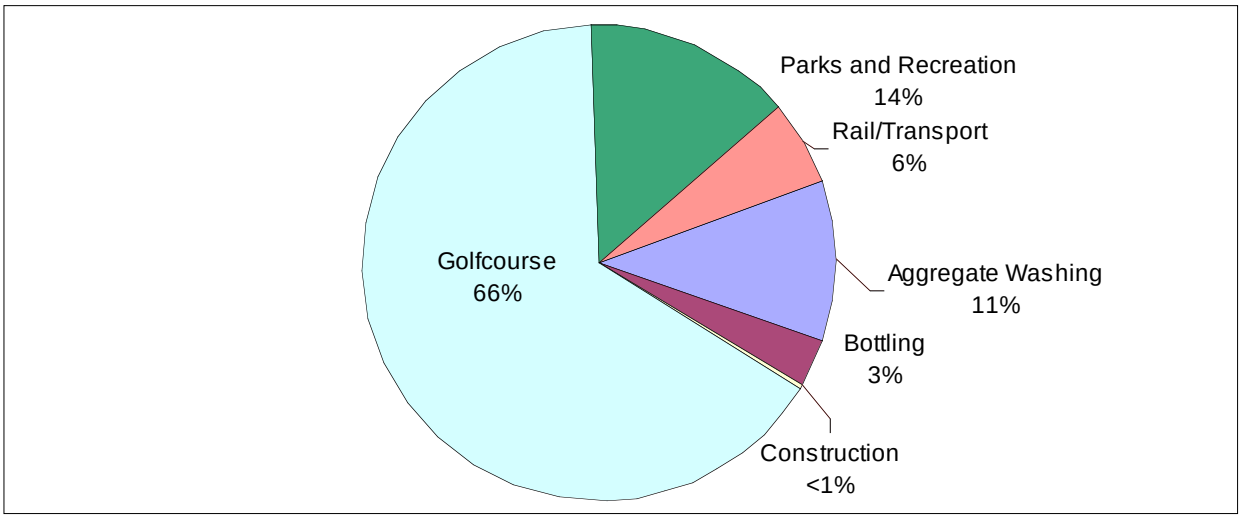
Table 5-14 Irrigation Allocations and Use and Reported Actual Water Use, Ram Sub-basin

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	2	27.1	27.1	0.0	0	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Subtotal	**2**	**27.1**	**27.1**	**0.0**	**0**	**N/A**
Total	Surface	2	27.1	27.1	0.0	0	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Total	**2**	**27.1**	**27.1**	**0.0**	**0**	**N/A**

5.3 Commercial Sector

There are 13 licences that allow diversion of 126 dam^3 of water in the Ram sub-basin. This allocation accounts for about two percent of total allocations in the sub-basin.

Figure 5-9 Water Allocation for Commercial Activities in the Ram Sub-basin



5.3.1 Water Allocations

Figure 5-9 shows how this allocation is distributed among the various commercial sector activities, including golf course (66 percent), parks and recreation (14 percent), aggregate washing (11 percent), rail/transport (6 percent), bottling (three percent), and construction (less than one percent). Surface water accounts for 73 percent of the allocations and the largest allocation is for golf course. Groundwater accounts for 27 percent of the allocations and, like surface water, the largest allocation is also for golf course.

5.3.2 Licensed Water Use

Table 5-15 provides a summary of licensed allocations, use and return for various activities within the commercial sector in the Ram sub-basin. The table shows that all of the allocations are licensed to be used with no requirements for return flow.

5.3.3 Actual Water Use

At the present time Alberta Environment's Water Use Reporting System contains no information on actual water use in 2005 by any of the licensees in the commercial sector in the Ram sub-basin. Given the lack of information on actual water use, it is assumed that all licensees are withdrawing and using the full amount of water to which they are entitled. Although this assumption will overstate the actual commercial sector water use, this sector accounts for about two percent of total allocations in the sub-basin so overall water use estimates are likely to be greatly unaffected.

