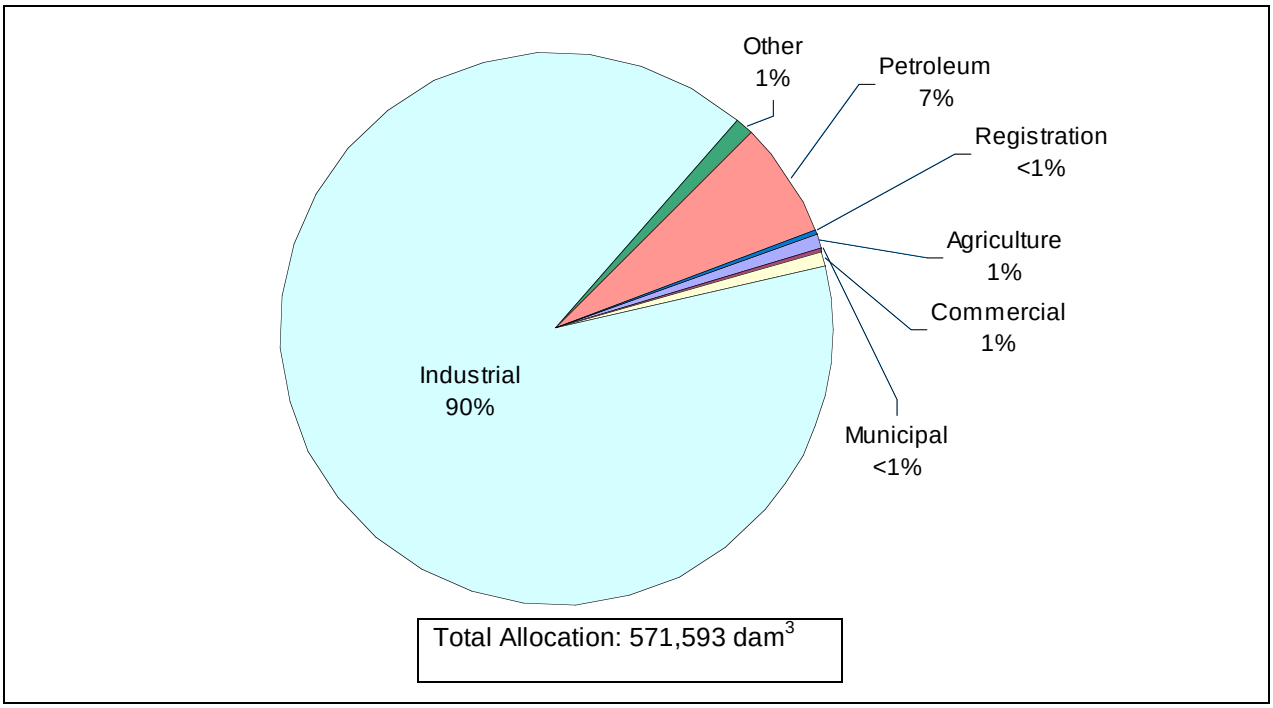
10.0 BEAVERHILL

The Beaverhill Sub-basin is about 4,400 km^2 in area and occupies approximately 8 percent of the North Saskatchewan Basin. In 2005, the sub-basin had a population of about 586,100 people, which represents about 51 percent of the Basin population, with a population density of about 133 people per square kilometre. The Beaverhill Sub-basin consists all or parts of one eight urban municipalities, six rural municipalities and one specialized municipality.

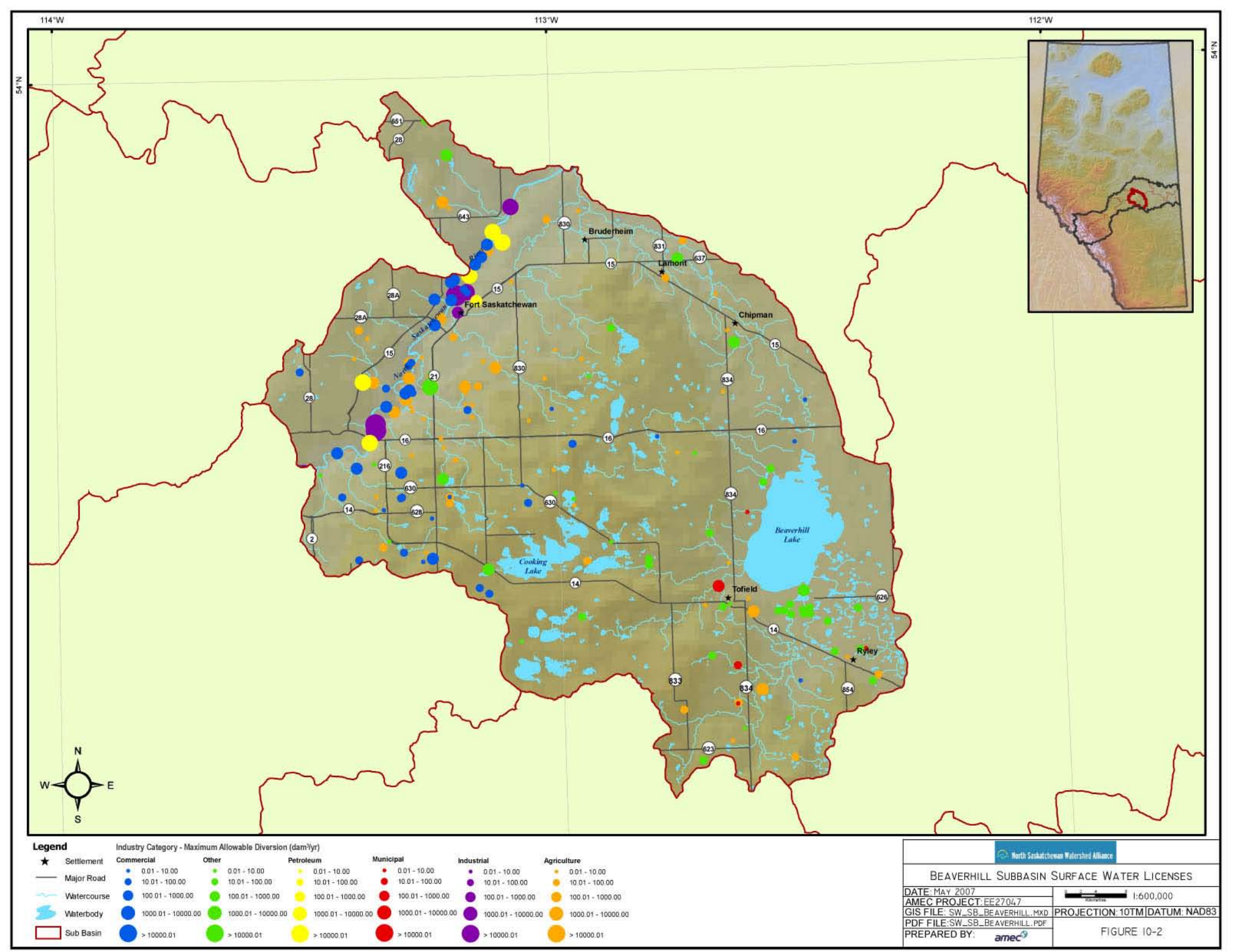
Total allocations in the sub-basin in 2005 were 571,593 dam^3. An overview of current surface and groundwater allocations is provided in Figure 10-1. It shows that the industrial sector accounts for 90 percent of total allocations or 515,113 dam^3. The remaining allocations are for agriculture (including registrations), municipal, commercial, petroleum and other sectors. Groundwater allocations (2,009 dam^3) account for less than 1 percent of allocations in the Beaverhill Sub-basin.

Figure 10-1 Distribution of Active Water Allocations in the Beaverhill Sub-basin



Figures 10-2 and 10-3 show the location, allocation and sector of all active water licences in the Beaverhill Sub-basin. The locations of registrations issued in this sub-basin are provided in Figure 10-4.

Figure 10-2 Beaverhill Sub-basin Surface Water Licences



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	0.01 - 10.00	0.01 - 10.00	0.01 - 10.00	0.01 - 10.00	0.01 - 10.00
10.01 - 100.00	10.01 - 100.00	10.01 - 100.00	10.01 - 100.00	10.01 - 100.00	10.01 - 100.00
100.01 - 1000.00	100.01 - 1000.00	100.01 - 1000.00	100.01 - 1000.00	100.01 - 1000.00	100.01 - 1000.00
1000.01 - 10000.00	1000.01 - 10000.00	1000.01 - 10000.00	1000.01 - 10000.00	1000.01 - 10000.00	1000.01 - 10000.00
> 10000.01	> 10000.01	> 10000.01	> 10000.01	> 10000.01	> 10000.01

North Saskatchewan Watershed Alliance

Beaverhill Subbasin Surface Water Licenses

DATE: May 2007	1:600,000
AMEC PROJECT: EE27047	
GIS FILE: SW_SB_Beaverhill.mxd	PROJECTION: 10TM | DATUM: NAD83
PDF FILE: SW_SB_Beaverhill.pdf	
PREPARED BY: amec	FIGURE 10-2

