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Milk River Consumptive Water Use Study

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Paterson Earth &Water Consulting Ltd.
Lethbridge, Alberta

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Prepared for the
International Joint Commission

Milk River Consumptive Water Use Study

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Aerial view of Town of Milk River (page 33) – courtesy of the Town of Milk River.

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Executive Summary

Introduction

The Boundary Waters Treaty of 1909 provides the general principles for preventing and resolving disputes over waters that are shared between Canada and the United States from the Pacific to the Atlantic oceans. The Boundary Waters Treaty established the International Joint Commission to regulate shared water uses, and to investigate and recommend solutions for boundary water issues. With respect to water sharing of the St. Mary and Milk Rivers, development of the 1921 Order by the International Joint Commission directed how the waters of the two rivers are to be monitored and apportioned at the eastern crossing of the international boundary (west of Wildhorse, Alberta). For the past 95 years, the 1921 Order has been the basis for apportioning the flows of the St. Mary and Milk Rivers.

The Milk River Basin is the most northern river basin that drains into the Missouri/Mississippi river system. The Milk River originates in the Montana foothills and eastern slopes of the Rocky Mountains. Its total length is about 1,170 km (700 miles), and runs northeast from Montana into Alberta, and roughly parallels the International Boundary in Alberta before returning to Montana and joining up with the Missouri River southeast of Glasgow, Montana. The Milk River Basin is relatively dry, and drought is a constant threat. Agricultural production is generally restricted to native rangeland and low water use crops. Even irrigation cannot be considered a wholly reliable option because the intermittent natural flow of the Milk River

Estimates of water diversions, losses and consumptive use are important components for calculating the natural flow of the Milk River at the western and eastern boundary crossings, and assessing the apportionment of the Milk River between Montana and Alberta. The most current consumptive water use estimates were developed by Thompson (1986). Significant changes in the Milk River Basin have taken place during the past 30 years.

In December, 2015 the International Joint Commission initiated a project to assess historic and current consumptive water use, diversions and losses related to irrigation, municipal and domestic purposes in the Milk River Basin upstream of the eastern crossing. The project is focused on the selected study area that was originally assessed by Thompson (1986). It encompasses the headwaters of the Milk River Basin, plus the southern tributary streams that originate in Montana, and includes the portion of the Milk River Basin that contributes flow to the river at the eastern crossing. The drainage area of the study area upstream of the eastern boundary crossing is about 6,700 km^2 (2,600 $miles^2$).

This report deals with the Consumptive Use part of the overall project in January, 2016.
The objectives of the study are to:

1. Review and comment on the consumptive use accounting practices and the origin of the consumptive use tables as determined by Thompson (1986) and used in existing apportionment calculations for the Milk River;

2. Update consumptive water values presently used to better represent current irrigation, municipal, and domestic water uses; and
3. Recommend and work with GIS and Remote Sensing components of the consumptive use project tools to compute and communicate consumptive uses.

Key Conclusions

Irrigation

Historically and currently, irrigation is by far the largest consumptive user of Milk River water in both the Montana and Alberta portions of the study area. In the Montana portion of the Milk River Basin, irrigation accounts for about 99% of the total historic water use, and about 98% of the current total water use. In the Alberta portion of the Milk River Basin, irrigation accounts for about 93% of the total historic water use and about 92% of the current total water use.

Comparison of Current and Historic Water Use - The current water use assessment provides a more accurate estimate of actual water use when compared with the historic water use assessment carried out by Thompson (1986).

- Thompson (1986) estimated irrigation consumptive use largely on the basis of crop water requirements in both the Montana and Alberta portions of the study area. The current consumptive use assessment was partly based on studies carried out to measure water use by irrigation producers in both Montana and Alberta. These monitoring projects provide the most accurate information to date regarding irrigation water use.

- Continuing these types of initiatives would provide very useful information to assist with apportionment of the Milk River flow. However, to implement a long-term monitoring program similar to the one developed in the Alberta portion of the Milk River Basin study area could range from $250,000 to $400,000 (CDN$). Annual operating costs are also expected to be high because of the relatively remote nature of the irrigation systems and monitoring infrastructure.

Irrigation Area Assessment - Both the Thompson (1986) and current water use assessment studies estimated the size of the irrigation areas through the use of ground monitoring and aerial surveys. These methods appear to reasonably identify the areas irrigated by sprinkler (pivot and wheel move) systems because of the visibility of the irrigation infrastructure and more delineated evidence of crop growth. Accurately identifying flood (back flood) irrigated areas on tributary streams continues to be more difficult because irrigation is usually only carried out once in the spring, and only if runoff water is available.

Current Water Use: Montana – Current irrigation consumptive water use is significantly less than historic consumptive water use estimates, and appears to be related to the reduced area currently being irrigated. The historic total irrigated area in the Montana portion of the study area was estimated to about 2,000 hectares (4,942 acres) in 1982, while the current irrigated

area is estimated to about 1,477 hectares (3,650 acres). The difference appears to be mainly related to the irrigation area in the headwaters area of the Montana portion of the Milk River Basin.

Current Water Use: Alberta - For the Alberta portion of the Milk River Basin study area, current irrigation water use estimates are about 910 dam^3 (738 acre feet) less than the historic irrigation water use estimate. However, the current irrigated area estimate of 3,237 hectares (8,000 acres) is significantly higher than the historic irrigated area estimate of 1,810 hectares (4,473 acres), which would suggest that current water use should be higher. The reduced irrigation water use may be the result of a significant increase in the use of advanced pivot irrigation systems, which are more water-use efficient than historic irrigation systems.

Municipal Water Use

Municipal water use represents a very small part of the total water use in both the Montana and Alberta portions of the study area.

Montana - Historically municipal water use represented <1% of the total water use in the Montana portion of the study area. Sweetgrass was the only community to receive water from the Milk River, and it did so through the works of the Village of Coutts, Alberta. It used about 23 dam^3 (19 acre-feet) of water annually.

Currently, the community of Sweetgrass is still the only municipal water user to receive water from the Milk River in the Montana portion of the study area. It continues to obtain its water supply from the Village of Coutts, but currently uses about 16 dam^3 (13 acre-feet) per year, which is almost 35% less than its historic use.

Alberta – Historically, municipal water use from the Milk River in the Alberta portion of the study area was higher than for the Montana portion, representing about 7% of the total water used. The Town of Milk River and the Village of Coutts were the two communities that received their water from the Milk River, and their historic combined water use was about 396 dam^3 (321 acre-feet) per year. Currently, the combined total water use for the Town of Milk River and Village of Coutts is calculated to be 313 dam^3 (254 acre-feet) – a reduction of about 21% from historic levels.

Domestic and Agriculture Water Use

Domestic - Historic and current information regarding domestic water use from the Milk River is not readily available for either the Montana or Alberta portions of the study area. In the Alberta portion of the study area, groundwater is considered to be main source of domestic water use. Domestic surface water use is considered to represent a very small portion of total water use in both jurisdictions, and is not expected to have a measurable impact on the flow of the Milk River.

Agriculture – In the Montana portion of the study area, agricultural water use was not assessed, either historically or currently. It is considered to represent a very small part of the

total water use, with no measurable impact on the flow of the Milk River. In the Alberta portion of the study area, agricultural water use was not measured historically, and was also considered to have no measurable impact on the flow of the Milk River. Currently, the total agricultural water use related to the main stem of the Milk River is about 59 dam^3 (48 acre-feet) per year. This represents about 1.3% of the total water use in Alberta portion of the Milk River Basin.

Recommendations

Monitoring and Reporting – Irrigation is the single largest consumptive user of water in the Montana and Alberta portions of the Milk River Basin study area. Accurate and timely monitoring of the irrigation consumptive water use, combined with regular reporting, is recommended for both the Montana and Alberta portions of the Milk River Basin. This will allow both jurisdictions to more effectively and accurately assess the Milk River flows at the western and eastern boundary crossings.

It is recommended that a joint Montana/Alberta task team be assembled to develop a practical, cost-effective water monitoring and reporting system that can be applied in both the Montana and Alberta portions of the Milk River Basin.

Irrigation Area Assessment – It is recommended that an assessment be carried out every five years to more accurately identify and map the location and size of actively operating irrigation projects in both the Montana and Alberta portions of the study area. This assessment should include both sprinkler and flood (back flood) irrigation projects, and be linked to a monitoring and reporting program, if established. This information would be valuable to better identify and understand potential irrigation impacts on specific reaches of the Milk River and its tributaries, and supplement data collected through a monitoring and reporting program.

Rural Water Co-operatives – There are several rural water co-operatives operating within the Alberta portion of the Milk River Basin. Two of the water co-operatives obtain water from the Milk River through the works of the Town of Milk River, and their annual water use is included within the town's water use monitoring. Most of these utilize groundwater sources for their water supply, and accurate information regarding the water source, allocation and annual consumptive water use by the rural water co-operatives is not readily available.

It is recommended that Alberta Environment and Parks take steps to ensure that existing rural water co-operatives in the Milk River Basin comply with existing requirements to annually post information related to water source, water licence allocation, and water use.