Table 5-15 Licensed Commercial Allocations, Reported and Actual Water Use, Ram Sub-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	0	0.0	0.0	0.0	0	N/A	N/A
	Groundwater	2	13.5	13.5	0.0	0	N/A	N/A
	Subtotal	**2**	**13.5**	13.5	**0.0**	**0**	**N/A**	**N/A**
Bottling	Surface	2	4.4	4.4	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**2**	**4.4**	4.4	**0.0**	**0**	**N/A**	**N/A**
Construction	Surface	1	0.5	0.5	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**1**	**0.5**	0.5	**0.0**	**0**	**N/A**	**N/A**
Golf Courses	Surface	1	82.6	82.6	0.0	0	N/A	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A	N/A
	Subtotal	**1**	**82.6**	82.6	**0.0**	**0**	**N/A**	**N/A**
Parks and Recreation	Surface	1	4.9	4.9	**0.0**	0	N/A	N/A
	Groundwater	5	13.1	13.1	**0.0**	0	N/A	N/A
	Subtotal	**6**	**18.0**	18.0	**0.0**	**0**	**N/A**	**N/A**
Rail/Transport	Surface	0	0.0	0.0	**0.0**	0	N/A	N/A
	Groundwater	2	9.9	9.9	**0.0**	0	N/A	N/A
	Subtotal	**2**	**9.9**	9.9	**0.0**	**0**	**N/A**	**N/A**
Total	Surface	5	92.5	92.5	0.0	0	N/A	N/A
	Groundwater	8	33.9	33.9	0.0	0	N/A	N/A
	Total	**13**	**126.4**	**126.4**	**0.0**	**0**	**N/A**	**N/A**

5.3.4 Future Water Use Forecasts

Since most of the allocation (91 percent) is for three activities – golf courses, parks and recreation, and aggregate washing, forecasts of future demand will be based on those activities.

5.3.4.1 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. However, the population growth must be at a level that can, at a minimum, sustain one nine hole course before an expansion is expected to occur (*i.e.*. golf course expansion is not linearly related to population growth). Using this assumption and given the population growth rate in the Ram Sub-basin golf course expansion is not likely. Golf course water use is expected to remain unchanged at 83 dam^3 over the forecast period across all growth scenarios. This method also assumes that the proportion of surface and groundwater will not change over the forecast period relative to 2005. Table 5-16 shows the expected water use for golf course

Table 5-16 Projected Water Use for Golf Courses, Ram Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low, Medium, High Growth	Surface	83	83	83	83	83
	Groundwater	0	0	0	0	0
	Total	**83**	**83**	**83**	**83**	**83**

5.3.4.2 Parks and Recreation

Future water use is expected to increase as a result of regional population growth. Projections are based on 0.6 percent annual growth for the Low Growth scenario, 1.2 percent for the Medium Growth scenario and 2.1 percent for the High Growth scenario. The resulting projections are shown in Table 5-17.

Table 5-17 Projected Water Use for Parks and Recreation, Ram Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	5	5	5	5	6
	Groundwater	13	13	14	14	15
	Total	**18**	**19**	**19**	**20**	**20**
Medium Growth	Surface	5	5	6	6	6
	Groundwater	13	14	15	16	17
	Total	**18**	**19**	**20**	**22**	**23**
High Growth	Surface	5	6	6	6	7
	Groundwater	13	14	15	16	17
	Total	**18**	**20**	**21**	**23**	**24**

In 2025 water use is expected to be 20 dam^3 under Low Growth which is an 11 percent increase from 2005. Under High Growth water use is expected to 24 dam^3 which is a 33 percent increase. Water use is expected to be 28 percent higher by 2025 under Medium Growth.

5.3.4.3 Aggregate Washing

Demand for aggregate material (and water use) is related to the level of economic activity, particularly construction so the water use 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 (Medium Growth) and 3.2 percent (High Growth). Projections using these assumptions are shown in Table 5-18. It is noted that although one of the licences is set to expire by 2011, it is assumed that the licence will be renewed for the duration of the forecast period under similar terms and conditions.