Figure 10-3 Beaverhill Sub-basin Groundwater Licences

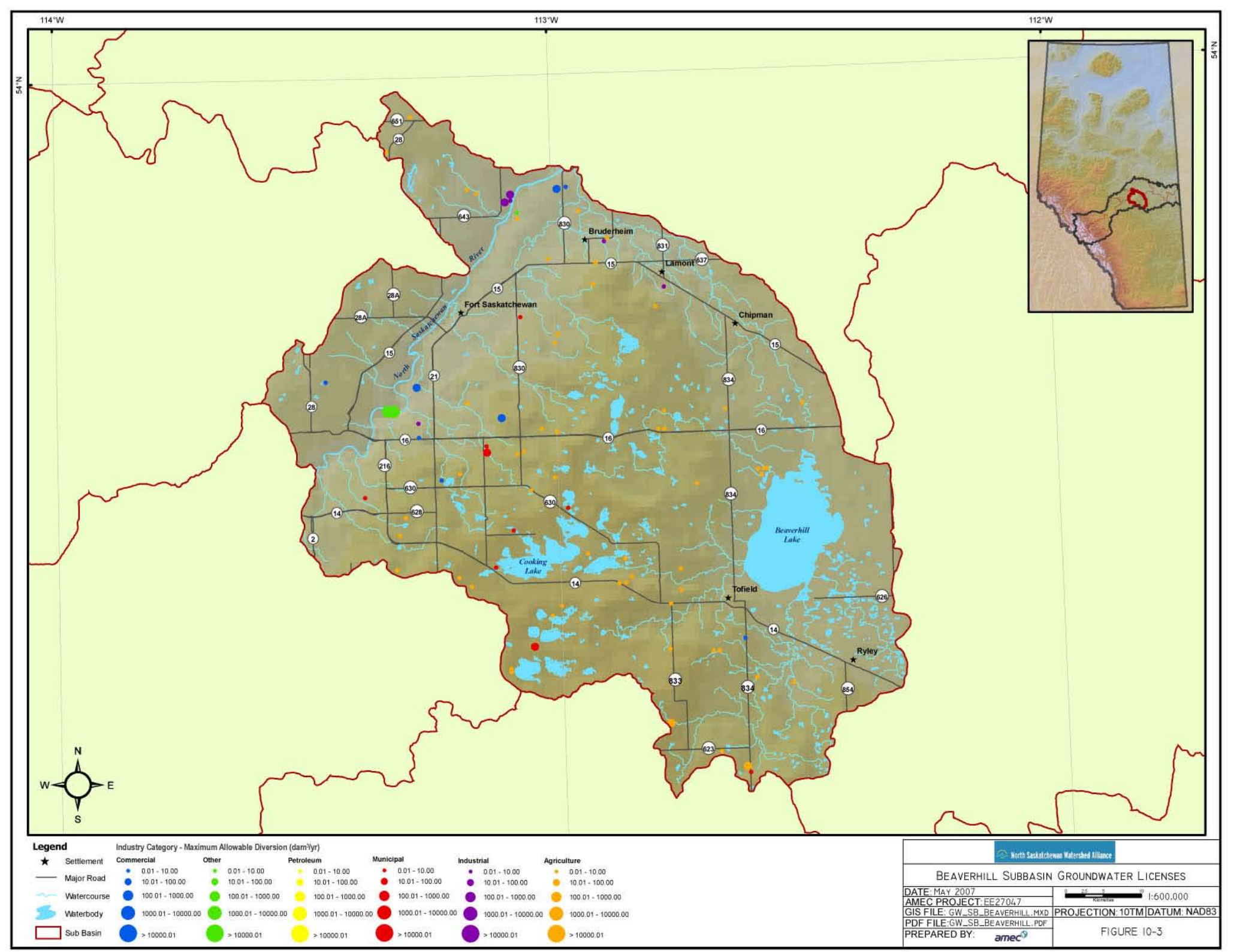
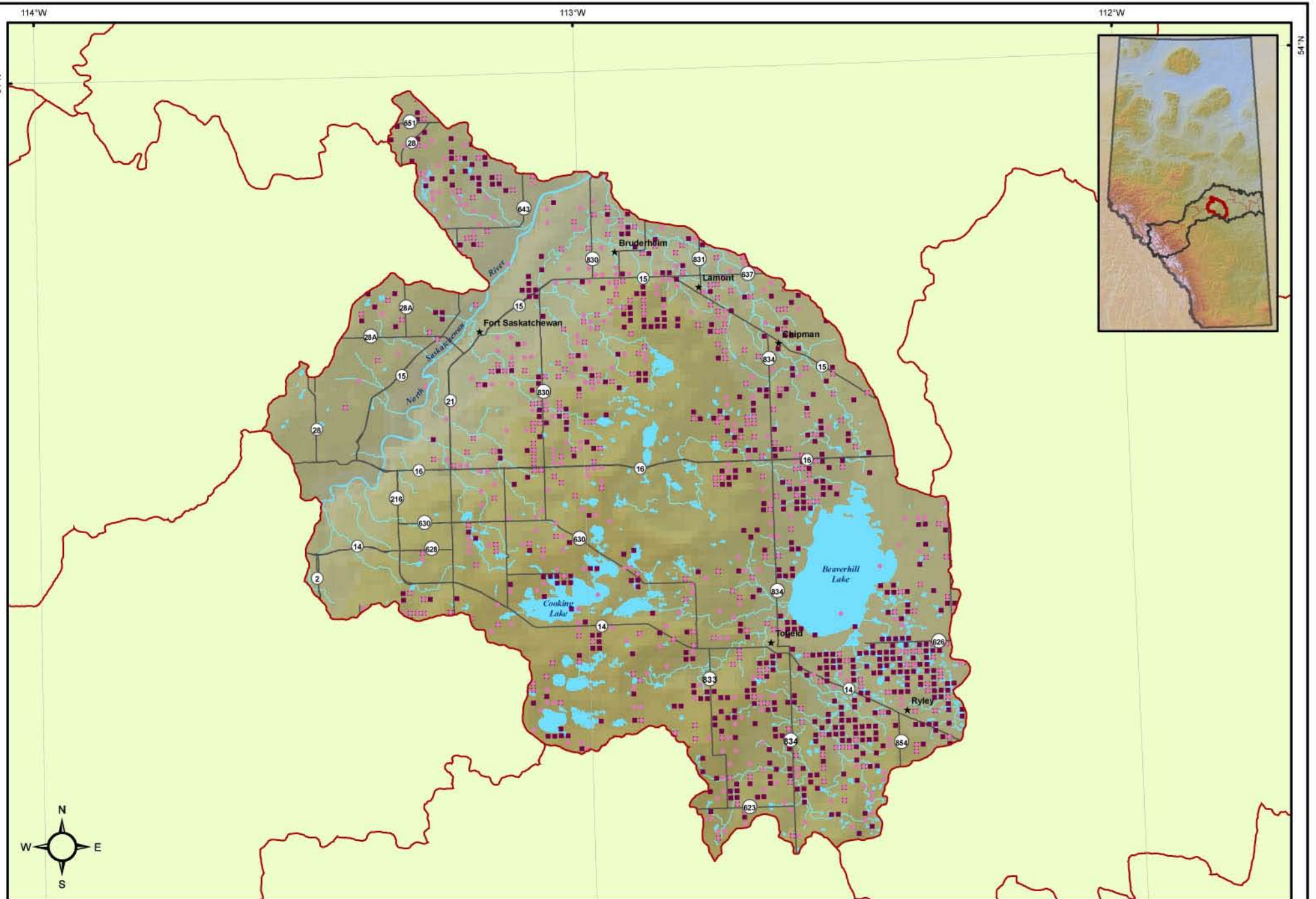

114°W
113°W
112°W
54°N
Bruderheim
Lamont
Fort Saskatchewan
Chipman
Tofield
Ryley
Beaverhill Lake
Cooking Lake
North Saskatchewan River
N
W
E
S
Legend
Settlement
Major Road
Watercourse
Waterbody
Sub Basin
Industry Category - Maximum Allowable Diversion (dam³/yr)
Commercial
Other
Petroleum
Municipal
Industrial
Agriculture
0.01 - 10.00
10.01 - 100.00
100.01 - 1000.00
1000.01 - 10000.00
> 10000.01
North Saskatchewan Watershed Alliance
BEAVERHILL SUBBASIN GROUNDWATER LICENSES
DATE: MAY 2007
AMEC PROJECT: EE27047
GIS FILE: GW_SB_BEAVERHILL.MXD
PDF FILE: GW_SB_BEAVERHILL.PDF
PREPARED BY: amec
1:600,000
PROJECTION: 10TM | DATUM: NAD83
FIGURE 10-3

Figure 10-4 Beaverhill Sub-basin Registrations



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

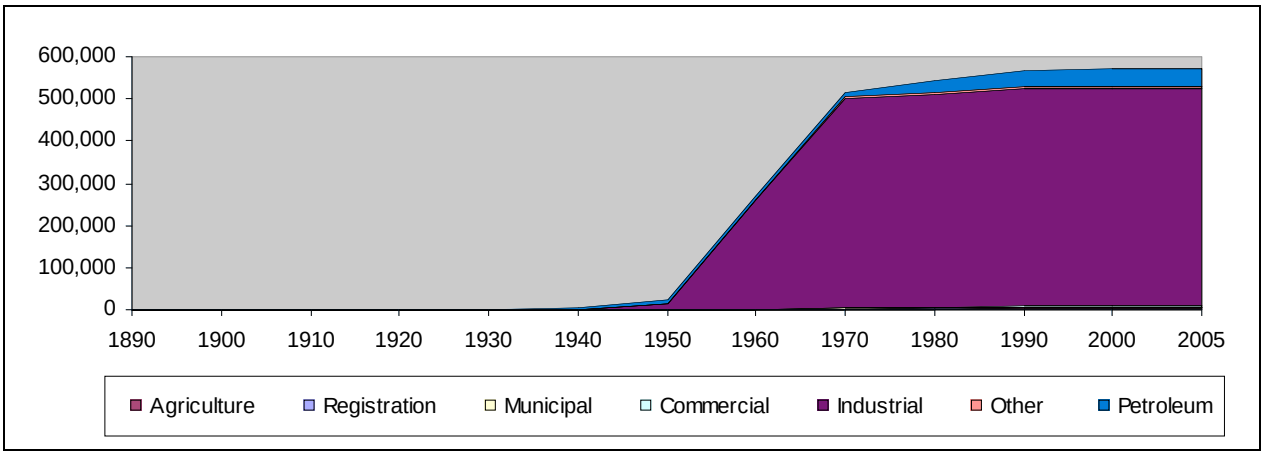
North Saskatchewan Watershed Alliance

BEAVERHILL SUBBASIN REGISTRATIONS

DATE: MAY 2007	1:600,000
AMEC PROJECT: EE27047	
GIS FILE: RG_SB_BEAVERHILL.MXD	PROJECTION: 10TM | DATUM: NAD83
PDF FILE: RG_SB_BEAVERHILL.PDF	
PREPARED BY: amec	FIGURE 10-4

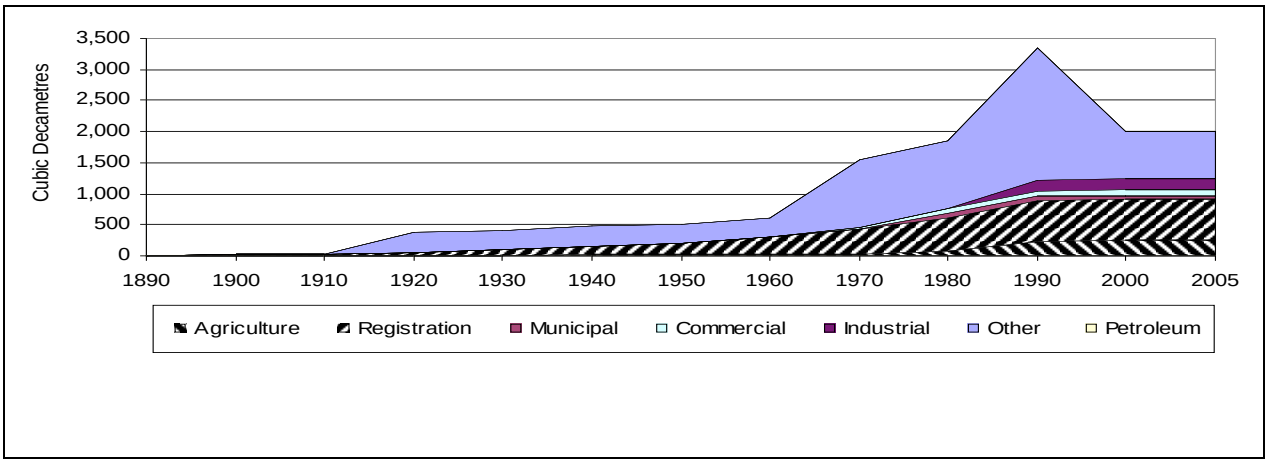
An historical perspective on water allocations among the sectors is provided in Figure 10-5 (surface water) and Figure 10-6 (groundwater). The two largest allocations for surface water in the Beaverhill Sub-basin are for the industrial and petroleum sectors. Allocations for the industrial sector were first issued in the 1950s, increased substantially to the 1970s but have remained unchanged since then. Allocations for the petroleum sector were first issued in the 1940s, increased substantially until 2000, but have remained unchanged since then. The remaining sectors with surface water allocations have licences that were issued in the 1940s and 1950s. Registrations have priority dates that date back to the 1890s.

Figure 10-5 Historical Trends in Surface Water Allocation in the Beaverhill Sub-basin



The largest allocations for groundwater are for the other sector and registrations. The other sector allocations were first issued in the 1910s, increased substantially up to 1990s, decreased slightly, and remained unchanged since 2000. Registrations have priority dates back to the 1890s and allocations increased up to 1990s but have remained unchanged since then. Groundwater allocations for the remaining sectors display a similar pattern, although licences were generally issued much later than registrations.

Figure 10-6 Historical Trends in Groundwater Allocation in the Beaverhill Sub-basin



10.1 Municipal and Residential Sector

10.1.1 Population

The population of Beaverhill Sub-basin is predominantly urban, as shown in Table 10-1. Eighty-five percent of the population lives in urban municipalities, mostly in Edmonton. The specialized municipality of Strathcona Country contains 14 percent of the sub-basin population and rural municipalities account for less than 1 percent of the population. Strathcona County had the highest growth rate from 2001 to 2006 at almost 15 percent. Urban municipalities grew by almost 10 percent, while rural municipalities experienced a population decline of 0.5 percent over the inter-censal period.

Table 10-1 Population Distribution and Growth in the Beaverhill Sub-basin

	2006		2001	2001 to 2006 Population Change
	Population	Percent	Population	Percent
Urban Municipality	499,910	85.3%	455,827	9.7%
Specialized Municipality	82,409	14.1%	71,897	14.6%
Rural Municipality	3,782	0.6%	3,802	-0.5%
Total	**586,101**	**100.0%**	**531,525**	**10.3%**

Table 10-2 lists all municipalities situated in the Beaverhill Sub-basin, their estimated 2006 population that lived in the Beaverhill Sub-basin, and a summary of their water licence information.

Table 10-2 Municipal Populations and Water allocations within Beaverhill Sub-basin

Municipal Name		2006 Population	Water Source	2005 Allocation (dam^3)
Urban	CITY OF EDMONTON	479,426		
	CITY OF FORT SASKATCHEWAN	14,957		
	TOWN OF TOFIELD	1,876	SURFACE	746.3
	TOWN OF LAMONT	1,664		
	TOWN OF BRUDERHEIM	1,215		
	VILLAGE OF RYLEY	458		
	VILLAGE OF CHIPMAN	238		
	CITY OF ST. ALBERT	76		
Specialized	STRATHCONA COUNTY	82,409	GROUNDWATER	34.5
			SURFACE	8.0
Rural	BEAVER COUNTY	1,700	SURFACE	9.9
	STURGEON COUNTY	1,091		
	LAMONT COUNTY	913		
	CAMROSE COUNTY	45	GROUNDWATER	1.2
	IMPROVEMENT DISTRICT NO. 13	21		
	LEDUC COUNTY	12		

The major urban population centres are Edmonton (479,426 residents) and the City of Fort Saskatchewan (14,957). The mixed rural and urban specialized municipality of Strathcona County has a large population within the sub-basin (82,409). Beaver County has the largest population of the rural municipalities (1,700).