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1.0 Introduction

The Boundary Waters Treaty of 1909 provides general principles for preventing and resolving disputes over waters that are shared between Canada and the United States from the Pacific to the Atlantic oceans. The Boundary Waters Treaty established the International Joint Commission to regulate shared water uses, and to investigate and recommend solutions for boundary water issues. With respect to water sharing of the St. Mary and Milk Rivers, development of the 1921 Order by the International Joint Commission directed how the waters of the two rivers are to be monitored and apportioned at the eastern crossing of the international boundary (west of Wildhorse, Alberta). For the past 95 years, the 1921 Order has been the basis for apportioning the flows of the St. Mary and Milk Rivers (Figure 1.1).

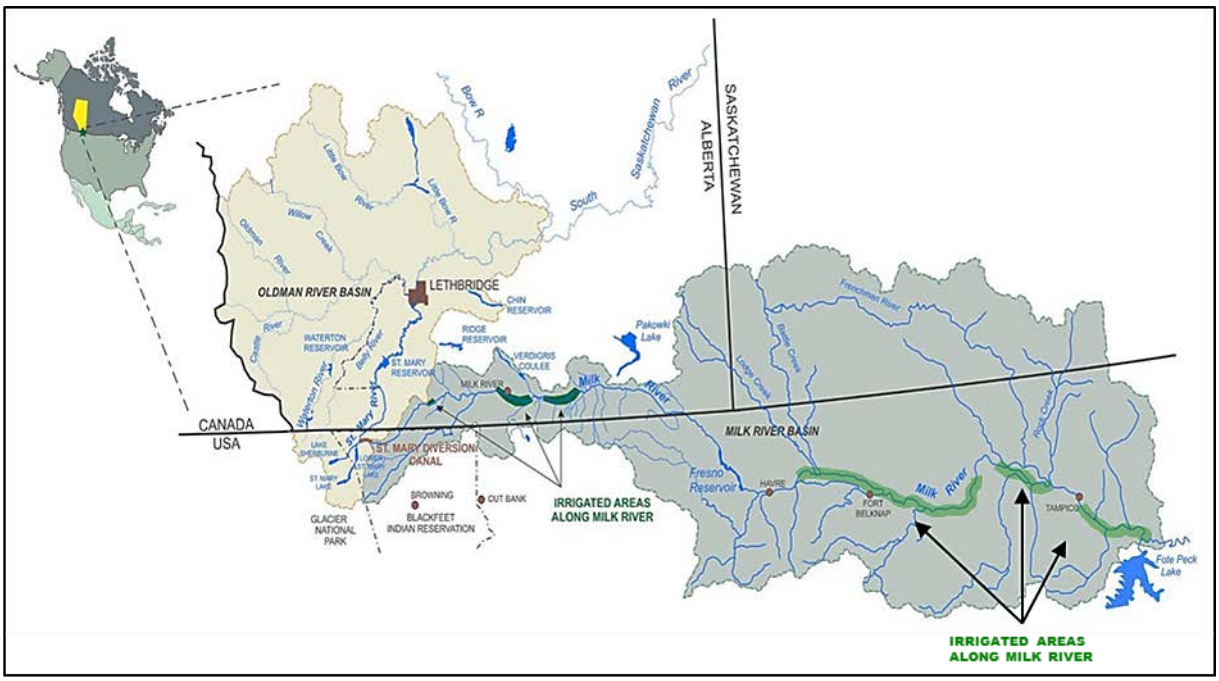

Figure 1.1. Overview of St. Mary and Milk River Basins.

Estimates of water diversions, losses and consumptive use are important components for calculating the natural flow of the Milk River at the western and eastern boundary crossings, and assessing the apportionment of the Milk River between Montana and Alberta. The most current consumptive water use estimates were developed by Thompson (1986). It was recognized that significant changes in the Milk River Basin have taken place in the past 30 years. The demand for water in the basin continues to grow, and technologies related to water management have changed significantly.

In December, 2015 the International Joint Commission initiated a project to assess historic and current consumptive water use, diversions and losses related to irrigation, municipal and domestic purposes in the Milk River Basin upstream of the Eastern Crossing (the study area).

Paterson Earth & Water Consulting Ltd. was awarded the Consumptive Use part of the overall project in January, 2016.

The objectives of the study are to:

4. Review and comment on the consumptive use accounting practices and the origin of the consumptive use tables as determined by Thompson (1986) and used in existing apportionment calculations for the Milk River;
5. Update consumptive water values presently used to better represent current irrigation, municipal, and domestic water uses; and
6. Recommend and work with GIS and Remote Sensing components of the consumptive use project tools to compute and communicate consumptive uses.

2.0 Milk River Basin Overview

This chapter provides a brief overview of the characteristics of the entire Milk River Basin in United States (Montana) and Canada (Alberta and Saskatchewan). This is intended to provide context for the remainder of the report which focuses on the portion of the basin that has implications for apportionment of Milk River flow at the eastern crossing of the International Boundary.

2.1 Geography

The total area of the Milk River Basin is about 61,642 km^2 (23,800 miles^2), and is located within the State of Montana, and the Provinces of Alberta and Saskatchewan (Figure 1.1). The area of the Milk River Basin in Montana is about 40,200 km^2 (15,521 miles^2), and represents about 65% of the total basin. The area in Alberta is about 6,500 km^2 (2,510 miles^2) and represents about 11% of the watershed. About 14,942 km^2 (5,769 miles^2) of the watershed is located in Saskatchewan, which represents about 24% of the total area. (Milk River Watershed Council Canada, 2013).

The Milk River originates in the foothills of Montana at an elevation of about 3,060 m (9,500 feet). Its origins are located in the Blackfeet Indian Reservation and Glacier National Park. Its total length is about 1,170 km (700 miles), and runs northeast from Montana into Alberta, and roughly parallels the International Boundary in Alberta. The river re-enters Montana west of the boundary crossing of Wildhorse, Alberta, and eventually joins the Missouri River just east (downstream) of Fort Peck Reservoir in Montana.

Prairie grassland – Milk River Basin

In the Alberta part of the basin, most of the landscape through which the Milk River traverses consists of

undulating prairie grasslands. The Government of Alberta owns about 60% of the land area in the Alberta portion of the basin, and the remaining 40% is under private ownership. Much of the public land is leased for cattle ranching.

Chinook arch over southern Alberta

2.2 Population and Municipal Water Supply

Approximately 3,300 people live in the Alberta portion of the Milk River Basin. The Town of Milk River (population 800) and the Village of Coutts (population 280) pump water from the Milk River to storage ponds located near the communities that help provide needed water during times when the flow of the Milk River is low. Warner, another major centre in the basin, gets it water from the St. Mary River, via the Milk River Ridge Reservoir, which is located outside the Milk River Basin.

The population in the Montana portion of the Milk River Basin is estimated to be about 35,600. Havre is the largest urban centre in the basin, with a population of about 9,300 (2010). Municipal water use in the basin is about 3,200 dam^3 (2,600 acre-feet) annually (St. Mary River and Milk River Basins Study Summary Report, 2012), which is about 57% of the 5,670 dam^3 (4,600 acre-feet) available for municipal use. The community of Sweetgrass, located along the Canada-United States border adjacent to the Village of Coutts, Alberta, obtains its water supply from the Milk River in Alberta through a co-operative agreement with the Village of Coutts.

2.3. Temperature and Precipitation

Precipitation in the basin is highly variable, with most occurring from May to September. Snowfall contributes about 30% of the total precipitation (Milk River Watershed Council Canada, 2013). This region experiences relatively cold winters and warm, dry summers. Warm chinook winds are a common occurrence during the winter months. Prolonged drought cycles can severely restrict agricultural cropping alternatives. The regional climate is modified in Alberta by the Milk River Upland, the Sweetgrass Hills and Cypress Hills and in Montana by the Bears Paw Mountains (Klohn Crippen Consultants Ltd., 2003). Modifications usually relate to higher precipitation on the upland areas and reduced precipitation on the downward side of the uplands.

In the western region of the Milk River Basin, which is located in Montana, precipitation ranges from greater than 660 mm (26 inches) in the foothills to less than 400 mm (16 inches) near the Canadian border. Figure 2.2 shows the monthly average precipitation for this region, using data from the weather station at Babb, Montana.

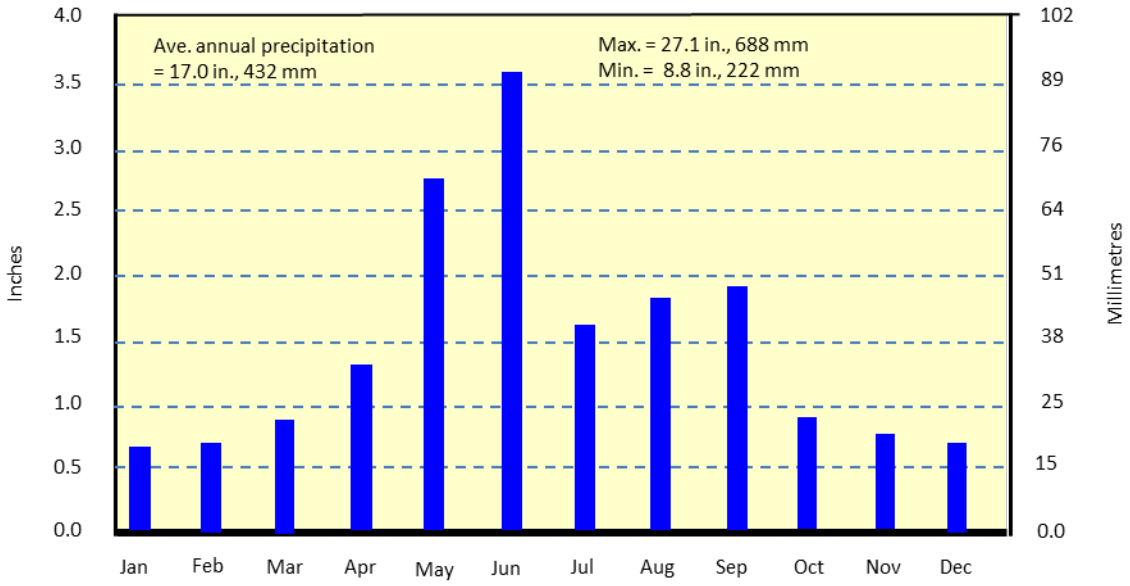

Figure 2.1. Summary of precipitation for Babb, Montana (1961 – 2007).