Table 5-18 Projected Water Use for Aggregate Washing
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	0	0	0	0	0
	Groundwater	14	15	16	17	18
	Total	**14**	**15**	**16**	**17**	**18**
Medium Growth	Surface	0	0	0	0	0
	Groundwater	14	16	17	19	22
	Total	**14**	**16**	**17**	**19**	**22**
High Growth	Surface	0	0	0	0	0
	Groundwater	14	16	19	22	26
	Total	**14**	**16**	**19**	**22**	**26**

Water use in 2025 is expected to be 18 dam^3 under Low Growth which is a 29 percent increase from 2005. Under High Growth water use is expected to 26 dam^3 which is an 86 percent increase. Water use is expected to be 57 percent higher by 2025 under Medium Growth.

5.3.5 Summary

A summary of the projected water demand for the commercial sector in the Ram Sub-basin is provided in Table 5-19. Note that this forecast combines the estimates for golf courses, parks and recreation, and aggregate washing (which together account for 91 percent of allocation in the sub-basin), with the assumption that all of the water use allowed for the remaining commercial activities is being fully utilized.

Under Low Growth scenario, water use in 2025 is projected to rise to 133 dam^3, a 5 percent increase from current levels. Under the High Growth scenario, water use is projected to rise to 145 dam^3, a 14 percent increase. Water use is projected to increase by 10 percent from the current level by 2025 under Medium Growth.

Table 5-19 Projected Water Use for the Commercial Sector, Ram Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	93	93	93	93	94
	Groundwater	34	35	37	38	39
	Total	**127**	**128**	**130**	**131**	**133**
Medium Growth	Surface	93	93	94	94	94
	Groundwater	34	36	39	42	45
	Total	**127**	**130**	**133**	**136**	**139**
High Growth	Surface	93	94	94	94	95
	Groundwater	34	38	41	46	51
	Total	**127**	**131**	**135**	**140**	**145**

5.4 Petroleum Sector

In the Ram Sub-basin, there are 23 active licences which allocate 4,548 dam^3 of water to the petroleum sector (Table 5-20) Petroleum allocations accounts for about 60 percent of total allocations in the sub-basin. Most of the water allocated (69 percent) is for surface water (3,132 dam^3).

Almost all of the water allocated to the petroleum sector in the Ram Sub-basin is for injection activities (4,546 dam^3), but a small amount of water has been licensed to gas and petrochemical plants (1 dam^3).

5.4.1 Injection

There are 22 water licences issued for injection activities in the Ram Sub-basin. They allow withdrawals of up to 1,415 dam^3 of surface water and 3,132 dam^3 of groundwater. Injection water allocations commenced in the 1960s and have increased overtime. Licensees are expected to consume 100 percent of the water they are allowed to withdraw.

5.4.1.1 Actual Water Use

Detailed summaries of reported water used for injection have been prepared by Geowa based on EUB data and are presented in Table 5-19 In 2005, an estimated 1,849 dam^3 of fresh water was diverted for injection purposes. This volume includes 1,272 dam^3 of surface water and 577 dam^3 of groundwater. Based on the data, injection activities in the sub-basin are currently diverting and using approximately 41 percent of their licensed allocations and use.

Table 5-20 Licensed Allocations, Estimated Actual Water Use for the Petroleum Sector, Ram Sub-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	4	3,131.8	3,131.8	0.0	1,272	41%	41%
	Groundwater	18	1,414.5	1,414.5	0.0	575	41%	41%
	Subtotal	**22**	**4,546.3**	**4,546.3**	**0.0**	**1,848***	**41%**	**41%**
Gas/ Petrochemical Plant	Surface	0	0.0	0.0	0.0	0		
	Groundwater	1	1.3	1.3	0.0	1	100%	100%
	Subtotal	**1**	**1.3**	**1.3**	**0.0**	**1****	**100%**	**100%**
Total	Surface	4	3,131.8	3,131.8	0.0	1,273	41%	41%
	Groundwater	19	1,415.7	1,415.7	0.0	577	41%	41%
	Total	**23**	**4,547.5**	**4,547.5**	**0.0**	**1,849**	**41%**	**41%**

* EUB water use data provided by Geowa.
** Estimates assume the licensee is using the full entitlement of their licence.