10.1.2 Allocations

Nearly all of the residents of the Beaverhill Sub-basin (99 percent) reside in the Edmonton Capital Region and obtain their water from the North Saskatchewan River from diversions in the Strawberry Sub-basin (Section 8.1). It is estimated that only about 2,700 people obtain their water from other sources, either as unlicensed household users or under the terms of a municipal licence. As of 2005, there were 18 active municipal water licences for 10 licensees in Beaverhill Sub-basin. These licences allow maximum withdrawals of 850 dam^3 per year. As shown in Figure 10-1, municipal water uses only account for 0.1 percent of licensed water allocations in the basin.

Surface water licences account for 94 percent of total municipal water allocations in the sub-basin, the largest of which is for the Town of Tofield (746 dam^3). The maximum amount of surface water that can be withdrawn in Beaverhill Sub-basin by the municipal sector is 796 dam^3, of which 36 dam^3 is allocated to rural use and 14 dam^3 is allocated to other use. Groundwater licences represent 6 percent of total municipal water allocations. Licences allow withdrawals of up to 54 dam^3, of which urban users can withdraw up to 30 dam^3. Rural users can withdraw up to 18 dam^3 of groundwater and other users are allocated withdrawals of 6 dam^3.

Licensees that are not municipalities but have municipal water use licences within the Beaverhill Sub-basin are shown in Table 10-3.

Table 10-3 Additional Municipal Water Use Licensees in the Beaverhill Sub-basin

Licensee	Water Source	Allocation (dam^3)
HUTTERIAN BRETHREN CHURCH OF CARMANGAY	SURFACE	18.5
HALF MOON LAKE WATER CO-OP	GROUNDWATER	9.9
ANTLER LAKE WATER CONSERVATION SOCIETY	GROUNDWATER	8.6
RURKA, CAROL	SURFACE	7.4
WIENS AGRICULTURAL ENTERPRISES	SURFACE	3.7
ZOOK, DONALD	SURFACE	2.5

10.1.3 Licensed Water Use

Under the terms of municipal licences, allocations assume that up to 266 dam^3 will be used (i.e. 31 percent of allocations can be consumed and/or lost) with the remainder (69 percent or 584 dam^3) will be returned after use (Table 10-4). Return flows range from 80 percent of urban groundwater allocation to 75 percent of urban surface water allocations and 64 percent of other groundwater allocations. All other municipal allocations have no allowances for return flow.

Table 10-4 Licensed Municipal Allocations and Use and Estimated Actual Use, Beaverhill Sub-basin

Water Use	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Estimated Actual Water Use (dam^3)		
			Allocation	Water Use	Return Flow	Diversion	Estimated Use	Return Flow
Urban*	Surface	2	746	190	556	409	160	249
	Groundwater	5	30	6	24	16	6	11
	Subtotal	**7**	**776**	**196**	**580**	**425**	**165**	**260**
Rural**	Surface	3	14	14	0	8	8	0
	Groundwater	3	18	18	0	10	10	0
	Subtotal	**6**	**32**	**32**	**0**	**18**	**18**	**0**
Other***	Surface	3	36	36	0	20	20	0
	Groundwater	2	6	2	4	3	1	2
	Subtotal	**5**	**43**	**39**	**4**	**24**	**22**	**2**
Total	Surface	8	796	240	556	436	187	249
	Groundwater	10	54	26	28	30	17	13
	Total	**18**	**850**	**266**	**584**	**466**	**204**	**262**

* 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

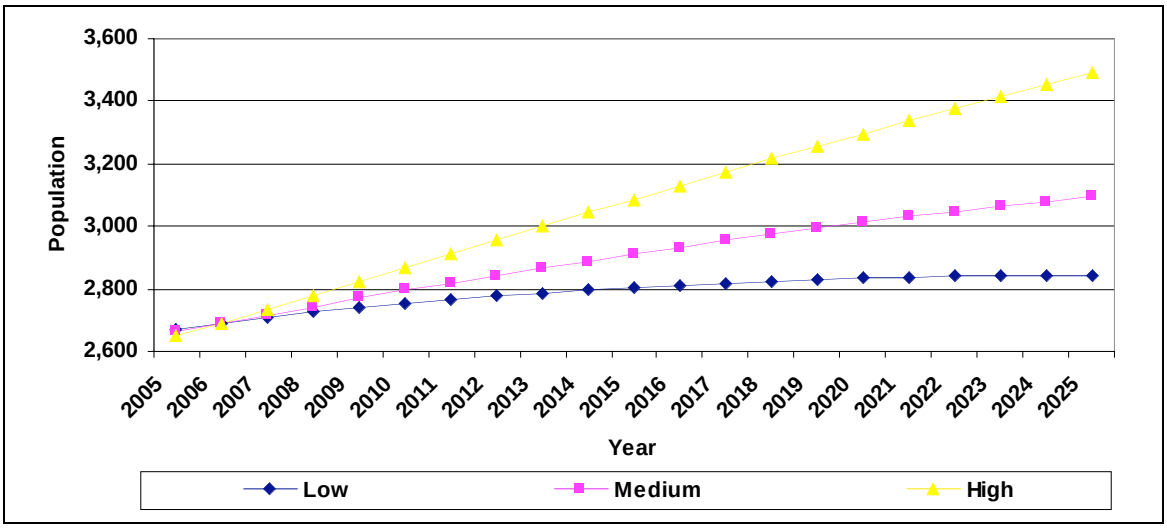
10.1.4 Actual Water Use

Total municipal water use in the Beaverhill Sub-basin in 2005 is estimated to be 204 dam^3, including 187 dam^3 of surface water and 17 dam^3 of groundwater. These estimates were derived by combining population estimates with the average per capita water use estimate of 76 m^3 that was used for neighbouring Sturgeon County. There was no MWWS flow data for communities in the Beaverhill Sub-basin that were outside the Edmonton Capital Region distribution system. This estimate of water use represents 77 percent of licensed use and 24 percent of the allocation. These numbers describe water use by people living outside the Edmonton Capital Region.

10.1.5 Future Water Use Forecasts

Figure 10-7 shows low, medium and high population projection scenarios for the portion of the Beaverhill Sub-basin outside the Edmonton Capital Region based on Alberta Finance Census Division projections. The population forecasts in Figure 10-7 have been used to predict future municipal surface and groundwater use. The resulting forecasts of water use are provided in Table 10-5, and are based on the estimated per capita water use in 2005.

Figure 10-7 Beaverhill Sub-basin Population Growth Forecasts



Based on population growth forecasts, municipal water use in 2025 in the Beaverhill Sub-basin is expected to be 16 percent higher than at present under the Medium Growth scenario. Under the Low Growth forecast, municipal water use will increase by only 6 percent over the forecast period, but would increase by 32 percent under the High Growth scenario

Table 10-5 Projected Municipal Water Use in the Beaverhill Sub-basin

(dam^3)

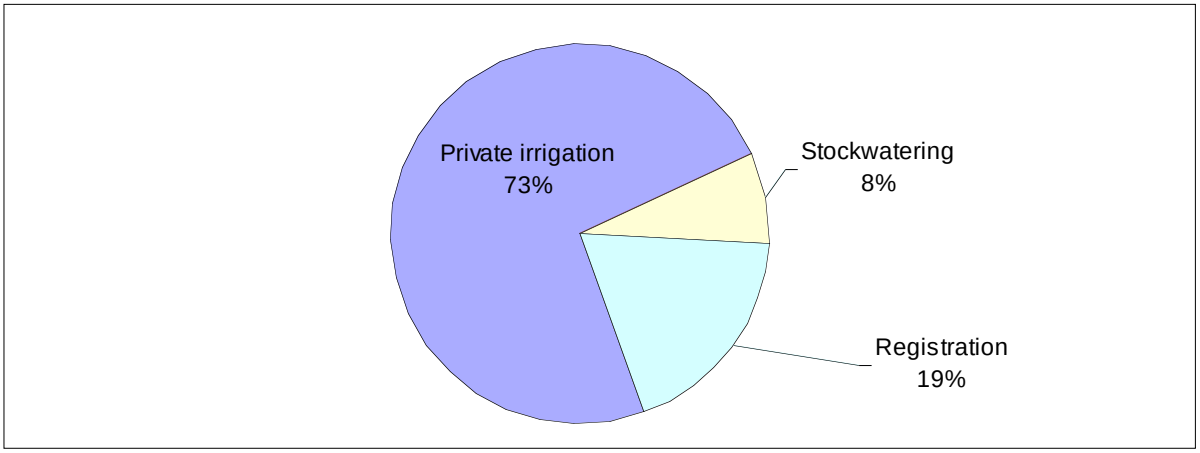
Scenario	Source	2005	2010	2015	2020	2025
Low Population Growth	Surface	187	193	196	198	199
	Groundwater	17	18	18	18	18
	Total	**204**	**210**	**214**	**217**	**217**
Medium Population Growth	Surface	187	196	204	212	217
	Groundwater	17	18	19	19	20
	Total	**204**	**214**	**223**	**231**	**237**
High Population Growth	Surface	187	202	218	233	246
	Groundwater	17	18	20	21	22
	Total	**204**	**221**	**238**	**254**	**269**

10.2 Agriculture Sector

As of December 2005 a total of 5,257 dam^3 had been allocated to the agricultural sector in the Beaverhill Sub-basin. This includes 1,959 registrations representing 1,147 dam^3 and 171 licences representing 5,026 dam^3 of water. Water allocated to agriculture accounts for 1 percent of all allocation in the Beaverhill Sub-basin.

Figure 10-8 shows how this water is distributed among the different agricultural activities in the sub-basin. The largest allocation is for private irrigation (73 percent). Registration accounts for 19 percent and stockwatering accounts for 8 percent of total allocations.

Figure 10-8 Water Allocation for Agricultural Activities in the Beaverhill Sub-basin, 2005



A total of 1,141 registrations and 89 licences allow withdrawal of up to 5,257 dam^3 of surface water; this accounts for 85 percent of water allocations for the agricultural sector. Licences issued for groundwater account for the other 15 percent of allocations, with 915 dam^3 being allocated through 818 licences and 82 registrations.

10.2.1 Overview of Agriculture

Based on information from the 2001 Census of Agriculture, there were about 1,799 farms in the Beaverhill Sub-basin (15 percent of North Saskatchewan total) with an average size of 456 acres. At the North Saskatchewan Basin level there are about 12,300 farms with an average size of 625 acres. Farms in the Beaverhill Sub-basin cover an area of nearly 820,000 acres; this is equivalent to about 3,322 km^2 or about 75 percent of the sub-basin. As shown in Table 10.6, 64 percent of the land in the basin is used to raise crops. About 27 percent of agricultural land is pasture. The rest of the lands are in summer fallow or other uses.

Table 10-6 Agricultural Land Use in the Beaverhill Sub-basin, 2001

Land Use	Acres	Percent
Crop Land	526,984	64.2%
Summerfallow	27,514	3.4%
Tame/Seeded Pasture	84,414	10.3%
Natural Pasture	128,199	15.6%
Other	53,717	6.5%
Total	**820,828**	**100.0%**

The types of farming activity vary within the sub-basin. 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. The table shows that the Beaverhill Sub-basin accounts for 15 percent of total farms in the North Saskatchewan. About 36 percent of the farms in the sub-basin raise beef cattle and about 23 percent are grain and oilseed farms. Speciality farms make up about 19 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 lower share. The general mix of other types of farms is similar for both the Beaverhill Sub-basin and the North Saskatchewan Basin.

Table 10-7 Classifications of Farms in the Beaverhill 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	1.5%	10.7%	1.9%
Cattle (beef) Farms	35.6%	11.0%	45.8%
Hog Farms	1.3%	12.6%	1.4%
Poultry & Egg Farms	1.8%	23.7%	1.1%
Wheat Farms	5.7%	19.2%	4.2%
Grain & Oilseed Farms	23.2%	16.8%	19.6%
Field Crop Farms	7.7%	12.6%	8.6%
Fruit Farms	0.3%	26.6%	0.2%
Misc. Specialty Farms	18.7%	20.5%	12.9%
Sum of Livestock Comb. Farms	2.8%	15.4%	2.6%
Sum of Vegetable Farms	0.2%	21.9%	0.1%
Sum of Other Comb Farms	1.2%	11.6%	1.5%
Total	**100%**	**14.6%**	**100%**

10.2.2 Stockwatering

As noted in Table 10-7 about 38 percent of farms in the Beaverhill Sub-basin were classified as livestock operations, primarily cattle. Estimated livestock populations for major species are provided in Table 10-8. The table shows that there are about 315,000 cattle and calves which, together, accounted for about 14 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 10-8 Estimated Livestock Populations in the Beaverhill Sub-basin, 2001

Livestock Species	Beaverhill	North Saskatchewan	% North Saskatchewan
Hens and Chicken	1,848,137	3,090,930	59.8%
Turkey	8,776	41,519	21.1%
Cattle	224,806	990,169	22.7%
Calves	90,363	365,725	24.7%
Pigs	94,603	232,169	40.7%
Sheep and Lamb	14,254	55,204	25.8%
Horse and Ponies	10,407	35,172	29.6%
Bison	3,841	18,906	20.3%
Deer	1,650	2,864	57.6%
Elk	1,495	6,426	23.3%

10.2.2.1 Water Allocation

Overall, 2,074 licences and registrations have been issued for livestock watering with total allocation amounting to 1,635 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 10-9 summarizes current water licences and registrations issued for livestock according to the water source. It shows that surface water accounts for about 44 percent of allowable diversions for livestock and that registrations account for 70 percent of the allocations.