Source: Figliuzzi and Dolan, 2009.

In the Alberta portion of the Milk River Basin, the mean annual precipitation ranges from about 400 mm (16 inches) in the western part of the basin, represented by the weather station at Cardston, Alberta (Figure 2.2) to about 300 mm (12 inches) in the eastern part, represented by the weather station at Manyberries, Alberta (Figure 2.3).

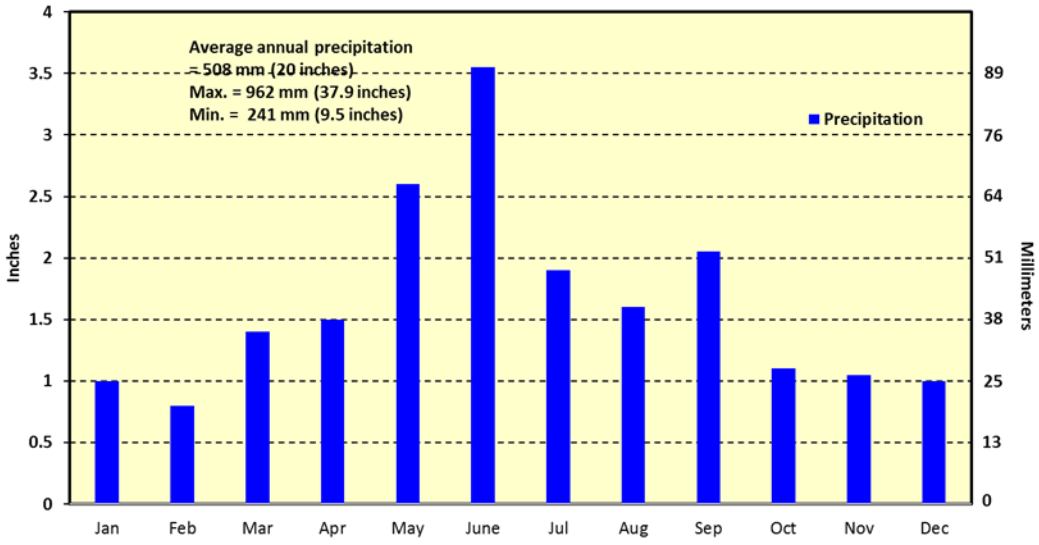

Figure 2.2. Average monthly precipitation at Cardston, Alberta (1925 – 2000)
Source: Figluzzi and Dolan, 2009.

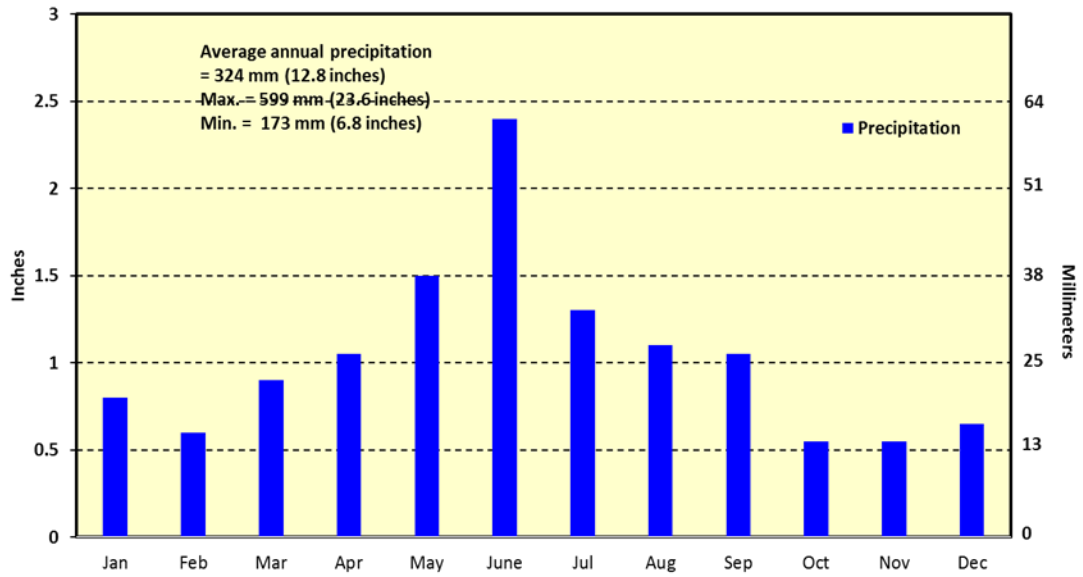

Figure 2.3. Average monthly precipitation at Manyberries, Alberta (1925 – 2000).

Source: Figliuzzi and Dolan, 2009.

2.2 Agricultural Development

Agricultural development in the Alberta and Montana portions of the Milk River Basin is comprised of a mix of pasture and cropland. Most of the agriculture is carried out under rainfed conditions, and includes cereals, oilseeds, forages, native range, and tame pasture. Native pasture represents about 65% of the land in the Alberta portion of the basin and about 44% of the Montana portion. Montana has about 33% of the basin in cropland while Alberta has about 17% (Milk River Watershed Council Canada, 2013). Table 2.1 provides a more detailed breakdown of the agricultural development in the basin.

Table 2.1. Agricultural land use in the Milk River Basin (2012).

Land Use	Alberta (%)	Montana (%)
Crop Land	17	33
Developed	0	1
Tame/Seeded Pasture	6	1
Natural Range	65	44
Forest	1	2
Water/Wetland	3	5
Shrub Land	5	12
Non Vegetated	3	2
Total	**100**	**100**

Source: Derived from Milk River Watershed Council Canada, 2013

In the Alberta portion of the Milk River Basin, the total area under active irrigation is not well defined, as it may vary from year to year depending on precipitation, water supply and the feed supplies ranchers may have on hand. Nearly all irrigation takes place along the Milk River main stem, and is focused in areas immediately west of the Town of Milk River and at several locations between the Town of Milk River and the and the Eastern Crossing (Figure 1.1).

Relatively secure water supplies are generally available in the Milk River to irrigate about 3,200 hectares (8,000 acres) of land (St. Mary River and Milk River Basins Study Technical Report, 2012; and Figliuzzi and Dolan, 2009). About 92% of the irrigation adjacent to the Milk River uses sprinkler (pivot and wheel-roll) irrigation systems, while flood irrigation constitutes only about 8% of the total (Figliuzzi and Dolan, 2009). There are also many small back-flood irrigation projects associated with tributary streams in the basin. However, irrigation frequency for these projects is very unpredictable because of the intermittent flow in the tributary streams. It is felt that many of these projects act as controlled wetland drainage systems and are generally considered to be net contributors to the Milk River (Figliuzzi and Dolan, 2009). About 60% (Table 2.2) of the irrigation is for forages or silage crops that supports the region's livestock industry. The remaining 40% is comprised of a variety of cereal and specialty crops.

Pivot irrigation system

Table 2.2. Irrigated crop mix in the Milk River Basin in Alberta (2009).

Crop	Percent of Total
Alfalfa (2 cut)	21.5
Barley (silage)	6.4
Grass (hay)	21.3
Tame Pasture	7.8
Timothy Hay	3.1
Triticale	0.7
Native Pasture	9.3
Canola	7.1
Dry beans	0.4
Dry peas	6.6
Grass (seed)	5.4
Hard Spring Wheat	9.4
Oats	1.0
Total	100

Source: Figliuzzi and Dolan, 2009.

In the Montana portion of the Milk River basin the large majority of the irrigation development occurs downstream of Fresno Dam and Reservoir, which is located about 89 kilometres (50 miles) downstream of the Canada-United States boundary. A number of irrigation diversion dams and pumping stations along the Milk River supply water to about 58,700 hectares (145,000 acres) of agricultural lands (Figure 1.1).

Agricultural land use along the Milk River in Montana is predominantly cow-calf ranching, with most irrigated production used for winter feed. The Milk River irrigated crop mix varies from year to year but averages about 20% grain and 80% forages. Flood irrigation is practised on about 78% of the irrigated area along the Milk River, and sprinkler systems account for about 22% of the area. Table 2.3 summarizes the irrigation methods in Montana's portion of the Milk River basin.

Table 2.3 Summary of irrigation methods in Montana portion of the Milk River Basin.

Irrigation Method	Percent of Total Area
Flood (leveled land)	54
Flood (unleveled land)	24
Sprinkler (pivot)	12
Sprinkler (wheel move)	10
Total	100

Source: Figliuzzi and Dolan, 2009.