5.4.1.2 Forecasts

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 forecasts from the EUB and CAPP have oil production decreasing by between 30 and 38 percent between 2005 and 2015, with 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 Ram Sub-basin in Table 5-20 assumes declining rates of water use required that match the rates at which oil production in Alberta is expected to decline.

Table 5-21 Forecast of Injection Water Use in the Ram Sub-basin

(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Production	Surface	1,272	1,272	746	746	445
	Groundwater	577	577	338	338	202
	Total	**1,849**	**1,849**	**1,084**	**1,084**	**647**
Medium Production	Surface	1,272	1,272	785	785	468
	Groundwater	577	577	356	356	213
	Total	**1,849**	**1,849**	**1,141**	**1,141**	**681**
High Production	Surface	1,272	1,272	891	891	532
	Groundwater	577	577	404	404	242
	Total	**1,849**	**1,849**	**1,295**	**1,295**	**774**

Petroleum forecasts are unavailable 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 Production scenario, water use for injection in 2025 will decline by 65 percent from current levels. Under the High Production scenario, the decline will be 58 percent.

5.4.2 Gas/Petrochemical Plants

In the Ram Sub-basin, one groundwater licence that has been issued for gas and petrochemical plant activities allowing withdrawals of up to 1.3 dam^3. Gas and petrochemical plant water allocations commenced in the 1990s. Licensees are expected to consume 100 percent of the groundwater they are allowed to withdraw.

There is no information on the actual water diversions and consumption for the single gas and petrochemical plant licence and, for purposes of this analysis; it is assumed that the licence holder is using their full entitlement. In the absence of information about this component of the petroleum sector, it is assumed that water use by gas and petrochemical plants in the Ram Sub-basin will remain constant for the forecast period.

5.4.3 Summary

Petroleum water allocations account for almost 60 percent of the allocations in the Ram Sub-basin. Almost all of petroleum water allocations and use are for injection. Water use data show that although water licences allow up to 4,546 dam^3 of water to be consumed for injection purposes, licensees are using about 41 percent of this amount.

It is expected that in the future there will be a slight decline in water requirements for injection activities as oil production from existing oilfields decline. Water requirements for gas and petrochemical facilities in the Ram Sub-basin are not expected to change over the forecast period. The overall water use projections for the petroleum sector are provided in Table 5-22.

Table 5-22 Forecast of Petroleum Water Use in the Ram Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,272	1,272	746	746	445
	Groundwater	577	577	338	338	202
	Total	**1,849**	**1,849**	**1,084**	**1,084**	**647**
Medium Growth	Surface	1,272	1,272	785	785	468
	Groundwater	577	577	356	356	213
	Total	**1,849**	**1,849**	**1,141**	**1,141**	**681**
High Growth	Surface	1,272	1,272	891	891	532
	Groundwater	577	577	404	404	242
	Total	**1,849**	**1,849**	**1,295**	**1,295**	**774**

Under the Low Production scenario, water use for petroleum activities in 2025 will decline by 65 percent from current levels. Under the High Production scenario, the decline will be 58 percent.

5.5 Industrial Sector

In the Ram Sub-basin, there are two active groundwater licences which allocate 5.1 dam^3 of water to the industrial sector. Industrial allocations accounts for 0.1 percent of total allocations in the sub-basin. There are two groundwater licences: one for mining other than coal (4.9 dam^3) and one for other industrial activities (0.2 dam^3). The two licences assumed that all water withdrawals will be consumed (Table 5-23)

There is no information on actual water use diversions or consumption for the two water licences for these activities. For the 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 5-24).