10.2.2.2 Licensed Water Use

Table 10-9 shows that licences and registrations issued for livestock assume that all withdrawals will be used and there will be no return flow.

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 Beaverhill Sub-basin. However, a reasonable estimate of water use can be derived using the actual animal population in the basin from Table 10-8. Based on livestock populations for the Beaverhill Sub-basin in 2001, the total water required for livestock was estimated to be 3,409 dam^3, or about 208 percent of the licensed allocation.[1] The calculations for this estimate are provided 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".[2] In terms of water requirements by species, cattle accounts for about 80 percent of the total, about 8 percent is required by pigs, 4 percent is required by poultry, and all other species accounted for the remaining 8 percent.

The estimated actual consumption (3,409 dam^3) based on livestock populations shown in Table 10-10 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).

[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 10-9 Summary of Water Licences and Registrations Issued for Livestock Watering in the Beaverhill Sub-basin,

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use	
			Allocation	Water Use	Return	Licences Reporting	Reported Use (dam^3)
Registration	Surface	1,141	472.7	472.7	0.0	0	N/A
	Groundwater	818	673.8	673.8	0.0	0	N/A
	Subtotal	1,959	1,146.5	1,146.5	0.0	**0**	**N/A**
Stockwatering	Surface	**33**	**247.2**	**247.2**	**0.0**	0	N/A
	Groundwater	82	241.6	241.6	0.0	0	N/A
	Subtotal	115	488.7	488.7	0.0	**0**	**N/A**
Total	Surface	1,174	719.9	719.9	0.0	0	N/A
	Groundwater	900	915.3	915.3	0.0	0	N/A
	Total	**2,074**	**1,635.2**	**1,635.2**	**0.0**	**0**	**N/A**

Table 10-10 Estimated Livestock Water Requirements for 2001

Livestock Species	Animal Population	Daily Consumption (gallons)	Annual Use (dam^3)
Hens and Chickens	1,848,137	0.045	137.9
Turkey	8,776	0.15	2.2
Bulls	4,553	9.0	68.0
Milk Cows	8,306	30.0	413.2
Beef Cows	93,680	9.0	1,398.2
Heifers	28,440	6.0	283.0
Steers	12,308	6.0	122.5
Calves	90,363	3.0	449.6
Boars	605	6.5	6.5
Sows and Gilts - Breeding	9,030	6.5	97.3
Nursing and Weaner Pigs	29,874	0.5	24.8
Grower and Finishing Pigs	55,094	1.5	137.0
Sheep and Lambs	14,254	2.0	47.3
Horse and Ponies	10,407	10.0	172.6
Bison	3,841	2.0	12.7
Deer	1,650	10.0	27.4
Elk	1,495	3.5	8.7
Total			**3,408.8**

Since 56 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 4,217 dam^3 would be required to support the animal populations in Table 10-10. This water requirement is about 160 percent of the water allocation through licences and registrations. With actual water exceeding water allocations for livestock, it is expected that farmers are using their rights as exempted agricultural users to acquire the water they need for their animal populations.

10.2.2.4 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 major new or expanded 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 of supporting a 5,000-head back grounding operation and a 20,000-head operation. The figures show that there are some townships that meet all of the criteria for backgrounding operations only. For townships that meet some of the criteria limiting factors include groundwater and landscape. Based on Alberta Agriculture's assessment, it would appear that there are some opportunities for backgrounding operations in the Beaverhill Sub-basin. Table 10-11 shows water use projections to 2025. By 2025, relative to 2005, water use is expected to 11 percent, 30 percent and 60 percent higher under Low, Medium and High Growth Scenarios respectively**.**

Table 10-11 Projected Water Use for Livestock in the Beaverhill Sub-basin, (dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	2309	2,365	2,430	2,496	2,564
	Groundwater	1908	1,954	2,008	2,062	2,119
	Total	**4,217**	**4,319**	**4,437**	**4,558**	**4,683**
Medium Growth	Surface	2309	2,455	2,618	2,791	2,975
	Groundwater	1908	2,029	2,164	2,306	2,458
	Total	**4,217**	**4,484**	**4,782**	**5,097**	**5,432**
High Growth	Surface	2309	2,589	2,909	3,265	3,663
	Groundwater	1908	2,139	2,404	2,698	3,027
	Total	**4,217**	**4,728**	**5,313**	**5,964**	**6,690**

10.2.3 Irrigation

The other major use of water for agricultural purposes is irrigation or crop watering. Irrigation in this sub-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 3,192 acres of land in the Beaverhill 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 3,731 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 56 licences that allocate approximately 4,537 dam^3 for irrigation purposes. All of this allocation is from surface water.

10.2.3.2 Licensed Use

Table 10-12 shows that licences issued for irrigation include a return flow allowance of about 130 dam^3, which represents 3 percent of the allocation. Licensed use is 4,407 dam^3.

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. 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 (4,217 dam^3) is about the same amount of water as used for cropwatering.

Table 10-12 Irrigation Allocations and Use and Reported Actual Water Use, Beaverhill Sub-basin

Activity	Source	Number of Licences/ Registrations	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)	
			Allocation	Water Use	Return	Licences Reporting	Reported Use
Private irrigation	Surface	56	4,536.7	4,407.1	129.7	0	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Subtotal	**56**	**4,536.7**	4,407.1	**129.7**	**0**	**N/A**
Total	Surface	56	4,536.7	4,407.1	129.7	0	N/A
	Groundwater	0	0.0	0.0	0.0	0	N/A
	Total	**56**	**4,536.7**	**4,407.1**	**129.7**	**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, due to climatic conditions and poor returns on forage production additional forage production is not expected. It is assumed that available forage will be able to support modest increases in livestock populations. Irrigation water use is projected remain at 4,407 dam^3 over the forecast period.

10.2.4 Summary

In summary, current agricultural water use in the Beaverhill Sub-basin is estimated to be about 8,624 dam^3, of which 49 percent is for stockwatering and 51 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. Table 10-13 provides a summary of future agricultural water use.

Table 10-13 Projected Water Use for Agriculture in the Beaverhill Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	6,716	6,772	6,837	6,903	6,971
	Groundwater	1,908	1,954	2,008	2,062	2,119
	Total	**8,624**	**8,726**	**8,844**	**8,965**	**9,090**
MediumGrowth	Surface	6,716	6,862	7,025	7,198	7,382
	Groundwater	1,908	2,029	2,164	2,306	2,458
	Total	**8,624**	**8,891**	**9,189**	**9,504**	**9,839**
High Growth	Surface	6,716	6,996	7,316	7,672	8,070
	Groundwater	1,908	2,139	2,404	2,698	3,027
	Total	**8,624**	**9,135**	**9,720**	**10,371**	**11,097**

Agricultural water use in 2025 would be about 9,090 dam^3 (an increase of 5 percent from 2005) under Low Growth. Under High Growth, water use is projected to be 11,097 dam^3 by 2025; this represents an increase of 29 percent from 2005. For Medium Growth, agricultural water use in 2025 is expected to increase by 14 percent over current levels.

10.3 Commercial Sector

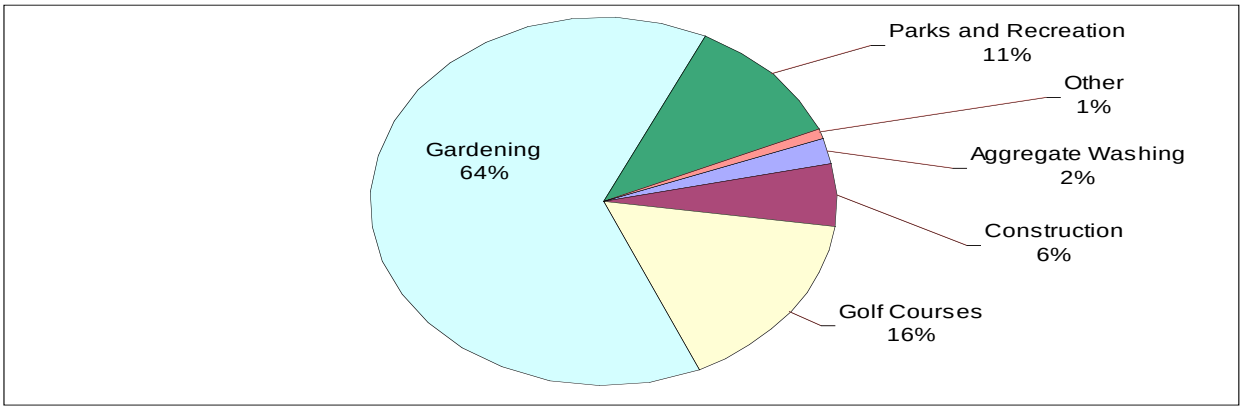
There are 58 licences that allow diversion of 5,127 dam^3 of water in the Beaverhill sub-basin for commercial purposes. This allocation accounts for less than 1 percent of total allocations in the sub-basin.

10.3.1 Water Allocations

Figure 10-9 shows how this allocation is distributed among the various commercial sector activities, including gardening (64 percent), golf courses (16 percent), parks and recreation (11 percent), construction (6 percent) aggregate washing (8 percent), construction (6 percent), aggregate washing (2 percent) and other (1 percent). Surface water accounts for 98 percent of

allocations and the largest allocation is for gardening. Groundwater accounts for the remaining two percent of the allocations and the largest allocation is for golf courses.

Figure 10-9 Water Allocation for Commercial Activities in the Beaverhill Sub-basin



10.3.2 Licensed Water Use

Table 10-12 provides a summary of licensed allocations, use and return for various activities within the commercial sector in the Beaverhill sub-basin. The table shows that not all of the allocations can be used, 303 dam^3 (6 percent of allocation) is to be returned to surface water sources. The return flow requirements vary by activity with construction activity accounting for most of the return flow.

10.3.3 Actual Water Use

At the present time Alberta Environment's Water Use Reporting System contains very little information on actual water use in 2005 by any of the licensees in commercial sector in the Beaverhill sub-basin. As shown in Table 10-14, actual water use has been reported by one licensee, this use represents less than 1 percent of licensed use. 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 less than 1 percent of total allocations in the sub-basin so overall water use estimates are not likely to be greatly affected.

Table 10-14 Licensed Commercial Allocations, Reported and Actual Water Use, Beaverhill Sub-basin

Activity	Source	Number of Licences	Licensed Allocation and Use (dam^3)			Reported Actual Water Use (dam^3)		
			Allocation	Water Use	Return	Licences Reporting	Reported Use	Percent of Allocation
Aggregate Washing	Surface	3	90.5	56.7	33.8	0	N/A	N/A
	Groundwater	1	21.0	21.0	0.0	0	N/A	N/A
	Subtotal	**4**	**111.5**	77.7	**33.8**	**0**	**N/A**	**N/A**
Construction	Surface	2	283.7	14.8	268.9	0	N/A	N/A
	Groundwater	1	6.3	6.3	0.0	0	N/A	N/A
	Subtotal	**3**	**290.0**	21.1	**268.9**	**0**	**N/A**	**N/A**
Gardening	Surface	19	3,251.4	3,251.4	0.0	1	7	N/A
	Groundwater	3	21.0	21.0	0.0	0	N/A	N/A
	Subtotal	**22**	**3,272.4**	3,272.4	**0.0**	**1**	**7**	**N/A**
Golf Courses	Surface	13	786.8	786.8	0.0	0	N/A	N/A
	Groundwater	2	35.8	35.8	0.0	0	N/A	N/A
	Subtotal	**15**	**822.5**	822.5	**0.0**	**0**	**N/A**	**N/A**
Other	Surface	2	49.4	49.4	**0.0**	0	N/A	N/A
	Groundwater	0	0.0	0.0	**0.0**	0		
	Subtotal	**2**	**49.4**	49.4	**0.0**	**0**	**N/A**	**N/A**
Parks and Recreation	Surface	10	569.6	569.6	**0.0**	0	N/A	N/A
	Groundwater	2	11.6	11.6	**0.0**	0	N/A	N/A
	Subtotal	**12**	**581.3**	581.3	**0.0**	**0**	**N/A**	**N/A**
Total	Surface	49	5,031.3	4,728.7	302.7	1	N/A	N/A
	Groundwater	9	95.6	95.6	0.0	0	N/A	N/A
	Total	**58**	**5,127.0**	**4,824.3**	**302.7**	**1**	**N/A**	**N/A**

10.3.4 Future Water Use Forecasts

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

10.3.4.1 Gardening

There has been growth in greenhouse operations in the sub-basin over the last decade, and this trend is likely to continue owing to large population centres in and around the sub-basin which provides a market for greenhouse products. Future water use is projected assuming average annual growth rate ranging from 1.3 percent (Low Growth) and 4.5 percent (High Growth). Under the Medium Growth an annual increase of 3.8 percent in assumed; this is the average annual growth rate of greenhouse farms in the sub-basin between 1996 and 2001, as calculated using information in the Census of Agriculture. Projections using these assumptions are shown in Table 10-15.