2.3 Crop Water Deficit – Alberta

In Alberta, the crop water deficit is calculated using the difference between actual evapotranspiration (AET) and growing season precipitation. For the Milk River Basin, a modified Priestley-Taylor equation was used to calculate potential evapotranspiration (PET), and crop coefficients developed to calculate the AET. Precipitation data was interpolated from representative weather stations in the Milk River Basin (Figliuzzi and Dolan, 2009).

Weather data from 1971 to 2000 was used to compute average monthly crop water deficits for alfalfa at two sites. Weather data at Cardston was used to represent the western region of the Milk River Basin in Alberta and Manyberries weather data was used to represent the eastern region of the basin. Table 2.4 shows the computed average monthly crop water deficits at these two sites. The 30-year average crop water deficit at Cardston is 336 millimeters (13.3 inches) and 493 millimeters (19.4 inches) at Manyberries. The maximum annual crop water deficit at Cardston is 566 millimeters (22.3 inches) and 693 millimeters (27.3 inches) at Manyberries. The minimum annual deficit at Cardston is 33 millimeters (1.3 inches) and 224 millimeters (8.8 inches) at Manyberries.

Table 2.4. Average monthly crop water deficit for alfalfa (3-cut) at Cardston and Manyberries, Alberta.

Month	Cardston		Manyberries	
	millimetres	inches	millimetres	inches
April	-29	-1.1	5	-0.2
May	53	2.1	94	3.7
June	76	3.0	107	4.2
July	122	4.8	142	5.6
August	66	2.6	86	3.4
September	48	1.9	69	2.7
Irrigation Season Total	**336**	**13.3**	**493**	**19.4**

Source: Figliuzzi and Dolan, 2009.

2.4 Crop Water Deficit – Montana

In Montana, the Blaney Criddel method was used to calculate the seasonal alfalfa evapotranspiration (ET) requirement at selected weather stations in the Milk River Basin from1970 to 2000. The crop water deficit for Babb was used to represent the Montana part of the Milk River Basin in the study area. The crop water deficit for this location was 323 millimeters (12.7 inches) (Figure 2.6) for the growing season from May 22 to September 14 (Figliuzzi and Dolan, 2009).

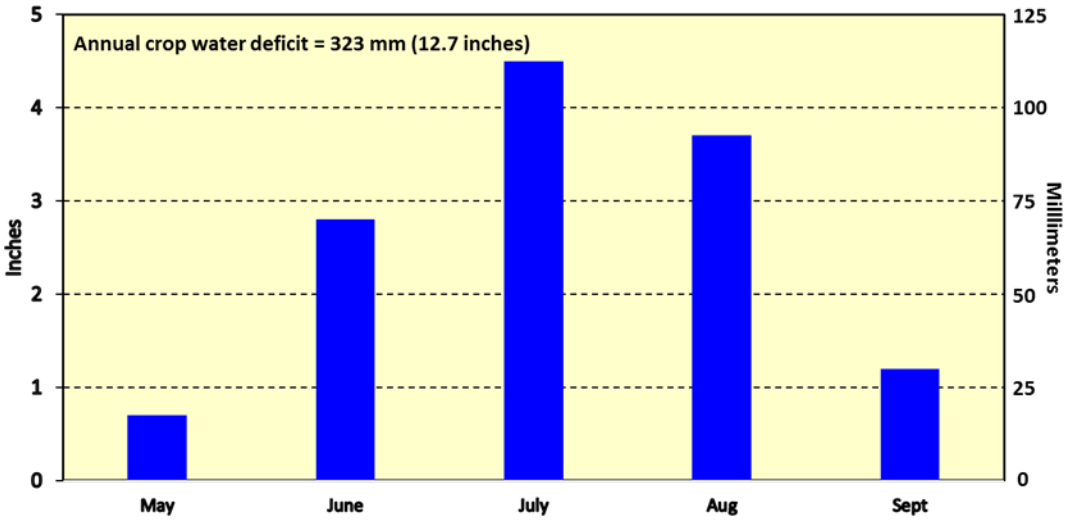

Figure 2.4. Monthly average crop water deficit at Babb, Montana (1971 – 2000)
Source: Figliuzzi and Dolan, 2009.

3.0 International Agreements

The Boundary Waters Treaty of 1909 between the United States and Canada was developed to deal with boundary waters between the United States and Canada. The Treaty also established the International Joint Commission (IJC) as a formal mechanism to investigate and resolve

boundary water issues.

Article VI of the Boundary Waters Treaty provides the framework for measuring and apportioning the flows of the St. Mary River, the Milk River, and the Eastern Tributaries of the Milk River (Lodge Creek, Battle Creek, and the Frenchman River). Questions over the interpretation of Article VI led to development of the 1921 Order by the IJC, which directed how the waters of the two rivers at the international boundary were to be apportioned and measured. For the past 95 years, the 1921 Order has been used as the basis for apportioning the flows of the St. Mary and Milk Rivers.

3.1 St. Mary River

Irrigation Season (April 1 to October 31): *During the irrigation season when the natural flow of the St. Mary River at the point where it crosses the international boundary is six hundred and sixty-six (666) cubic feet per second or less Canada shall be entitled to three-fourths and the United States to one-fourth of such flow.*

During the irrigation season when the natural flow of the St. Mary River at the point where it crosses the international boundary is more than six hundred and sixty-six (666) cubic feet per second Canada shall be entitled to a prior appropriation of five hundred (500) cubic feet per second, and the excess over six hundred and sixty-six (666) cubic feet per second shall be divided equally between the two countries.

Non-irrigation Season (November 1 to March 31): *During the non-irrigation season the natural flow of the St. Mary River at the point where it crosses the international boundary shall be divided equally between the two countries.*

3.2 Milk River

Irrigation Season (April 1 to October 31): *During the irrigation season when the natural flow of the Milk River at the point where it crosses the international boundary for the last time (commonly and hereafter called the Eastern Crossing) is six hundred and sixty-six (666) cubic feet per second or less, the United States shall be entitled to three-fourths and Canada to one-fourth of such natural flow.*

During the irrigation season when the natural flow of the Milk River at the Eastern Crossing is more than six hundred and sixty-six (666) cubic feet per second the United States shall be entitled to a prior appropriation of five hundred (500) cubic feet per second and the excess over six hundred and sixty-six (666) cubic feet per second shall be divided equally between the two countries.

Non-irrigation Season (November 1 to March 31): *During the non-irrigation season the natural flow of the Milk River at the Eastern Crossing shall be divided equally between the two*

countries. The 1921 Order also states that the channel of the Milk River in Canada may be used at the convenience of the United States for the conveyance, while passing through Canadian territory, of waters diverted from the St. Mary River.

3.3 Administration

Formal administration of the Boundary Waters Treaty and the 1921 Order of the IJC involved a daily determination of the natural flow of the Milk and St. Mary Rivers at their respective boundary crossings. With respect to the Milk River, estimation of natural flow at the eastern crossing into USA required making adjustments to recorded flow to account for diversions, water use, and increased losses as a result of higher flows due to US diversions. A formula for computing natural flow of the Milk River at its eastern entrance to the US can be expressed as follows:

$$\mathbf{Q_{nex} = Q_{rex} - US_{div} + E_{inc} + US_{use} + C_{use} - C_{div}} \qquad \textbf{Equation 1}$$

where,

$\mathbf{Q_{nex}}$ = natural flow of the Milk River at the eastern crossing into US,
$\mathbf{Q_{rex}}$ = recorded flow of the Milk River at the eastern crossing into US,
$\mathbf{US_{div}}$ = US diversion from the St. Mary River to the North Fork of the Milk River,
$\mathbf{E_{inc}}$ = increased evaporation due to the increase in flow from Q_{nat} to (Q_{nat} + US_{div}),
$\mathbf{US_{use}}$ = US water use along the North Fork and upper Milk River in Montana, and along all US northern flowing tributaries that contribute to flow in the Milk River in Canada,
$\mathbf{C_{use}}$ = Canadian water use along the main stem of the Milk River and along all Canadian tributaries that contribute to flow in the Canadian portion of the Milk River, and
$\mathbf{C_{div}}$ = Canadian diversions to the Milk River from outside of the Milk River Basin.

Historically, low water use in the upper Milk and St. Mary Rivers in Montana, and in the Milk River in Alberta, made extensive monitoring and computations to accurately define all elements of Equation 1 unnecessary. However, prolonged low flows in the Milk River, increased water use and potential consideration of new storage development in Alberta in the mid-1980s prompted the United States Geological Survey to consider refining the apportionment computation procedures by incorporating consumptive use into the natural flow determination (Thompson, 1986).

4.0 Project Study Area

The study area includes the Milk River Basin from its headwaters in northwestern Montana, and all of the basin in Alberta and Montana to the point of re-entry into the United States. The area includes parts of northern Montana and southern Alberta (Figure 4.1). It includes the foothills in the western part of the basin and the prairie region in the central and eastern parts. The altitude of the study area ranges from about 2,700 metres (8,900 feet) above sea level in the headwaters region to about 820 metres (2,700 feet) above sea level at the downstream end (Thompson, 1986).