Table 5-23 Forecast of Industrial Water Use in the Ram Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low, Medium, High Growth	Surface	0	0	0	0	0
	Groundwater	5	5	5	5	5
	Total	**5**	**5**	**5**	**5**	**5**

Table 5-24 Licensed Allocations and Estimated Water Use for the Industrial Sector, Ram Sub-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
Mine-other	Surface	0	0.0	0.0	0.0	0.0	0%	0%
	Groundwater	1	4.9	4.9	0.0	5	100%	100%
	Subtotal	**1**	**4.9**	**4.9**	**0.0**	**5***	**100%**	**100%**
Other Industrial	Surface	0	0.0	0.0	0.0	0	0%	0%
	Groundwater	1	0.2	0.2	0.0	0	100%	100%
	Subtotal	**1**	**0.2**	**0.2**	**0.0**	**0***	**100%**	**100%**
Total	Surface	0	0.0	0.0	0.0	0		
	Groundwater	2	5.1	5.1	0.0	5	100%	100%
	Total	**2**	**5.1**	**5.1**	**0.0**	**5**	**100%**	**100%**

* Actual water use is assumed to be 100 percent of licensed consumption.

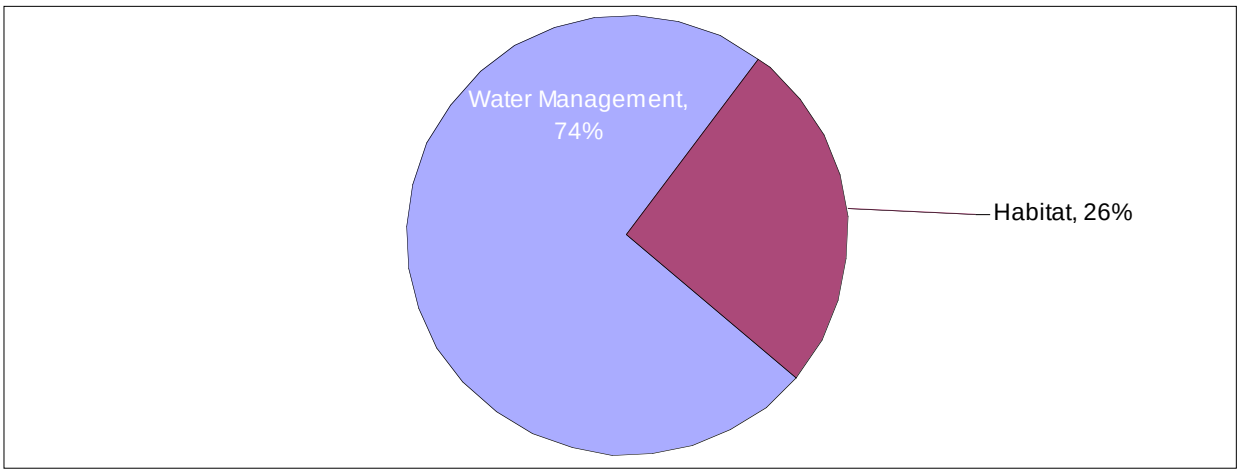
5.6 Other Sector

In the Ram Sub-basin there are seven active licences which allocate 244 dam^3 of water to the other sector, These licences expect that most water will be used and small amounts (7.7 dam^3 will be returned after use. The other sector activities account for about 3 percent of licensed water use in the Ram Sub-basin and less than 1 percent in the North Saskatchewan Basin. All of the water allocated is for surface water. Other sector uses include water management for flood control and lake stabilization, and fish, wildlife and habitat enhancement (Figure 5-10).

Water licences have been issued to Alberta Environment (two), Ducks Unlimited (two), and private individuals (three). Figure 5-10.

Table 5-25 summarizes the water allocation, use, and return associated with the licences for each activity in the Ram Sub-basin.

Figure 5-10 Other Sector Water Allocation by Use in the Ram Sub-basin



5.6.1 Water Management

In the Ram Sub-basin, three surface water licences have been issued for water management activities. They allow withdrawals of up to 181 dam^3 of water. Water management water allocations commenced in the 1980s and increased slightly in the 1990s. Licence holders are expected to consume all of the water they withdraw.