Table 10-15 Projected Water Use for Gardening, Beaverhill Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	3,251	3,468	3,699	3,946	4,209
	Groundwater	21	22	24	25	27
	Total	**3,272**	**3,490**	**3,723**	**3,972**	**4,236**
Medium Growth	Surface	3,251	3,917	4,721	5,688	6,854
	Groundwater	21	25	30	37	44
	Total	**3,272**	**3,942**	**4,751**	**5,725**	**6,898**
High Growth	Surface	3,251	4,051	5,049	6,292	7,840
	Groundwater	21	26	33	41	51
	Total	**3,272**	**4,078**	**5,081**	**6,332**	**7,891**

By 2025 water use is expected to be 4,236 dam^3 under Low Growth which is a 30 percent increase from 2005. Under High Growth water use is expected to be 7,891 dam^3 by 2025, which is a 141 percent increase from 2005. Water use is expected to be 111 percent higher by 2025 under Medium Growth.

10.3.4.2 Golf Courses

The water demand forecast for golf course follows the approach outlined in Watrecon (2005) which assumes that water demands will increase based on expansion of golf courses as a result of population growth. However, the population growth must reach a specified threshold before an additional nine hole course will be developed (*i.e.* golf course expansion is not linearly related to population growth). For the Medium and High Growth Scenarios, the population growth rate is enough to support development of additional golf courses over the entire forecast period. For the Low Growth Scenario, the growth rate is enough to support a single golf course expansion up to 2020 after which time water use is expected to remain unchanged. The resulting projections in Table 10-16 show that water use under the Low Growth Scenario is

expected to increase to 1,296 dam^3 by 2025, which is a 58 percent increase from current use. Using the High Growth Scenario, water demand for golf courses is projected to increase to 2,997 dam^3 by 2025 which is a 264 percent increase from current use. Water use is expected to be 126 percent higher by 2025 under Medium Growth.

Table 10-16 Projected Water Use for Golf Courses, Beaverhill Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	787	1,007	1,162	1,239	1,239
	Groundwater	36	46	53	57	57
	Total	**823**	**1,053**	**1,215**	**1,296**	**1,296**
Medium Growth	Surface	787	1,084	1,394	1,627	1,782
	Groundwater	36	50	64	74	81
	Total	**823**	**1,134**	**1,458**	**1,701**	**1,863**
High Growth	Surface	787	1,317	1,859	2,401	2,866
	Groundwater	36	60	85	110	131
	Total	**823**	**1,377**	**1,944**	**2,511**	**2,997**

10.3.4.3 Parks and Recreation

Future water use is expected to increase as a result of regional population growth. Projections are based on 0.3 percent annual growth for the Low Growth Scenario, 0.8 percent for the Medium Growth Scenario and 1.6 percent for the High Growth Scenario. The resulting projections are shown in Table 10-17**.**

Table 10-17 Projected Water Use for Parks and Recreation, Beaverhill Sub-basin
(dam^3)'

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	569	578	586	595	604
	Groundwater	12	12	12	13	13
	Total	**581**	**590**	**599**	**608**	**617**
Medium Growth	Surface	569	592	616	641	667
	Groundwater	12	12	13	14	14
	Total	**581**	**605**	**629**	**655**	**681**
High Growth	Surface	569	616	667	722	782
	Groundwater	12	13	14	15	16
	Total	**581**	**629**	**681**	**737**	**798**

Water use is expected to be 617 dam^3 under Low Growth which is a six percent increase from current use. Under High Growth, water use is expected to be 798 dam^3 which is a 37 percent increase. Water use is expected to be 17 percent higher by 2025 under Medium Growth.

10.3.5 Summary

A summary of the projected water demand for the commercial sector in the Beaverhill Sub-basin is provided in Table 10-18. Note that this forecast combines the estimates for gardening, golf courses, and parks and recreation (which together account for 91 percent of allocation in the sub-basin), with the assumption that other commercial licensees are using their full allocations.

Table 10-18 Projected Water Use for the Commercial Sector, Beaverhill Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	4,729	5,175	5,569	5,902	6,174
	Groundwater	96	107	116	122	124
	Total	**4,825**	**5,282**	**5,686**	**6,024**	**6,298**
Medium Growth	Surface	4,729	5,715	6,853	8,078	9,425
	Groundwater	96	114	134	152	166
	Total	**4,825**	**5,830**	**6,987**	**8,230**	**9,591**
High Growth	Surface	4,729	6,106	7,697	9,537	11,610
	Groundwater	96	126	159	193	225
	Total	**4,825**	**6,232**	**7,856**	**9,730**	**11,835**

Under the Low Growth Scenario, water use is projected to rise to 6,298 dam^3 which is a 31 percent increase from current levels by 2025. Under the High Growth Scenario, water use is projected to rise to 11,835 dam^3 which is a 145 percent increase by 2025. Water use is projected to increase by 99 percent from the current level by 2025 under Medium Growth.

10.4 Petroleum Sector

In the Beaverhill Sub-basin, 13 surface water licences allocate 38,883 dam^3 of water to the petroleum sector for gas and petrochemical plants. Petroleum allocations accounts for almost 7 percent of total allocations in the sub-basin and almost 2 percent of the total allocations in the North Saskatchewan Basin. The licences assume that up to 27,985 dam^3 will be used and that up to 10,899 dam^3 will be returned (Table 10-19).

10.4.1 Water use

Of the 13 licences issued in the Beaverhill Sub-basin, 11 provided water use information for 2005 to WURS. These licensees reported using 15,604 dam^3 of the 33,092 dam^3 they were entitled to use. No use information is available for the two remaining water licences and, for the purposes of this report, these two licence holders are assumed to use 100 percent of their entitlement (5,791 dam^3). In total, gas and petrochemical plants in the Beaverhill Sub-basin are estimated to have used 21,395 dam^3 of surface water in 2005. About 84 dam^3 of saline water was also used for injection.

Table 10-19 Licensed Allocations, Estimated Actual Water Use for the Petroleum Sector, Beaverhill 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
Gas/ Petrochemical Plant	Surface	13	38,883.4	27,984.5	10,898.9	21,395	77%	55%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Subtotal	**13**	**38,883.4**	**27,984.5**	**10,898.9**	**21,395**	**77%**	**55%**
Total	Surface	13	38,883.4	27,984.5	10,898.9	21,395	77%	55%
	Groundwater	0	0.0	0.0	0.0	0.0		
	Total	**13**	**38,883.4**	**27,984.5**	**10,898.9**	**21,395**	**77%**	**55%**
* Estimates based on WURS data and assuming 100 percent consumption for those licences where use information is not available.								

10.4.2 Future Water Use

There are currently plans[3] to construct four new upgraders in the Beaverhill Sub-basin in the near future in addition to the one upgrader currently under construction. These include projects that are being constructed or proposed by BA Energy, North American Oil Sands Corporation, Petro-Canada, Shell Canada, and Total E & P. Although two of these projects may be located in the Sturgeon basin, they are proposing to draw water from the North Saskatchewan River. A summary of available information on these projects, including their scheduled operation dates, production capacity and gross water requirements are provided in Table 10-20. While additional upgraders may eventually be proposed in the sub-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. According to available information, the five upgraders when operating at their ultimate capacity are expected to require 76,468 dam^3 of freshwater from the North Saskatchewan River. In addition to the five upgraders, the first phase of a coal gasification plant being proposed by Sherritt International is scheduled to begin operations by 2012, with three additional units to follow. The facility is expected to require between 2,400 dam^3 and 9,500 dam^3 of water per year from the North Saskatchewan River.

An estimate of total water requirements for these six projects is provided in Figure 10-10, which is based on the information in Table 10-20 and the assumption that all phases of the various projects are constructed on regular intervals once the additional phase has been completed.

Figure 10-10 Water Requirements for Proposed Major Projects, Beaverhill Sub-basin

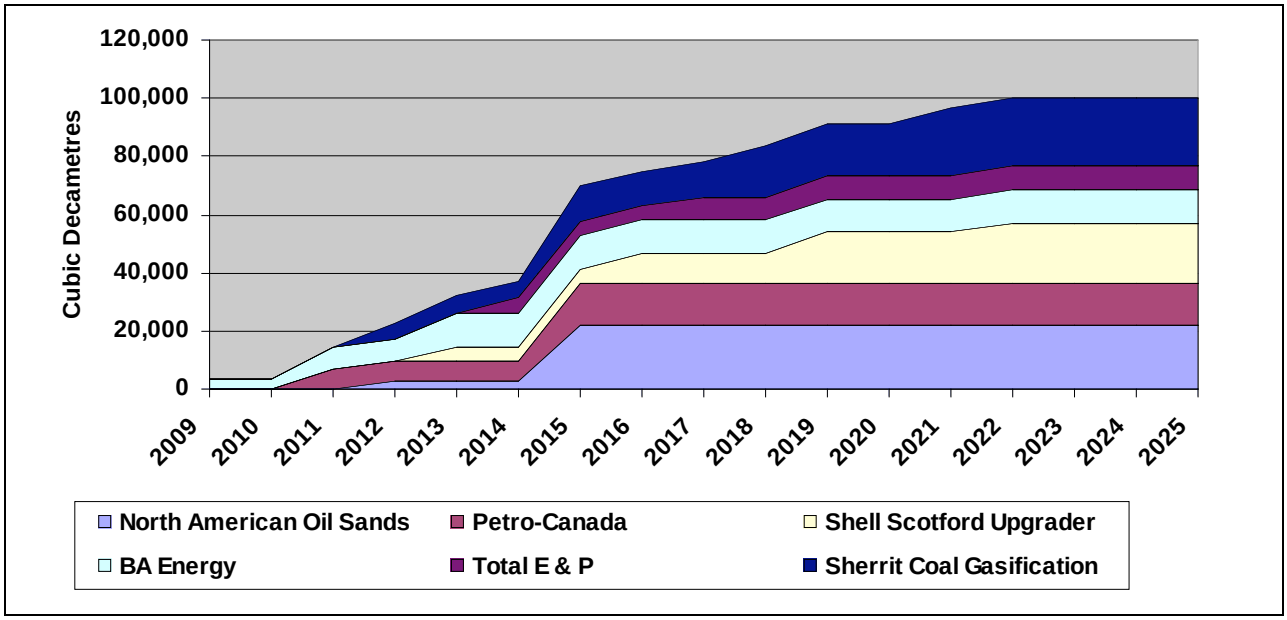


Table 10-20 List of Proposed Upgraders & Gas Plants in the Beaverhill Sub-basin[4]

Company	Name of Project	Status	Timeline for Operations	Amount of Product	Water Required (dam^3)	Average Water Requirement (litres/barrel)
BA Energy	Upgrader Project	Phase 1 Approved in 2005	Phase 1 - 2009 Phase 2 - 2011 Phase 3 - 2013	Phase 1 – 77,500 BPD Phase 2 – +91,125 BPD Phase 3 - +91,125 BPD	3384 dam^3 – 2009 7363 dam^3 – 2011 11,350 dam^3 - 2013	120
North American Oil Sands Corporation	Upgrader Project	Proposed Terms of Reference	Phase 1 - 2012 Phase 2 - 2015	Phase 1- 75,000 BPD Phase 2- 250,000 BPD	2,628 dam^3 per year by 2012 21,640 dam^3 per year by 2015[5]	Phase 1 – 96 Phase 2 – 235
Petro-Canada	Fort Hills Sturgeon Upgrader Project	EIA submitted	Phase 1 - 2011 Phase 2 & 3 - 2014/15	Phase 1- 165,000 BPD Phase 2&3 340,000 BPD	14,454 dam^3 per year diverted from NSR at capacity	118
Shell Canada	Scotford Upgrader 2 Project	Proposed Terms of Reference	Phase 1 – 2013 Phases 2, 3 & 4 - unknown	Phase 1 - 100,000 bbl/day Phases 2,3 &4 – 100,000 bbl/day each	21,024 dam^3 per year (Estimated based on Scotford's current licensed and production capacity).	145
Total E & P	Upgrader Project	Public Disclosure Issued	Phase 1 - 2013/14 Phase 2 - unknown	Phase 1 – 130,000 BPD Phase 2 – 70,000+ BPD	Estimated. 5,200 dam^3 increasing to 8,000 dam^3 per at capacity from NSR	110
Total Water Requirements for Upgraders at Capacity					**76,468 dam^3**	**145**
Sherritt International Corporation	Dodds-Roundhill Coal Gasification Project	Preparing Terms of Reference	Phase 1 – 2012 Phases 2, 3 & 4 unknown	Phase 1 - 270 MM scfd of pipeline grade hydrogen Phases 2, 3 & 4 270 MMscfd of hydrogen each	Phase 1 - 2,400 to 9,500 dam^3 per year likely from NSR Other phases would have similar requirements	NA
Total Water Requirements for All New Industrial Projects at Capacity					**100,268 dam^3**	

[4] Alberta Environment. June, 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

[5] North American Oil Sands Corporation (Craig Popoff), personal communications. June 4, 2007)

It should be noted that these represent gross water requirements and, as some of the water is being used for cooling, there will be some return flow. According to the application by Petro-Canada[6], between 72 and 80 percent of water diversions will be consumed and the balance will be returned after use. With this assumption, estimated water use when all new industrial operations are operating at capacity will be about 63,200 dam^3.