The North Fork Milk River, which originates in Montana, flow northeastward and becomes the North Milk River in Alberta. The South Fork Milk River flows northeast into southern Alberta to become the Milk River. The combined drainage area of the rivers upstream from their entry into Canada is about 1,200 km^2 (460 mi^2). The two rivers join west of the Town of Milk River, Alberta and flow eastward for about 210 kilometres (130 miles) on a roughly parallel course to the Alberta/Montana boundary before re-entering Montana. The drainage area of the study area upstream of the eastern boundary crossing is about 6,700 km^2 (2,600 miles^2) (Thompson, 1986).

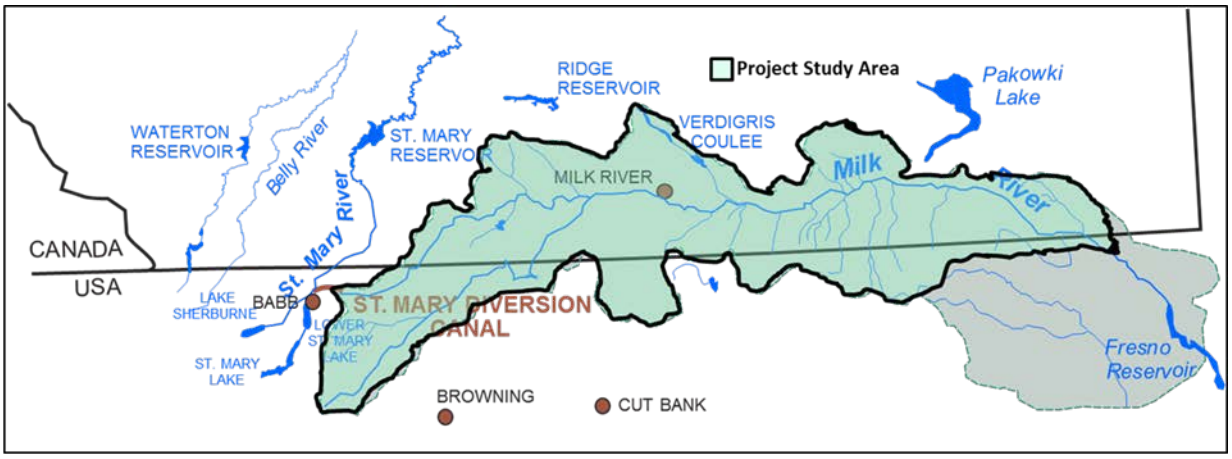

Figure 4.1. Approximate outline of study area.
Derived from Thompson, 1986

A number of northward flowing streams in the Montana portion of the study area contribute to the Milk River flow in the study area, including Red Creek (Red River in Canada), Police Coulee (Police Creek in Canada), Deer Creek, Miners Coulee, Breed Creek and Bear Creek. These streams intermittently flow north from the Sweetgrass Hills in Montana to the Milk River in Alberta and are collectively known as the southern or Sweetgrass tributaries. Water from these international streams has been allocated for agricultural and irrigation use in both Montana and Alberta. Consumptive uses from these southern Sweetgrass tributaries are indirectly included in the determination of the natural flow of the Milk River. (International St. Mary-Milk Rivers Administrative Measures Task Force, 2006).

From the northern edge of the study area in Alberta, Verdigris and Pakowki Coulees flow south to join the Milk River. These coulees have minimal natural flow normally, but can see significant flow during rapid runoff events.

5.0 Consumptive Water Use Assessment in Montana

5.1 Historic Consumptive Water Use – Montana

5.1.1 Historic Irrigation Water Use

Irrigation in both Canada and the United States has always accounted for the majority of the water consumption in the basin upstream of the Milk River eastern crossing into Montana. Thompson (1986) reported that aerial photography, telephone surveys and onsite checks of selected projects conducted in 1982 in the study area indicated that about 770 hectares (1900 acres) were under flood irrigation (usually referred to as back flood irrigation in Canada) and about 320 hectares (800 acres) were under sprinkler irrigation in the Montana headwaters area of the North Fork and Milk River (Table 5.1; Appendix A-1).

About 530 hectares (1300 acres) were under flood Irrigation and 380 hectares (950 acres) under sprinkler irrigation (Table 5.2; Appendix A-1) associated with the southern Sweetgrass tributary streams in the Montana part of the study area. The combined total irrigated area in the Montana portion of the Milk River Basin was about 2,000 hectares (4,942 acres).

Based on these assumptions and calculations, Thompson (1986) estimated that the irrigation consumptive use in the Montana headwaters part of the study area was 2,648 dam^3 (2,147 acre-feet), and 2,356 dam^3 (1,910 acre-feet) for the southern Sweetgrass tributaries (Table 5.2; Appendix A-1). Total irrigation water use for the Montana portion of the Milk River Basin was therefore estimated to be 5,004 dam^3 (4,057 acre-feet). This equates to an annual irrigation rate of 250 millimetres per hectare (10 inches per acre).

Table 5.1. Historic mean monthly irrigation requirements for crops in the Montana headwaters portion of the Milk River Basin study area.

		Flood		Sprinkler		Total Area	
		Ha	Acres	Ha	Acres	Ha	Acres
	Area →	770	1,900	320	800	1,090	2,000
		Application		Application		Total Volume	
Dates		mm	inches	mm	inches	dam^3	ac-ft
May 16-31		102	4	30	1.2	880	713
June 1-15		102	4	30	1.2	880	713
June 16-30				30	1.2	99	80
July				119	4.7	386	313
August				94	3.7	304	247
Sept 1-15				30	1.2	99	80
Total		**204**	**8**	**333**	**13.2**	**2,648**	**2,147**

Source: Derived from Thompson, 1986

Table 5.2. Mean monthly irrigation requirements for crops in the Montana southern Sweetgrass tributaries portion of the Milk River Basin study area.

		Flood		Sprinkler		Total	
		Ha	Acres	Ha	Acres	Ha	Acres
	Area →	530	1,300	380	950	910	2250
		Application Amount				Total Volume	
Dates		mm	inches	mm	inches	dam^3	ac-ft
May 16-31		102	4	30	1.2	651	528
June 1-15		102	4	30	1.2	651	528
June 16-30				30	1.2	117	95
July				119	4.7	459	372
August				94	3.7	361	293
Sept 1-15				30	1.2	117	95
Total		**204**	**8**	**333**	**13.2**	**2,356**	**1,910**

Source: Derived from Thompson, 1986

5.1.2 Historic Municipal Water Use

Sweetgrass is the only Montana community in the study area that used municipal water from the Milk River, and its water was purchased from the Village of Coutts, Alberta. Thompson (1986) used average annual recorded water use values from pumping records provided by Alberta Environment from 1964 to 1979. It was estimated that about 17% of water withdrawn by the Village of Coutts was sold to the community of Sweetgrass. Based on this assumption, it was estimated that Sweetgrass used about 23 dam^3 (19 acre-feet) of water per year from the Milk River in Alberta. Table 5.3 provides a breakdown of the average estimated water use by Sweetgrass on a monthly basis.

5.1.3 Historic Domestic Use

Domestic use was considered to be water consumed by small, unincorporated communities and farms in the study area. Most of the water consumed by domestic use was from groundwater sources, and was not considered to have any effect on surface flow in the Milk River and its tributaries. Livestock consumption of water from flowing streams were also assumed to be minor.

5.1.4 Total Historic Consumptive Water Use

The total historic consumptive water use for the Montana portion of the study area is estimated to be about 5,027 dam^3 (4,075 acre-feet). Irrigation makes up nearly all of this total at about 5,004 dam^3 (4,057 acre-feet), with municipal use a distant second at about 23 dam^3 (19 acre-feet). Domestic and livestock use were considered to be minimal and were not considered in the total consumptive use calculations.

Table 5.3 Historic mean monthly water withdrawal for the community of Sweetgrass, Montana*

Month	Volume	
	Dam^3	Acre-Feet
January	1.48	1.2
February	1.36	1.1
March	1.60	1.3
April	1.36	1.1
May	1.97	1.6
June	2.71	2.2
July	3.58	2.9
August	2.84	2.3
September	1.97	1.6
October	1.48	1.2
November	1.23	1.0
December	1.23	1.0
Total	**22.81**	**18.5**

* Water is withdrawn from the Milk River in Alberta, via the Village of Coutts
Source: Thompson, 1986

5.2 Current Consumptive Water Use - Montana

5.2.1 Current Irrigation Water Use – Headwaters Region

The Montana Department of Natural Resources carried out a study from 2008 to 2009 to more accurately measure irrigation water use in the Upper Milk River Basin of Montana (Montana Department of Natural Resources, 2012). This study was similar to a study carried out by Alberta Environment and Parks from 2007 to 2012 to measure irrigation water use in the Alberta portion of the Milk River Basin. Flow meters and flumes were installed to estimate irrigation water use throughout the cropping season. Estimated diversions, by month and by watershed, are summarized in Table 5.4.

Based on farmer interviews, it is estimated that about 567 ha (1,401 acres) were being irrigated on a somewhat regular basis on the South Fork of the Milk River (Montana Department of Natural Resources, 2012). The study did not proportion the irrigated lands into sprinkler and flood irrigation. The study did recognize that most of the sprinkler irrigation being carried out used centre-pivot systems, and it was assumed there would be no return flow. Where diversions were reported but not measured, 203 mm (8 inches) of water was assumed to be consumed per hectare (acre) irrigated, which is similar to the assumption made by Thompson (1986). The study indicated that no lands have been irrigated on the North Fork in the 10 years prior to 2012.