There is no information on the actual water diversions and consumption for water management licences. For purposes of this analysis, it is assumed that the licence holders are using their full entitlements. In the absence of information about this component of the other sector, it is assumed that water use by water management projects in the Ram Sub-basin will remain constant for the forecast period.

Table 5-25 Licensed Allocations and Estimated Actual Water Use for the Other Sector, Ram Sub-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	3	180.9	173.2	7.7	180	100%	100%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**3**	**180.9**	**173.2**	**7.7**	**173**	**100%**	**100%**
Habitat	Surface	4	62.9	62.9	0.0	63	100%	100%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**4**	**62.9**	**62.9**	**0.0**	**63**	**100%**	**100%**
Total	Surface	7	243.8	236.1	7.8	236	100%	97%
	Groundwater	0	0.0	0.0	0.0	0		
	Total	**7**	**243.8**	**236.1**	**7.7**	**236**	**100%**	**97%**

5.6.2 Habitat Enhancement

In the Ram Sub-basin, four surface water licences have been issued for wildlife and habitat enhancement projects allow withdrawals of up to 63 dam^3 of water. Habitat enhancement allocations commenced in the 1970s and increased slightly in the 1990s. Licences assume that licensees will consume 100 percent of the water they withdraw.

There is no information on the actual water diversions and consumption for habitat enhancement licences and, for purposes of this analysis, it is assumed that the licence holders are using their full entitlements. In the absence of information about this component of the other sector, it is assumed that water used by habitat enhancement projects in the Ram Sub-basin will remain constant for the forecast period.

5.6.3 Summary

The other sector in the Ram Sub-basin is dominated by water allocated for water management. These projects account for 74 percent of the water allocation and 77 percent of the licensed water use. In the absence of information about the other sector in the Ram Sub-basin, it is assumed that water used by habitat enhancement projects will remain constant for the forecast period.

Table 5-26 Forecast of Water Use for the Other Sector in the Ram Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
	Surface	236	236	236	236	236
	Groundwater	0	0	0	0	0
	Total	**236**	**236**	**236**	**236**	**236**

5.7 Summary

Table 5-27 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the Ram Sub-basin. In total, existing licences and registrations allow a maximum of 7,632 dam^3 of water to be withdrawn. Of this total, 73 percent (5,563 dam^3) is expected to be used. Figure 5-11 shows the allocations, licensed use and actual use for the different sectors. Actual use (3,420 dam^3) is about 61 percent of licensed use. The largest water user is the petroleum sector. Figure 5-12 shows the forecasts to 2025 for all of the sectors under Medium Growth. By 2025 water use is expected to decrease by about 32 percent under Low Growth (Table 5-28), about 29 percent under Medium Growth (Table 5-29), and about 22 percent under High Growth (Table 5-30).

Table 5-27 Summary of Allocations and Estimated Water Use, Ram Sub-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		2,388	326	2,062	6%	736	226%	22%
Agricultural	Stockwatering	295	295	0	5%	441	149%	13%
	Irrigation	27	27	0	0%	27	27%	1%
Commercial		126	126	0	2%	126	100%	4%
Petroleum		4,547	4,548	0	82%	1849	41%	54%
Industrial		5	5	0	0%	5	100%	0%
Other		244	236	8	4%	236	100%	7%
Total		**7,632**	**5,563**	**2,070**	**100%**	**3,420**	**61%**	**100%**