Although it is expected that the five upgraders and gasification will be built in the Beaverhill Sub-basin, different forecasts have been developed using different assumptions about when these facilities become fully operational. In Table 10-18 the High Growth Scenario assumes that the three upgraders are 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 three upgraders are fully operation by 2015 and the gasification plant requires 2,400 dam^3. The Low Growth Scenario assumes that the upgraders only require half the water they are estimated to need and there is no gasification plant. These water use forecasts are provided in Table 10-21.

Table 10-21 Forecast of Petroleum Water Use in the Beaverhill Sub-basin
(dam^3)

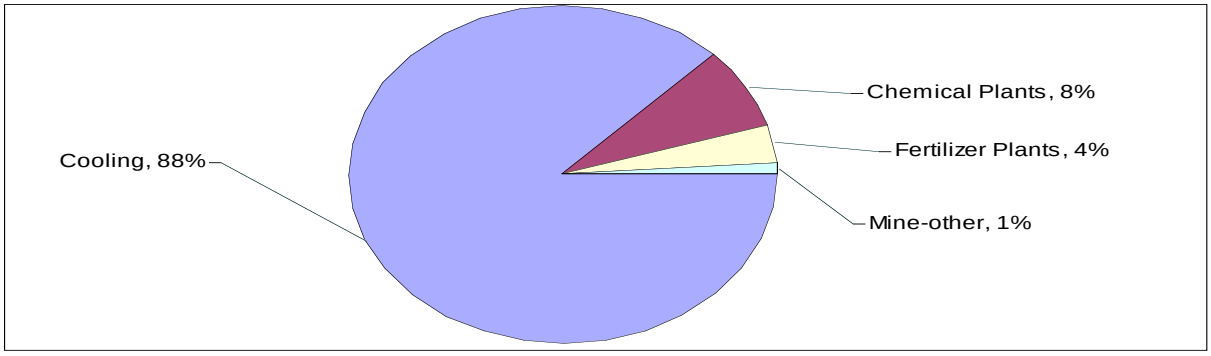
Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	21,395	23,933	46,317	74,694	84,598
	Groundwater	0	0	0	0	0
	Total	**21,395**	**23,933**	**46,317**	**74,694**	**84,598**
Medium Growth	Surface	21,395	23,933	73,742	89,689	96,593
	Groundwater	0	0	0	0	0
	Total	**21,395**	**23,933**	**73,742**	**89,689**	**96,593**
High Growth	Surface	21,395	23,933	77,684	100,343	102,593
	Groundwater	0	0	0	0	0
	Total	**21,395**	**23,933**	**77,684**	**100,343**	**102,593**

10.5 Industrial Sector

In the Beaverhill Sub-basin, 26 active licences allocate 515,113 dam^3 of water to the industrial sector. Industrial allocations accounts for 90 percent of total allocations in the sub-basin. Almost all of the water allocated is for surface water (514,935 dam^3) which accounts for 69 percent of the industrial licences.

[6] Petro-Canada (2007) Fort Hills Sturgeon Upgrader Project Application. Available at http://www.petro-canada.ca/pdfs/5_Water_Management.pdf

Figure 10-11 Industrial Water Allocation by Use in the Beaverhill Sub-basin



As shown in Figure 10-11, 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 other industrial activities.

10.5.1 Cooling

10.5.1.1 Water Allocations

About 88 percent of the allocations are for cooling purposes for thermal power generation or cooling such as air conditioning (450,917 dam^3). Details of the licences issued to the industrial sector in the Beaverhill Sub-basin are provided in Table 10-22. The table shows that three licences have been issued for cooling purposes, with all of this allocation being for surface water. Water allocations for cooling were issued in the 1960s and increased slightly in the 1970s.

10.5.1.2 Licensed Water Use

As shown in Table 10-22, the licences issued for cooling purposes assume that only about 5 percent of surface water allocations will be used. Return flow allowances in these licences amounted to 427,797 dam^3 for surface water.

10.5.1.3 Actual Water Use

There are two licence holders in the Beaverhill Sub-basin: EPCOR and Praxair Canada Inc. There is 2005 use information for two of the three cooling licences. The two licences account for 97 percent of licensed use. However, EPCOR is in the process of upgrading their Clover Bar plant so they did not use any water in 2005. Assuming the third licence issued to Praxair Canada Inc. is using its full allocation, cooling plants in the Beaverhill Sub-basin are estimated to have used 609 dam^3 of water in 2005.

Table 10-22 Licensed Allocations and Estimated Water Use for the Industrial Sector, Beaverhill 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
Cooling	Surface	3	450,917.1	23,120.4	427,796.8	609	3%	0.1%
	Groundwater	0	0.0	0.0	0.0			
	Subtotal	**3**	**450,917.1**	**23,120.4**	**427,796.8**	**609***	**3%**	**0.1%**
Chemical Plants	Surface	6	39,347.9	30,093.5	9,254.4	12,960	43%	33%
	Groundwater	1	5.5	5.5	0.0	6	100%	100%
	Subtotal	**7**	**39,353.4**	**30,099.0**	**9,254.4**	**12,966**	**43%**	**33%**
Fertilizer Plants	Surface	5	19,455.2	16,558.1	2,897.1	11,654	70%	60%
	Groundwater	4	171.5	171.5	0.0	172	100%	100%
	Subtotal	**9**	**19,626.6**	**16,729.5**	**2,897.1**	**11,827****	**71%**	**60%**
Manufacturing	Surface	0	0.0	0.0	0.0			
	Groundwater	2	1.2	1.2	0.0	1	100%	100%
	Subtotal	**2**	**1.2**	**1.2**	**0.0**	**1****	**100%**	**100%**
Mine-other	Surface	3	5,154.3	3,351.3	1,803.0	1,849	55%	36%
	Groundwater	0	0.0	0.0	0.0			
	Subtotal	**3**	**5,154.3**	**3,351.3**	**1,803.0**	**1,849*****	**55%**	**36%**
Other Industrial	Surface	1	60.5	60.5	0.0	61	100%	100%
	Groundwater	1	0.2	0.2	0.0	0	100%	100%
	Subtotal	**2**	**60.7**	**60.7**	**0.0**	**61****	**100%**	**100%**
Total	Surface	18	514,935.0	73,183.7	441,751.2	27,133	37%	5%
	Groundwater	8	178.4	178.4	0.0	179	100%	100%
	Total	**26**	**515,113.3**	**73,362.1**	**441,751.2**	**27,312**	**37%**	**5%**

* Actual water use is estimated based on WURS data and assuming the remaining licence holder is using their full entitlement.
** Actual water use assumes licence holders are using the full entitlement of their licence.
*** Actual water use based on WURS data.

10.5.1.4 Forecasts of Future Water Use

As previously mentioned, the Clover Bar (EPCOR) power plant is being renovated and EPCOR expects to resume operating within the terms of their existing water licences. These licences allow them to use 22,511 dam^3 of surface water when operating at full capacity, but they expect to use only about 8,000 dam^3 during a year of typical operations.

It is anticipated that for the forecast period there will be no new water licences issued for cooling purposes in the Beaverhill Sub-basin. The forecast of future water use for cooling in the sub-basin is provided in Table 10-23 and assumes that the two licence holders will use their full entitlement by 2010.

The Low Growth Scenario includes the upgrades at Clover Bar will require 8,000 dam^3 of surface water by 2015. The Medium Growth Scenario (most likely) has Clover Bar requiring 8,000 dam^3 of by 2010. The High Growth Scenario includes the option where Clover Bar uses the full capacity of its licences (22,511 dam^3).

Table 10-23 Forecast of Cooling Water Use in the Beaverhill Sub-basin

(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	609	609	8,609	8,609	8,609
	Groundwater	0	0	0	0	0
	Total	**609**	**609**	**8,609**	**8,609**	**8,609**
Medium Growth	Surface	609	8,609	8,609	8,609	8,609
	Groundwater	0	0	0	0	0
	Total	**609**	**8,609**	**8,609**	**8,609**	**8,609**
High Growth	Surface	609	23,120	23,120	23,120	23,120
	Groundwater	0	0	0	0	0
	Total	**609**	**23,120**	**23,120**	**23,120**	**23,120**

Under the Low Growth Scenario, water use for cooling in 2025 will increase by almost 141 percent from current levels. Under the High Growth Scenario, water use could increase by almost 380 percent.

10.5.2 Chemical Plants

10.5.2.1 Water Allocations

Almost 8 percent of the allocations for the industrial sector in the Beaverhill Sub-basin are for chemical plants (39,353 dam^3). This includes one groundwater licence for 6 dam^3 and six surface water allocations with a total allocation of 39,348 dam^3. Allocations of surface water for chemical plants commenced in the 1950s, increased significantly between the 1970s and 1990s, and have remained constant since then.

10.5.2.2 Licensed Water Use

As shown in Table 10-22, the licences issued to chemical plants assume that about 5 percent of surface water diversions and all groundwater diversions will be consumed. Return flow allowances in licences amounted to 9,254 dam^3.

10.5.2.3 Actual Water Use

The WURS database has water use information for five of the seven water licences issued for chemical plants in the Beaverhill Sub-basin. These licences account for just over 99 percent of licensed allocations and use. Analysis of the WURS database indicates that plants with surface water allocations were using an average of 33 percent of their allocations and 5 percent of the water that they are expected 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 10-22 were calculated assuming that these percentages apply to all chemical plants in the Beaverhill Sub-basin. Based on this assumption, the total water use by chemical plants in 2005 is estimated to be 12,960 dam^3, consisting of 12,955 dam^3 of surface water and 6 dam^3 of groundwater.

10.5.2.4 Forecasts of Future Water Use

There is one known proposed chemical plant in the Beaverhill Sub-basin: Alberta Sulphur Terminals' proposed Bruderheim Sulphur Forming and Shipping Facility. The proponent will be submitting their EIA to Alberta Environment in June, 2007. It is anticipated that the project will require 3 dam^3 per year in the initial operation phase (2009 and 2010), and 6 dam^3 per year once it reaches full scale operational phase (by 2015). At the present time no other projects have been proposed for the Beaverhill Sub-basin. The forecasts in Table 10-24 include the proposed Bruderheim Facility.

Table 10-24 Forecast of Chemical Water Use in the Beaverhill Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	12,960	12,960	12,963	12,968	12,968
	Groundwater	6	6	6	6	6
	Total	**12,966**	12,966	**12,968**	**12,974**	**12,974**
Medium Growth	Surface	12,960	12,963	12,968	12,968	12,968
	Groundwater	6	6	6	6	6
	Total	**12,966**	**12,968**	**12,974**	**12,974**	**12,974**
High Growth	Surface	12,960	12,968	12,968	12,968	12,968
	Groundwater	6	6	6	6	6
	Total	**12,966**	**12,974**	**12,974**	**12,974**	**12,974**

The Medium Growth Scenario reflects the water use as proposed in Alberta Sulphur Terminals' Public Disclosure document. The Low Growth Scenario has the project not starting until 2015. The High Growth Scenario has the company requiring all of the water by 2010.