The study indicated that the total irrigation water use in the Montana headwaters averaged about 839 dam^3 (680 acre-feet) in 2008 and 2009. This equates to an annual irrigation rate of 150 millimetres per hectare (6 inches per acre). Table 5.4 provide a more detailed estimate of water use, by month and by watershed.

Monitoring irrigation water use
Montana DNRC, 2012

Table 5.4. Estimated current irrigation water use in the headwaters of the Milk River Basin in Montana (2008 and 2009).

Year/Month	South Fork Watershed		Middle Fork Watershed		Milk River Proper		Total Volume	
2008	Volume		Volume		Volume			
	dam^3	ac-ft	dam^3	ac-ft	dam^3	ac-ft	dam^3	ac-ft
April	38	31					38	31
May	247	200	95	77	53	43	395	320
June					95	77	95	77
July	41	33			136	110	176	143
August					97	79	97	79
2008 Total	**326**	**264**	**95**	**77**	**381**	**309**	**802**	**650**
2009								
April	10	8					10	8
May	53	43	37	30			90	73
June	21	17	22	18	237	192	280	227
July	170	138			202	164	372	302
August	47	38			76	62	123	100
2009 Total	**301**	**244**	**59**	**48**	**516**	**418**	**876**	**710**
Average (2008/2009)	**313.5**	**254**	**77**	**62.5**	**448.5**	**363.5**	**839**	**680**

Source: Montana Department of Natural Resource Conservation, 2012.

5.2.2 Current Irrigation Water Use - Southern Sweetgrass Tributaries

Several streams that drain the Sweetgrass Hills flow north into Canada before joining the Milk River. These streams include Miners Coulee, Halfbreed Coulee, and Bear Creek, plus a number of smaller tributaries that flow into these systems. The higher rate of precipitation in the

Sweetgrass Hills help sustain base flows in these streams into the summer months, after other streams have stopped flowing.

As a result, Montana and Alberta farmers and ranchers have historically taken advantage of the unique conditions provided by the southern Sweetgrass tributaries and developed storage projects for irrigation and stock watering (Southern Tributaries Ad Hoc Task Force, 1993). As a result of extensive development adjacent to these streams in Montana, few if any irrigation projects are now operational along these streams in Alberta (Southern Tributaries Ad Hoc Task Force, 1993).

Effective September 1, 1991, five years after the Thompson (1986) report was completed, Miners Coulee, Halfbreed Coulee, Bear Creek and all their respective tributaries in Toole and Liberty Counties in Montana were closed to new surface water appropriations that are direct diversions (without an on-source storage facility) for irrigation or other consumptive uses during any time of the year (Figliuzzi and Dolan, 2009). However, applications of up to 3.7 dam^3 (3 acre-feet) per year for new domestic and stock watering purposes are still accepted.

For this study, it is therefore assumed that the irrigated area in the southern tributaries are currently about 910 hectares (2,249 acres), which is the same as that reported in Thompson (1986). It is also assumed the consumptive use will be the same, at about 2,356 dam^3 (1,910 acre-feet).

Sweetgrass Hills in Montana

Based on these assumptions and calculations, it is estimated that the total irrigation area in the Montana portion of the study area is about 1,477 hectares (3,650 acres). Total consumptive use in the Montana portion of the study area is estimated at 3,198 dam^3 (2,593 acre-feet). This equates to an annual irrigation rate of 216 millimetres per hectare (8.5 inches per acre).

5.2.3 Current Municipal and Domestic Water Use

There does not appear to be any municipal or industrial water uses in the headwaters part of the Milk River Basin in Montana (Montana Department of Natural Resource Conservation, 2012). There is also no information that indicates any significant water use for livestock purposes in this portion of the basin.

Sweetgrass continues to obtain its water supply from the Village of Coutts. Based on the International St. Mary – Milk Rivers Administrative Measures Task Force Report (2006), it is currently estimated that 20 % of the water annually withdrawn from the Milk River by the Village of Coutts is currently being supplied to the community of Sweetgrass. This equates to about 16 dam^3 (13 acre-feet) per year, based on the data shown in Table 6.6.

5.2.4. Total Current Consumptive Water Use

The total current consumptive water use in the Montana portion of the study area is estimated to be about 3,211 dam^3 (2,603 acre-feet). Irrigation comprises the large majority of the water use, with about 3,198 dam^3 (2,593 acre-feet) used annually, and only 16 dam^3 (13 acre-feet) used annually for municipal use. There is no domestic information available, but use is expected to be minimal.

6.0 Consumptive Water Use in Alberta

6.1 Historic Consumptive Water Use - Alberta

6.1.1 Historic Irrigation Water Use

In a telephone survey of licensed irrigators conducted in 1979, Alberta Environment found that about 610 hectares (1508 acres) were flood irrigated, and about 1,200 hectares (2,965 acres) were sprinkler irrigated in the Alberta portion of the Milk River Basin study area. Thompson (1986) adopted these irrigated areas as being representative for apportionment computations.

Back flood irrigation systems were usually located on tributary streams with intermittent flows. When water was available, water was held on the irrigation area until the root zone was saturated, then the surplus water was allowed to drain off. Flooding usually took place during the spring runoff period after the ground had thawed, typically from mid-May to mid-June. Thompson assumed an annual consumptive use of 203 mm (8 inches) over the back flooded area.

Back flood irrigation

Sprinkler irrigation in the Alberta portion of the Milk River Basin involved pumping water from flowing streams. Thompson adopted mean application depths for the sprinkler irrigation crops grown in the area (primarily crops that supported the cattle industry) based on advice from the United States Soil Conservation Service (Table 6.1, Appendix A-1). The mean application depths and seasonal distribution were used for period May 16 to September 15 each year.

Based on this information, the total irrigation water use was calculated as 5,168 dam^3 (4,190 acre-feet) for an estimated irrigation area of 1,810 hectares (4,473 acres). This equates to about 285 millimetres of irrigation water per hectare (11 inches per acre).

Table 6.1. Historic mean monthly irrigation requirements for crops in the Alberta portion of the Milk River Basin study area.

		Flood Irrigation		Sprinkler Irrigation		Total Area	
		Ha	Acres	Ha	Acres	Ha	Acres
	Area →	610	1508	1,200	2965	1,810	4473
		Irrigation Application		Irrigation Application		Volume	
Dates		mm	inches	mm	inches	dam^3	acre-feet
May 16-31		102	4	30	1.2	974	790
June 1-15		102	4	30	1.2	974	790
June 16-30				30	1.2	358	290
July				119	4.7	1,401	1,136
August				94	3.7	1,103	894
Sept 1-15				30	1.2	358	290
Total		**204**	**8**	**333**	**13.2**	**5,168**	**4,190**

Source: Thompson, 1986

6.1.2 Historic Municipal Water Use

Two communities in the study area in the Alberta portion of the Milk River Basin used water from the Milk River for municipal purposes. These include the Town of Milk River and Village of Coutts. Thompson (1986) used average annual recorded water use from pumping records provided by Alberta Environment from 1964 to 1979. The Town of Milk River average annual withdrawal was 280 dam^3 (230 acre-feet). For the Village of Coutts, the average annual withdrawal was 140 dam^3 (110 acre-feet), for a total consumptive use by the two communities of about 420 dam^3 (340 acre-feet) per year.

However, Sweetgrass, Montana was estimated to purchase 17% of the water withdrawn by the Village of Coutts (Thompson, 1986). Therefore, the total net volume of water used by the Town of Milk River and Village of Coutts was about 396 dam^3 (321 acre-feet).

6.1.3 Historic Domestic Water Use

As in the Montana portion of the Milk River Basin, Thompson (1986) felt that domestic and livestock use in the Alberta portion of the Milk River Basin was very small, and had minimal or no impact on the flow of the Milk River or its tributaries.

6.1.4 Total Historic Water Use

The total historic consumptive water use in the study area was about 5,564 dam^3 (4,373 acre-feet), which consists of 5,168 dam^3 (4,190 acre-feet) related to irrigation use (Table 6.1) and 396 dam^3 (321 acre-feet) related to municipal use (Section 6.1.2). Domestic use was considered to be minimal and was not included.

6.2 Current Consumptive Water Use - Alberta

6.2.1 Current Water Licence Allocation

There is a total water allocation volume of about 31,945 dam^3 (29,897 acre-feet) in the Alberta portion of the Milk River Basin, which includes both surface and ground water licenses and registrations in parts of the basin beyond the study area (Milk River Watershed Council Canada, 2013). Table 6.2 shows the water allocation use categories and allocation volumes for the entire Milk River Basin in Alberta. Not all of these allocations are for projects that deplete flow in the Milk River.

Table 6.2. Total water allocations in the Milk River Basin in Alberta (2012).

Category	Volume (dam^3)	Volume (acre-feet)	Number of Allocations	Total Volume (%)
Agriculture	4,628.5	3,752	453	14.5
Commercial	114.7	93	2	0.4
Habitat	988.0	801	7	3.1
Irrigation	24,680.7	20,009	126	77.3
Municipal	717.9	582	2	2.2
Water Co-ops	246.5	200	7	0.8
Recreation	33.3	27	1	0.1
Registration	534.9	434	1,801	1.7
Total	**31,944.5**	**25,898**	**2,399**	**100**

Source: Milk River Watershed Council Canada, 2013.