Figure 5-11 Water Allocations and Actual Use, by Sector, Ram Sub-basin

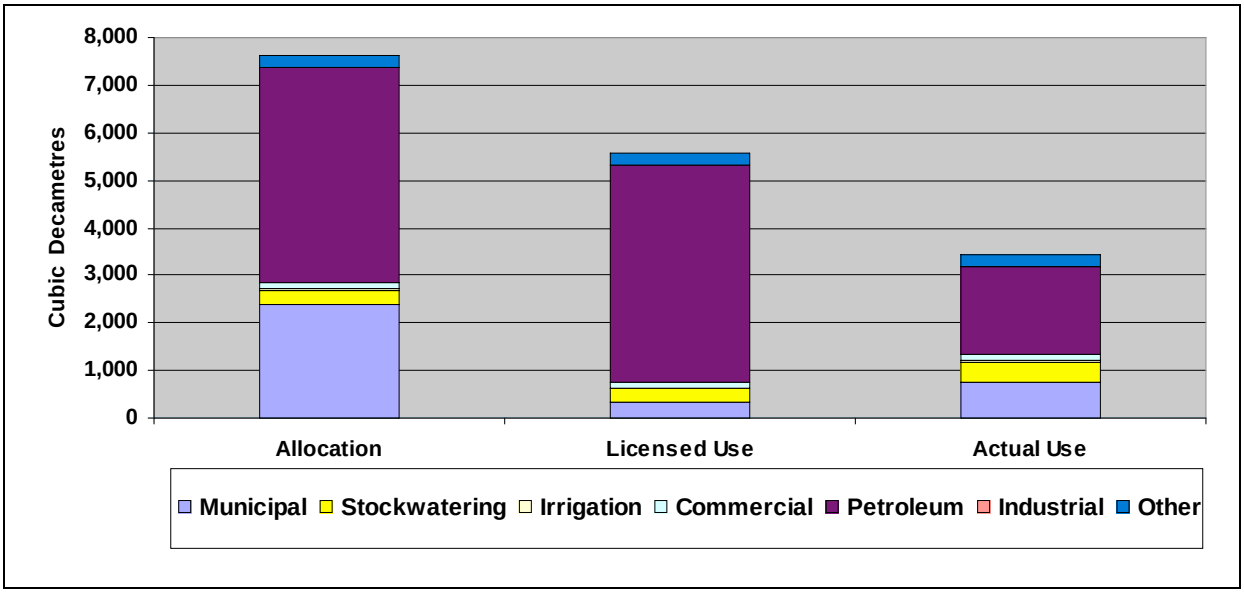


Figure 5-12 Forecast Water Use in Ram Sub-basin: Medium Scenario

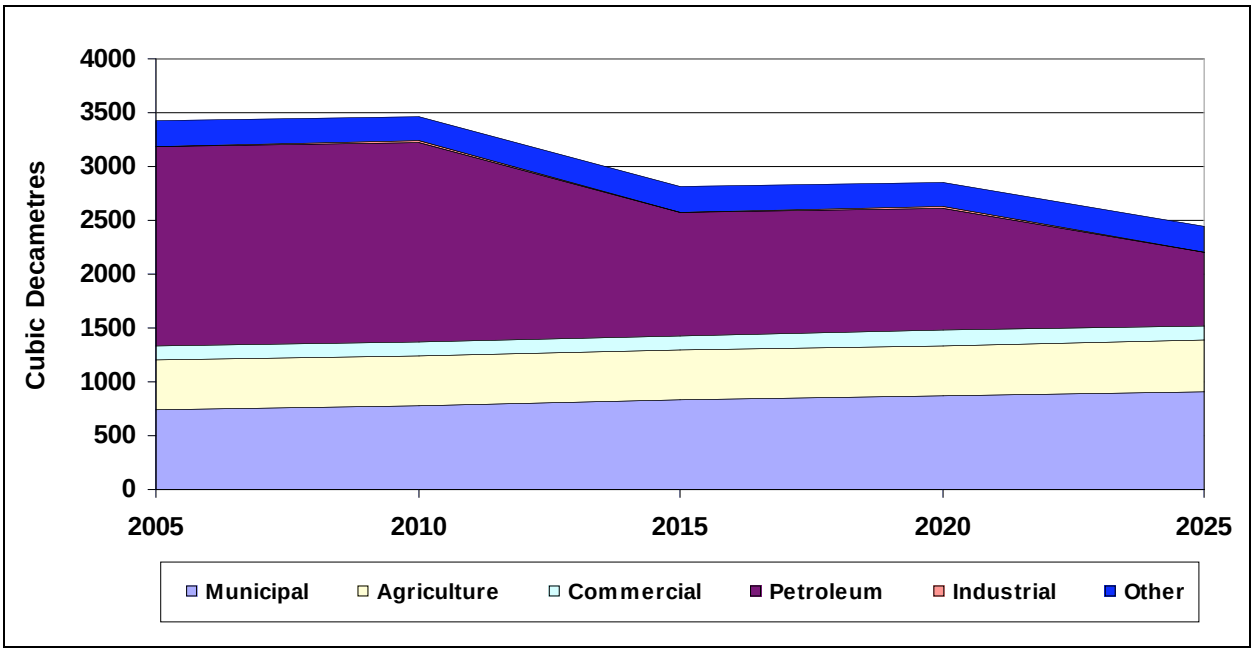


Table 5-28 Forecast Water Use, By Sector, Ram Sub-basin: Low Scenario

(dam^3)

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	554	578	596	613	625
	Agricultural	185	185	185	185	185
	Commercial	93	93	93	93	94
	Petroleum	1,272	1,272	746	746	445
	Industrial	0	0	0	0	0
	Other	236	236	236	236	236
	Total	**2,340**	**2,364**	**1,856**	**1,873**	**1,585**
Groundwater	Municipal	182	189	195	201	205
	Agricultural	283	283	283	283	283
	Commercial	34	35	37	38	39
	Petroleum	577	577	338	338	202
	Industrial	5	5	5	5	5
	Other	0	0	0	0	0
	Total	**1,081**	**1,089**	**858**	**865**	**735**
Total	Municipal	736	767	791	814	830
	Agricultural	468	468	468	468	468
	Commercial	127	128	130	131	133
	Petroleum	1,849	1,849	1,084	1,084	647
	Industrial	5	5	5	5	5
	Other	236	236	236	236	236
	Total	**3,421**	**3,454**	**2,714**	**2,739**	**2,319**

Table 5-29 Forecast Water Use, By Sector, Ram Sub-basin: Medium Scenario

(dam^3)

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	554	588	623	658	688
	Agricultural	185	185	185	185	185
	Commercial	93	93	94	94	94
	Petroleum	1,272	1,272	785	785	468
	Industrial	0	0	0	0	0
	Other	236	236	236	236	236