10.5.3 Fertilizer Plants

10.5.3.1 Water Allocations

Almost 4 percent of the allocations for the industrial sector in the Beaverhill Sub-basin are for fertilizer plants (19,627 dam^3). This includes five groundwater licences with a total allocation of 118 dam^3 and five surface water licences with a total allocation of 19,455 dam^3. Allocations of surface water for fertilizer plants commenced in the 1950s and have increased significantly since then, especially during the 1960s and 1980s.

10.5.3.2 Licensed Water Use

As shown in Table 10-22, the licences issued to fertilizer plants assume that all groundwater withdrawals will be used (no return flows) and that 85 percent of surface water withdrawals will be consumed. Return flow allowances in surface water licences amount to 2,897 dam^3.

10.5.3.3 Actual Water Use

The WURS database has water use information for nine of the 10 water licences issued for fertilizer plants in the Beaverhill Sub-basin. These licences account for all but 1 dam^3 of groundwater. 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 their licensed water use. It is estimated that plants with groundwater allocations are using 100 percent of their licensed allocations. The water use estimates in Table 10-22 assume that the one water licence for one dam^3 uses all of its allocation. Based on these assumptions, 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.

10.5.3.4 Forecasts of Future Water Use

In the absence of information about this component of the industrial sector, it is assumed that water used by fertilizer plant activities in the Beaverhill Sub-basin will remain constant for the forecast period. The single groundwater licence (172 dam^3) for fertilizer plants is scheduled to expire in 2006, but it is expected that this will be renewed. Consequently, future water use by fertilizer plants, as shown in Table 10-25, is expected to remain constant over the forecast period.

Table 10-25 Forecast of Fertilizer Water Use in the Beaverhill Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
	Surface	11,654	11,654	11,654	11,654	11,654
	Groundwater	172	172	172	172	172
	Total	**11,827**	**11,827**	**11,827**	**11,827**	**11,827**

10.5.4 Manufacturing

Two groundwater licences have been issued for the manufacturing sector. They allow withdrawals of just over 1 dam^3 of groundwater. Manufacturing water allocations commenced in the 1980s and have remained the same since. Licensees are expected to consume all of the groundwater they withdraw. There is no information on actual water diversions and consumption for the manufacturing sector. 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 activities in the Beaverhill Sub-basin will remain constant for the forecast period.

10.5.5 Mining other than Coal

Three surface water licences have been issued for mining other than coal, and they allow withdrawals of up to 5,154 dam^3 of surface water. Manufacturing water allocations commenced in the 1950s and grew in the 1960s and 1990s. As shown in Table 10-22, the licences issued to mining other than coal expect that 65 percent of diversions of surface water will be consumed. Return flow allowances in licences amounted to 1,803 dam^3.

According to WURS, mining other than coal licence holders used 1,849 dam^3 of water in 2005; this is approximately 55 percent of their expected use. 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 Beaverhill Sub-basin will remain constant for the forecast period (Table 10-26).

Table 10-26 Forecast of Water Use for Mining Other than Coal in the Beaverhill Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
	Surface	1,849	1,849	1,849	1,849	1,849
	Groundwater	0	0	0	0	0
	Total	**1,849**	**1,849**	**1,849**	**1,849**	**1,849**

10.5.6 Other Industry

Two licences have been issued to other industries and they allow withdrawals of up to 61 dam^3 of surface water and 0.2 dam^3 of groundwater. Licences for other industrial were first issued in the 1990s and allocations have remained constant since. Licensees are expected to consume all of the water they withdraw. There is no information on actual water diversions and consumption for the other industrial activities. For purposes of this analysis, it is assumed that licensees are using their full allocation. In the absence of information about this component of the industrial sector, it is assumed that water used by other industrial activities in the Beaverhill Sub-basin will remain constant for the forecast period (Table 10-27). Although the surface water licence is scheduled to expire in 2020, it is expected that this licence will be renewed.

Table 10-27 Forecast of Other Industrial Water Use in the Beaverhill Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
	Surface	61	61	61	61	61
	Groundwater	0	0	0.	0	0
	Total	**61**	**61**	**61**	**61**	**61**

10.5.7 Summary

The industrial sector in the Beaverhill Sub-basin is dominated by water allocations for cooling plants. These plants account for 88 percent of industrial water allocations but only 2 percent of actual water use in 2005. Water use data shows that although water licences allow up to 73,362 dam^3 of water to be consumed for industrial purposes, licensees are only using 37 percent of this amount.

In the future, there is expected to be light growth in water requirements for cooling plants an existing plant is upgraded. The forecasts in Table 10-28 assume that future water use by all industrial activities, except for cooling and chemical plants, will remain the same over the forecast period.

Table 10-28 Forecast of Industrial Water use in the Beaverhill Sub-basin
(dam^3)

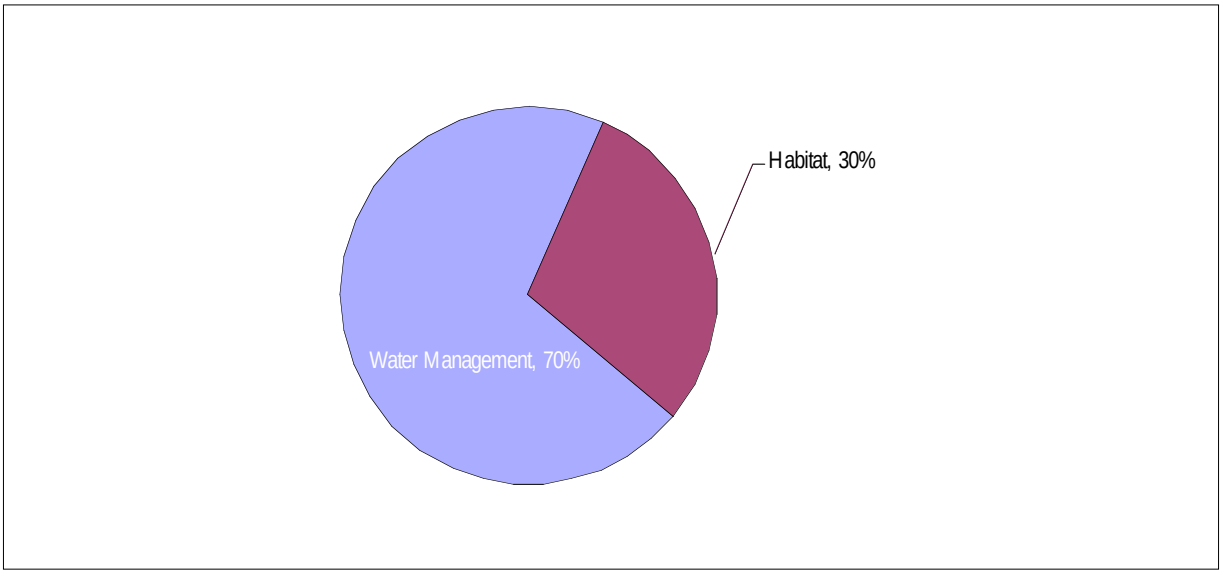
Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	27,133	27,133	35,136	35,141	35,141
	Groundwater	179	179	179	179	179
	Total	**27,313**	**27,313**	**35,315**	**35,321**	**35,321**
Medium Growth	Surface	27,133	35,136	35,141	35,141	35,141
	Groundwater	179	179	179	179	179
	Total	**27,313**	**35,315**	**35,321**	**35,321**	**35,321**
High Growth	Surface	27,133	49,652	49,652	49,652	49,652
	Groundwater	179	179	179	179	179
	Total	**27,313**	**49,832**	**49,832**	**49,832**	**49,832**

Table 10-28 shows that, for all three scenarios, the overall demand for water in the Beaverhill Sub-basin is expected to increase over the forecast period due to the increase in water required for generating power.

10.6 Other Sector

In the Beaverhill Sub-basin there are 46 active licences that allocate 5,448 dam^3 of water to the other sector. These licences assume that 37 percent of withdrawals will be con summed and that the balance (63 percent) will be returned. The other sector activities account for about 1 percent of licensed water use in the Beaverhill Sub-basin. Most (86 percent) of the water allocated is for surface water. Other sector uses include water management for flood control and lake stabilization, fish, wildlife and habitat enhancement, and other uses specified by the director (Figure 10-12).

Figure 10-12 Other Sector Water Allocation by Use in the Beaverhill Sub-basin



Water licences have been issued to Beaver County (2), City of Edmonton (3), Ducks Unlimited (25), Fisheries Management (2), Fort Saskatchewan Fish and Game Association (1), LaFarge Canada (1), Lexington Securities Co Ltd (1), Strathcona County (4), Teresen Pipeline (1), Westrock Aggregates Ltd (1), and private individuals (5). Some of the licences are for de-watering of gravel pits.

10.6.1 Water Management

In the Beaverhill Sub-basin, 14 surface water licences and three groundwater licences have been issued for water management activities. These licences allow withdrawals of up to 3,068 dam^3 of surface water and 766 dam^3 of groundwater. Water management allocations commenced in the 1950s for surface water and the 1920s for groundwater. Allocations for water management have increased since then, especially in the 1970s and the 1980s. Surface water licences expect that licence holders will consume up to 430 dam^3 and return up to 2,639 dam^3. Groundwater licences expect that licence holders will consume just over 1 dam^3 and will return up to 765 dam^3. Details of these licences are provided in Table 10-29.

There is no information on the actual water diversions and consumption for water management licences. For purposes of this analysis, it is assumed that licence holders are using their full allocations.

Table 10-29 Licensed Allocations and Estimated Actual Water Use for the Other Sector, Beaverhill Sub-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
Water Management	Surface	14	3,068.1	429.0	2,639.1	429.0	100%	100%
	Groundwater	3	766.0	1.2	764.8	1	100%	0%
	Subtotal	**17**	**3,834.1**	**430.2**	**3,403.9**	**430**	**100%**	**11%**
Habitat	Surface	28	1,609.0	1,589.3	19.7	1,589	100%	99%
	Groundwater	0	0.0	0.0	0.0	0		
	Subtotal	**28**	**1,609.0**	**1,589.3**	**19.7**	**1,589**	**100%**	**99%**
Specified	Surface	1	4.5	4.5	0.0	5	100%	100%
	Groundwater	0	0.0	0.0	0.0	0		
	Subtotal	**1**	**4.5**	**4.5**	**0.0**	**5**	**100%**	**100%**
Total	Surface	43	4,681.6	2,023.9	2,658.8	2,024	100%	43%
	Groundwater	3	766.0	1.2	764.8	1	100%	0%
	Total	**46**	**5,447.6**	**2,025.1**	**3,423.6**	**2,025**	**100%**	**37%**

In the future, there is expected to be light growth in water requirements for water management projects in the Beaverhill Sub-basin (see Section 2.3.7). The High Growth forecast in Table 10-30 assumes that future water use will increase by one licence every five years, with each licence being the size of the average current Ducks Unlimited projects. The Low Growth Scenario assumes that there is no change in water management projects. The Medium Growth Scenario includes that water use will increase at half the rate of the High Growth Scenario.

Table 10-30 Forecast of Water Management Water Use in the Beaverhill Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	430	430	430	430	430
	Groundwater	1	0	0	0	0
	Total	**430**	**430**	**430**	**430**	**430**
Medium Growth	Surface	430	485	540	595	650
	Groundwater	1	0	0	0	0
	Total	**430**	**485**	**540**	**595**	**650**
High Growth	Surface	430	540	650	760	870
	Groundwater	1	0	0	0	0
	Total	**430**	**540**	**650**	**760**	**870**

10.6.2 Habitat Enhancement

In the Beaverhill Sub-basin, 28 surface water licences have been issued for wildlife and habitat enhancement projects and they allow withdrawals of up to 1,609 dam^3 of water. Habitat enhancement allocations commenced in the 1960s. The licences assume that licensees will consume all of the water they withdraw. There is no information on the actual water diversions and consumption for habitat enhancement licences. For purposes of this analysis, it is assumed that licensees are using their full allocation.

Table 10-31 Forecast of Habitat Enhancement Water Use in the Beaverhill Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	1,589	1,589	1,589	1,587	1,587
	Groundwater	0	0	0	0	0
	Total	**1,589**	**1,589**	**1,589**	**1,587**	**1,587**
Medium Growth	Surface	1,589	1,623	1,657	1,689	1,723
	Groundwater	0	0	0	0	0
	Total	**1,589**	**1,623**	**1,657**	**1,689**	**1,723**
High Growth	Surface	1,589	1,699	1,809	1,917	2,027
	Groundwater	0	0	0	0	0
	Total	**1,589**	**1,699**	**1,809**	**1,917**	**2,027**

In the future, there is expected to be light growth in water requirements for habitat enhancement projects in the Beaverhill Sub-basin. The High Growth forecast in Table 10-31 assumes that future water use will increase by one new licence every five years, with each licence being the size of the average current Ducks Unlimited project. The Low Growth Scenario assumes that

there is no change in projects or water use. The Medium Growth Scenario assumes that water use will increase at half the rate of the High Growth Scenario.