Of the total volume of water allocated, about 47% (15,014 dam^3 – 12,172 acre-feet) is from the main stem of the Milk River (Table 6.3). The largest water allocation in the basin is for irrigation, which accounts for about 77% of the allocated water, and encompasses about 3,237 ha (8,000 acres) (St. Mary River and Milk River Basins Study Technical Report, 2012; and Figliuzzi and Dolan, 2009). Nearly all of the active irrigation in the Milk River Basin takes water from the main stem of the Milk River. Irrigation development adjacent to the tributaries is severely restricted because of the ephemeral nature of flow in the tributary streams.

Table 6.3. Total water allocations on the main stem of the Milk River in Alberta (2012).

Category	Volume (dam^3)	Volume (acre-feet)	Number of Allocations	Total Volume (%)
Agriculture	80.9	66	2	0.5
Irrigation	13,748.3	11,146	66	91.6
Municipal*	832.6	675	2	5.6
Water Co-ops	239.6	194	4	1.6
Registration	102.9	83	405	0.7
Total	**15,004.3**	**12,164**	**481**	**100**

* Includes 114.7 dam^3 (93 acre-feet) of water allocated for commercial purposes (B. Hills, pers. comm.).
Source: Milk River Watershed Council Canada, 2013.

Irrigation also represents the largest water allocation from the main stem of the Milk River, accounting for about 92% of the total. Municipal water allocation (Town of Milk River and the Village of Coutts) is a distant second, and accounts for 5.6% of the total.

The Milk River Basin has been under a moratorium since 1986 for the issuance of new irrigation licenses, as well as stock water licenses over 24.7 dam^3 (20 acre-feet). However, municipal, rural community water supply, and small agricultural stock watering applications may be approved on a case-by-case basis if Alberta Environment and Parks considers water to be available, and new developments do not negatively impact existing water users.

6.2.2 Current Irrigation Water Use

Active irrigation in the study area is estimated to be about 3,237 ha (8,000 acres) (St. Mary River and Milk River Basins Study Technical Report, 2012; and Figliuzzi and Dolan, 2009). Most of the irrigation utilizes sprinkler (pivot and wheel-roll) irrigation systems.

Since irrigation accounts for about 92% of the water allocation from the main stem of the Milk River, it largely drives the water use each year. Total annual water use from the Milk River can be quite variable, and will depend on several factors including: precipitation patterns, snow pack, spring snowmelt patterns, natural flow in the river, irrigation crop types, and demand by cattle producers for feed supplies.

Between 2007 and 2012, Alberta Environment and Parks monitored nearly all irrigation projects on the main stem of the Milk River to better assess the actual water use for all irrigation projects. The project also monitored actual water use for the Town of Milk River (including commercial water use within the town) and the Village of Coutts. Detailed consumptive water use tables for each year (2007 – 2012) are shown in Appendix A-2. This project was considered a pilot study to assess whether of remote, near real-time monitoring of private irrigation could be a long term cost-effective way to accurately assess water use in the Milk River Basin. If successful, it would facilitate better resource management and ensure compliance with water allocations and delivery of Montana entitlements.

Based on the monitoring study, the average annual irrigation water use was calculated to be 4,258 dam^3 (3,452 acre-feet) (Table 6.4). This equates to an average annual irrigation rate of 132 millimetres per hectare (5 inches per acre).

Monitoring irrigation water use on Milk River in Alberta

Table 6.4. Irrigation water allocation and current water use from the main stem of the Milk River in Alberta from 2007 to 2012*.

Year	Allocation** (dam^3)	Allocation** (acre-feet)	Water Use (dam^3)***	Water Use (acre-feet)***	Water Use Compared with Allocation (%)
2007	13,775	11,168	6,884	5,581	50
2008			4,057	3,289	29
2009			5,815	4,714	42
2010			1,596	1,294	12
2011			2,517	2,040	18
2012			4,676	3,791	34
Average			**4,258**	**3,452**	**31**

* Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

**Appendix A-2.

***Irrigation consumptive water use values obtained by subtracting municipal water use (Town of Milk River – including Milk River Golf Course; and Village of Coutts) from the total water use values (Appendix A-2). Values in Table 6.3 may include small volumes of domestic water use.

Table 6.5 provides a more detailed breakdown of the estimated irrigation water use on specific reaches of the Milk River main stem, based on telephone interviews and discussions with irrigation licensees in July and August, 2015.

Table 6.5. Irrigation water use from the Milk River (Alberta) in 2015*.

Location	Allocation* (dam^3)	Allocation* (acre-feet)	Water Use* (dam^3)	Water Use* (acre-feet)	Water Use Compared with Allocation (%)
North Milk River	1976.1	1,602	82.6	67	4.1
Milk River (upstream of North Milk)	151.7	123	0.0	0.0	0.0
Milk River (North Milk to Town of Milk River)	3,974.3	3,222	942.4	764	23.7
Milk River (downstream of Town of Milk River to Eastern Crossing)	8,456.9	6,856	4,164.3	3,376	49.2
Total	**14,559**	**11,803**	**5,189.3**	**4,207**	**49.0**

* Data Source – Alberta Environment and Parks – Brian Hills.

6.2.3 Current Municipal Water Use

The monitoring project initiated by Alberta Environment and Parks between 2007 and 2012 (Section 6.2.2) included actual water use for the Town of Milk River (which also includes commercial water use within the town) and the Village of Coutts. Two rural water co-operatives (501 Water Co-operative Ltd. and North Milk River Water Users Co-operative) obtain their water from the Town of Milk River's storage ponds, and are included in the reported water use for the town. The 501 Water Co-op has an annual water allocation of about 129 dam^3 (105 acre feet) and averaged about 13.8 dam^3 (11.2 acre-feet) of water (David Cody and Brian Hills pers. comm.). The North Milk River Co-op is estimated to consume about 23.6 dam^3 (19.1 acre-feet) annually (Brian Hills, pers. comm.). The monitoring study indicates the average volume of water diverted to the Town of Milk River was about 252 dam^3 (205 acre-feet) from 2007 to 2012, and ranged from a low of 160 dam^3 (130 acre-feet) to a high of 302 dam^3 (245 acre-feet) (Table 6.5).

Water diverted to the Village of Coutts averaged 77 dam^3 (62 acre-feet), but the average annual diversion was quite variable from 2007 to 2012, ranging from 0 dam^3 (0 acre-feet) in 2007 to 138 dam^3 (112 acre-feet) in 2008 and 2011 (Table 6.5). The net water use by the Village of Coutts is calculated to be less, because 20% of the water diverted to the Village of Coutts is provided to the community of Sweetgrass, Montana (International St. Mary – Milk Rivers Administrative Measures Task Force Report, 2006). The average current net water use for the Village of Coutts is therefore calculated to be 61 dam^3 (50 acre-feet). The combined total net water use for the Town of Milk River and Village of Coutts is calculated to be 313 dam^3 (254 acre-feet) (Table 6.6).

Town of Milk River, Alberta

The water use data in Table 6.6 is similar to longer term water use for the Town of Milk River reported in the Milk River Watershed Council Canada (2006) report, which indicates that the average annual water use for the Town of Milk River was about 306 dam^3 (248 acre-feet) from 1995 to 2003. However, water use for the Village of Coutts (Table 6.6) is about 50% less than that reported in the Milk River Watershed Council Canada (2006) report, which indicates that

155 dam^3 (126 acre-feet) was used by the Village of Coutts from 1971 to 2003. The updated recorded data in Table 6.6 is accepted as an indication of current water use.

Table 6.6. Municipal water use for the Town of Milk River and Village of Coutts from 2007 to 2012)*.

Year	Town of Milk River** Allocation = 382 ac-feet		Village of Coutts*** Allocation = 200 ac-feet	
	Water Use (dam^3)	Water Use (acre-feet)	Water Use (dam^3)	Water Use (acre-feet)
2007	302	245	0	0
2008	296	240	138	112
2009	272	221	58	47
2010	160	130	69	56
2011	296	240	138	112
2012	186	151	56	45
Average	**252**	**205**	**77**	**62.0**
Net Average* **	**252**	**205**	**61**	**50**
Total Municipal Use		**313 dam^3 (254 acre-feet)**		

* Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist). Detailed municipal water use values are shown in Appendix A-2 (Tables A-2.1b, A-2.2b, A-2.3b, A-2.4b, A-2.5b, and A-2.6b)

** Includes Milk River Golf Course

*** 20% of water diverted to the Village of Coutts is provided to the Town of Sweetgrass, Montana (International St. Mary – Milk Rivers Administrative Measures Task Force Report, 2006).

6.2.4 Agricultural Water Use

There is no accurate information regarding water use relative to water allocation in the Milk River Basin in Alberta. However, AMEC (2007) carried out a series of calculations to estimate the agricultural water use based on animal populations in the Basin. Table 6.7 shows the estimated livestock numbers in the entire basin, based on 2001 Census data, and the estimated annual water use for each livestock species. Total annual water use was estimated to be about 3,378 dam^3, which is about 73% of the water currently allocated to the agriculture sector (Table 6.1). This value does not include potential evaporation or seepage losses that might occur if water is stored in reservoirs for livestock use.