	Total	**2,340**	**2,374**	**1,923**	**1,958**	**1,671**
Groundwater	Municipal	182	193	204	215	226
	Agricultural	283	283	283	283	283
	Commercial	34	36	39	42	45
	Petroleum	577	577	356	356	213
	Industrial	5	5	5	5	5
	Other	0	0	0	0	0
	Total	**1,081**	**1,095**	**887**	**901**	**772**
Total	Municipal	736	781	827	873	914
	Agricultural	468	468	468	468	468
	Commercial	127	130	133	136	139
	Petroleum	1,849	1,849	1,141	1,141	681
	Industrial	5	5	5	5	5
	Other	236	236	236	236	236
	Total	**3,421**	**3,469**	**2,810**	**2,859**	**2,444**

Table 5-30 Forecast Water Use, By Sector, Ram Basin: High Scenario

(dam^3)

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	554	609	668	729	788
	Agricultural	185	185	185	185	185
	Commercial	93	94	94	94	95
	Petroleum	1,272	1,272	891	891	532
	Industrial	0	0	0	0	0
	Other	236	236	236	236	236
	Total	**2,340**	**2,396**	**2,074**	**2,135**	**1,836**
Groundwater	Municipal	182	199	219	239	258
	Agricultural	283	283	283	283	283
	Commercial	34	38	41	46	51
	Petroleum	577	577	404	404	242
	Industrial	5	5	5	5	5
	Other	0	0	0	0	0
	Total	**1,081**	**1,102**	**953**	**977**	**839**
Total	Municipal	736	808	887	968	1,046
	Agricultural	468	468	468	468	468
	Commercial	127	131	135	140	145
	Petroleum	1,849	1,849	1,295	1,295	774
	Industrial	5	5	5	5	5
	Other	**236**	**236**	**236**	**236**	**236**
	Total	**3,421**	**3,497**	**3,026**	**3,112**	**2,674**