10.6.3 Specified Use

In the Beaverhill Sub-basin, one surface water licence has been issued to a private individual for specified use by the director. The licence allows withdrawals of less than 5 dam^3 and was issued in the 1990s. The licensee is expected to consume all of the water they withdraw. There is no information on the actual water diversions and consumption for specified use licences. For purposes of this analysis, it is assumed that the licence holder is using their full allocation. In the absence of information about this component of the other sector, it is assumed that water used by specified use projects in the Beaverhill Sub-basin will remain constant for the forecast period.

10.6.4 Summary

The other sector in the Beaverhill Sub-basin is dominated by water allocated for water management. Water management projects account for 70 percent of the water allocation but only 21 percent of the licensed water use. Most of the licensed use (79 percent) is for habitat enhancement.

In the future, there is expected to be light growth in water requirements for other sector projects in the Beaverhill Sub-basin. The forecast in Table 10-32 combine the estimates for water management (Table 10-30), habitat enhancement (Table 10-31), and other specified (constant).

Table 10-32 Forecast of Other Sector Water Use in the Beaverhill Sub-basin
(dam^3)

Scenario	Source	2005	2010	2015	2020	2025
Low Growth	Surface	2,024	2,024	2,024	2,022	2,022
	Groundwater	1	0	0	0	0
	Total	**2,025**	2,024	2,024	2,022	2,022
Medium Growth	Surface	2,024	2,113	2,202	2,289	2,378
	Groundwater	1	0	0	0	0
	Total	**2,025**	**2,113**	**2,202**	**2,289**	**2,378**
High Growth	Surface	2,024	2,244	2,464	2,682	2,902
	Groundwater	1	0	0	0	0
	Total	**2,025**	**2,244**	**2,464**	**2,682**	**2,902**

Table 10-29 shows increases in water demand as low as 17 percent for the Medium Growth Scenario or as high as 43 percent for the High Growth Scenario.

10.7 Summary

Table 10-33 provides a summary of licensed allocations and estimated water use for each of the water use sectors in the Beaverhill Sub-basin. In total, existing licences and registrations allow a maximum of 571,594 dam^3 of water to be withdrawn. Of this total 20 percent (114,504 dam^3)

is expected to be used and the balance (457,089 dam^3) is to be returned after use. Figure 10-11 shows the allocations, licensed use and actual use for the different sectors. Actual use (64,386 dam^3) is about 56 percent of licensed use. The largest water user is the industrial sector. Figure 10-13 shows the forecasts to 2025 for all of the sectors under Medium Growth. By 2025 water use is expected to increase by about 114 percent under Low Growth (Table 10-31), about 139 percent under Medium Growth (Table 10-32), and about 155 percent under High Growth (Table 10-33).

Figure 10-13 Water Allocations and Actual Use, by Sector, Beaverhill Sub-basin

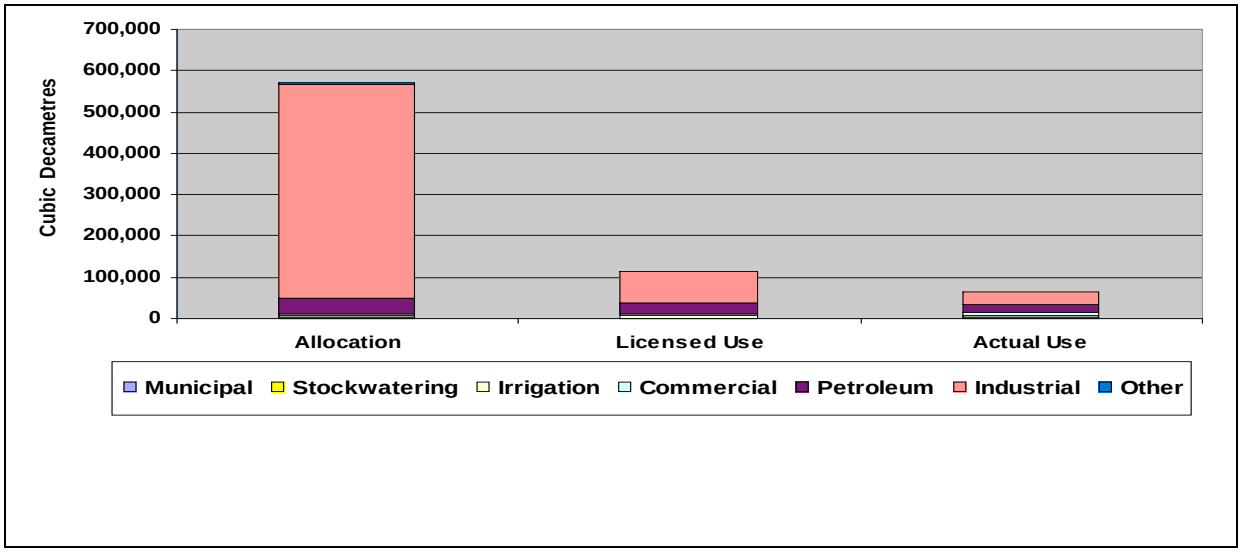


Figure 10-14 Forecast Water Use in Beaverhill Sub-basin: Medium Scenario

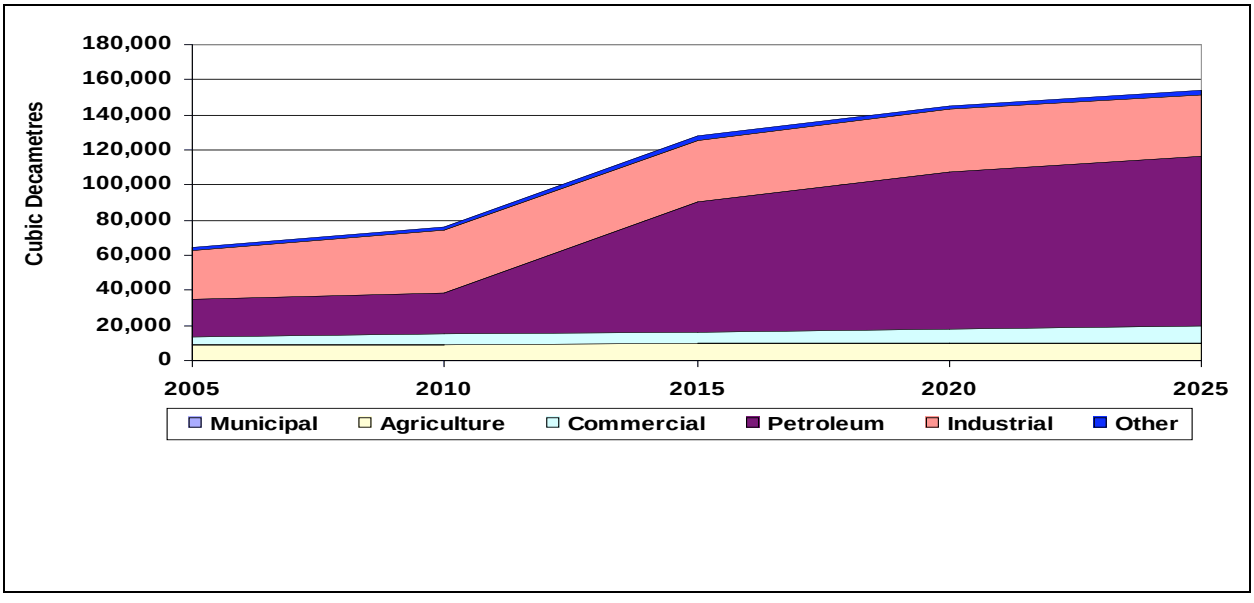


Table 10-33 Summary of Allocations and Estimated Water Use, Beaverhill Sub-basin

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		850	266	584	0%	204	77%	0%
Agricultural	Stockwatering	1,635	1,635	0	1%	4,217	258%	7%
	Irrigation	4,537	4,407	130	4%	4,407	100%	7%
Commercial		5,127	4,825	302	4%	4,825	100%	7%
Petroleum		38,883	27,984	10,899	24%	21,395	76%	33%
Industrial		515,113	73,362	441,751	64%	27,312	37%	42%
Other		5,448	2,025	3,423	2%	2,025	100%	3%
Total		**571,593**	**114,504**	**457,089**	**100%**	**64,386**	**56%**	**100%**

Table 10-34 Forecast Water Use, By Sector, Beaverhill Sub-basin: Low Scenario
(dam^3)

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	187	193	196	198	199
	Agricultural	6,716	6,772	6,837	6,903	6,971
	Commercial	4,729	5,175	5,569	5,902	6,174
	Petroleum	21,395	23,933	46,317	74,694	84,598
	Industrial	27,133	27,133	35,136	35,141	35,141
	Other	2,024	2,024	2,024	2,022	2,022
	Total	**62,184**	**65,230**	**96,079**	**124,860**	**135,105**
Groundwater	Municipal	17	18	18	18	18
	Agricultural	1,908	1,954	2,008	2,062	2,119
	Commercial	96	107	116	122	124
	Petroleum	0	0	0	0	0
	Industrial	179	179	179	179	179
	Other	1	0	0	0	0
	Total	**2,201**	**2,258**	**2,321**	**2,381**	**2,440**
Total	Municipal	204	211	214	216	217
	Agricultural	8,624	8,726	8,845	8,965	9,090
	Commercial	4,825	5,282	5,685	6,024	6,298
	Petroleum	21,395	23,933	46,317	74,694	84,598
	Industrial	27,312	27,312	35,315	35,320	35,320
	Other	2,025	2,024	2,024	2,022	2,022
	Total	**64,385**	**67,488**	**98,400**	**127,241**	**137,545**

Table 10-35 Forecast Water Use, By Sector, Beaverhill Sub-basin: Medium Scenario
(dam^3)

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	187	196	204	212	217
	Agricultural	6,716	6,862	7,025	7,198	7,382
	Commercial	4,729	5,715	6,853	8,078	9,425
	Petroleum	21,395	23,933	73,742	89,689	96,593
	Industrial	27,133	35,136	35,141	35,141	35,141
	Other	2,024	2,113	2,202	2,289	2,378
	Total	**62,184**	**73,955**	**125,167**	**142,607**	**151,136**
Groundwater	Municipal	17	18	19	19	20
	Agricultural	1,908	2,029	2,164	2,306	2,458
	Commercial	96	114	134	152	166
	Petroleum	0	0	0	0	0
	Industrial	179	179	179	179	179
	Other	1	0	0	0	0
	Total	**2,201**	**2,340**	**2,496**	**2,656**	**2,823**
Total	Municipal	204	214	223	231	237
	Agricultural	8,624	8,891	9,189	9,504	9,840
	Commercial	4,825	5,829	6,987	8,230	9,591
	Petroleum	21,395	23,933	73,742	89,689	96,593
	Industrial	27,312	35,315	35,320	35,320	35,320
	Other	2,025	2,113	2,202	2,289	2,378
	Total	**64,385**	**76,295**	**127,663**	**145,263**	**153,959**

Table 10-36 Forecast Water Use, By Sector, Beaverhill Sub-basin: High Scenario
(dam^3)

Source	Sector	2005	2010	2015	2020	2025
Surface Water	Municipal	187	202	218	233	246
	Agricultural	6,716	6,996	7,316	7,672	8,070
	Commercial	4,729	6,106	7,697	9,537	11,610
	Petroleum	21,395	23,933	77,684	100,343	102,593
	Industrial	27,133	27,133	35,136	35,141	35,141
	Other	2,024	2,244	2,464	2,682	2,902
	Total	**62,184**	**66,614**	**130,515**	**155,608**	**160,562**
Groundwater	Municipal	17	18	20	21	22
	Agricultural	1,908	2,139	2,404	2,698	3,027
	Commercial	96	126	159	193	225
	Petroleum	0	0	0	0	0
	Industrial	179	179	179	179	179
	Other	1	0	0	0	0
	Total	**2,201**	**2,462**	**2,762**	**3,091**	**3,453**
Total	Municipal	204	220	238	254	268
	Agricultural	8,624	9,135	9,720	10,370	11,097
	Commercial	4,825	6,232	7,856	9,730	11,835
	Petroleum	21,395	23,933	77,684	100,343	102,593
	Industrial	27,312	27,312	35,315	35,320	35,320
	Other	2,025	2,244	2,464	2,682	2,902
	Total	**64,385**	**69,076**	**133,277**	**158,699**	**164,015**