For the main stem of the Milk River, water allocation for agriculture and registration use totals about 81 dam^3 (147 acre-feet). Assuming that agricultural consumptive water use follows the same trend as agricultural water use in the entire Milk River Basin (73%), it is estimated that the agriculture sector currently consumes about 59 dam^3 (48 acre-feet) of water annually directly from the Milk River.

Table 6.7. Estimated livestock numbers and water use in the Milk River Basin, Alberta (2001).

Livestock Species	Number	Annual Water Use (dam^3)	Annual Water Use (acre-feet)
Cattle	278,384	2,577.1	2089.3
Calves	519	332.7	410.4
Hogs	125,289	345.3	280
Sheep and Lambs	12,002	39.8	29.8
Horses/Ponies	2,310	38.3	31.0
Hens and Chickens	565,475	42.2	34.2
Turkeys	519	0.1	0.1*
Bison	415	1.4	1.1
Elk	148	0.9	0.73
Total		**3,377.8**	**2,876.6**

* Actual value (0.08) rounded to 0.1
Source: Derived from AMEC, 2007.

Groundwater is an important water resource for agriculture and livestock owners in the Milk River Basin and supports many family farms and livestock operations. There are 39 licensed groundwater wells and 293 groundwater registrations in the Alberta portion of the watershed that have a combined water allocation of about 970 dam^3 (Milk River Watershed Council Canada, 2013).

About 60% of the groundwater licensed volume is allocated for rural water co-ops. Two of these (Milk River West Water Co-op and Warner West Water Co-op) are estimated to use a combined total of 124 dam^3 per year (Milk River Watershed Council Canada. 2006). A third rural water co-operative (Milk River East Water Co-op) is estimated to use 114 dam^3 per year.

About 13% of the licenses groundwater volume (127 dam^3 - 103 acre-feet) is allocated to agricultural stock watering and 14 dam^3 (12 acre-feet) for livestock feedlots. Groundwater registrations for domestic use account for 21% of the licensed groundwater volume in the basin. Water use from groundwater is expected to have a minimal impact on flow in the Milk River.

6.2.5 Total Current Consumptive Water Use

At present, about 4,630 dam^3 (3,754 acre-feet) of water is being used from the main stem of the Milk River, which is about 42% of the water currently allocated. Irrigation makes up about 92% of the total water use. Table 6.8 shows the current total consumptive water use from the Milk River main stem in Alberta and the comparison of water use to water allocation. This does not include water used for domestic purposes, because of a lack of reliable information. Much of the water used for domestic purposes in the basin is from groundwater sources, and little if any is diverted from the main stem of the Milk River. Most of the rural water co-ops located in the Alberta portion of the Milk River Basin also use groundwater (Milk River Watershed Council

Canada, 2006). The total volume of water allocated for both domestic and water co-ops is about 343 dam^3 (278 acre-feet), which is about 2% of the total.

Table 6.8. Consumptive water use compared with water allocation from the main stem of the Milk River in Alberta.

Category	Water Use*		Water Allocation*		Allocation %*
	dam^3	acre-feet	dam^3	acre-feet	
Agriculture	59	48	81	66	73
Irrigation	4,258	3,452	13,748	11,146	31
Municipal	313	254	833	675	38
Total	**4,630**	**3,754**	**14,662**	**11,887**	**32**

* Values rounded to nearest whole number.

The current total consumptive water use from the main stem of the Milk River, shown in table 6.8, is very similar to the total water use reported in the Milk River Watershed Council Canada (2013) report (Table 6.9).

Table 6.9. Comparison of total water allocation and total water use from the main stem of the Milk River in Alberta from 2007 to 2012.

Year	Water Allocation		Total Water Use	
	dam^3	acre-feet	dam^3	acre-feet
2007	13,500	10,900	7,339	5,950
2008			4,810	3,900
2009			6,168	5,000
2010			2,096	1,700
2011			2,837	2,300
2012			4,934	4,000
Average	**13,500**	**10,900**	**4,697**	**3,808**

Source: Derived from Milk River Watershed Council Canada, 2013

7.0 Comparison of Current and Historic Consumptive Water Use in Montana and Alberta

There are many parallels between Montana and Alberta regarding water use within the Milk River Basin, and the project study area. Irrigation is the dominant water user in both jurisdictions, but accurately assessing irrigation water use can be difficult because of the large number of variables that influence use each year. While demand for irrigation in the Milk River Basin and project study area is generally significant, annual flow of the Milk River and its tributaries are variable and unpredictable. Uncertainty regarding water supply will continue to deter investment in new irrigation systems. Table 7.1 provides an overview of the historic and current consumptive water use in the Montana and Alberta portions of the study area.

Table 7.1. Comparison of historic and current water use in Montana and Alberta.

	Montana						Alberta		Montana and Alberta	
	Upper Milk		Southern Sweetgrass Tributaries*		Total		Total		Total	
Historic Use										
Irrigated Area	Ha	Acres	Ha	Acres	Ha	Acres	Ha	Acres	Ha	Acres
	1,090	2,693	910	2,249	2,000	4,942	1,810	4,473	3,810	9,415
Water Use	Dam^3	Ac-ft	Dam^3	Ac-ft	Dam^3	Ac-ft	Dam^3	Ac-ft	Dam^3	Ac-ft
Irrigation Use	2,648	2,147	2,356	1,910	5,004	4,057	5,168	4,190	10,172	8,246
Other Ag. Use	Insignificant						Insignificant		Insignificant	
Municipal Use	0	0	23**	19	23	19	396	321	419	340
Total Historic Use	**2,648**	**2,147**	**2,379**	**1,929**	**5,027**	**4,075**	**5,564**	**4,373**	**10,591**	**8,586**
Current Use										
Irrigated Area	Ha	Acres	Ha	Acres	Ha	Acres	Ha	Acres	Ha	Acres
	567	1,401	910	2,249	1,477	3,650	3,237	8,000	3,384	8,358
Water Use	Dam^3	Ac-ft	Dam^3	Ac-ft	Dam^3	Ac-ft	Dam^3	Ac-ft	Dam^3	Ac-ft
Irrigation Use	839	680	2,356	1,910	3,195	2,593	4,258	3,452	7,453	6,042
Other Ag. Use	Insignificant						59	48	59	48
Municipal Use	0		16**	13	16	13	313	254	329	267
Total Current Use	**839**	**680**	**2,372**	**1,923**	**3,211**	**2,603**	**4,630**	**3,754**	**7,841**	**6,357**

*Includes Miners Coulee, Breed Creek, Bear Creek and other northern flowing tributaries.
**Diversion to community of Sweetgrass, Montana is directly from the Milk River in Alberta, through the works of the Village of Coutts, Alberta.

7.1 Comparison of Historic and Current Water Use - Montana

Irrigation dominates both the historic and current water use, making up about 99% of the total historic and current water use in the Montana portion of the study area (Table 7.1). The total historic irrigation consumptive water use for the Montana portion of the study area was estimated to be about 5,004 dam^3 (4,057 acre-feet), which equates to an annual irrigation rate of 250 millimetres per hectare (10 inches per acre). The current consumptive water use assessment estimated total irrigation water use to be significantly less, at 3,198 dam^3 (2,593 acre-feet), which equates to an annual irrigation rate of 216 millimetres per hectare (8.5 inches per acre).

The reduction in water use between the historic and current water use study appears to be directly related to the reduced area being irrigated. Thompson (1986) estimated the total irrigated area in the Montana portion of the study area was about 2,000 hectares (4,942 acres) in 1982, while the current water use assessment estimates about 1,477 hectares (3,650 acres) were irrigated in 2008 and 2009. Basin closures in 1991 for the southern tributaries portion of the study area effectively curtailed irrigation expansion in the area.

The estimated depth of water applied to the irrigated crops for the current water assessment is reduced slightly, from 250 millimetres per hectare (10 inches per acre) historically (Thompson, 1986) to about 216 millimetres per hectare (8.5 inches per acre). Thompson (1986) recognized that actual irrigation amounts might be substantially less that the numbers reported because of annual variability in runoff and flows in the tributaries and Milk River. This continues to hold true currently, particularly as it relates to irrigation associated with the southern southern Sweetgrass tributaries.

7.2 Comparison of Historic and Current Water Use - Alberta

Irrigation dominates both the historic and the current consumptive water use in the study area, representing about 93% of the total historic water use and about 92% of the current total water use. The total historic consumptive water use in the Alberta portion of the Milk River Basin study area was estimated to be about 5,564 dam^3 (4,190 acre-feet), while current total consumptive water use is somewhat less, at about 4,630 dam^3 (3,754 acre feet).

Assessing the current actual irrigated area continues to be a difficult task, and is carried out in a similar manner as Thompson (1986). Thompson (1986) estimated that about 1,810 ha (4,473 acres) of land was being irrigated in the Alberta portion of the Milk River Basin study area, based on telephone surveys carried out in 1979 by Alberta Environment. Current irrigation estimates also rely on aerial and telephone surveys. The current active irrigation in the study area is estimated to be 3,237 hectares (8,000 acres) (St. Mary River and Milk River Basins Study Technical Report, 2012; Figliuzzi and Dolan, 2009).

While the actual irrigated area may still be an estimate, the current consumptive water use assessment is considered to be more accurate than the historic data in Thompson (1986), because actual irrigation water use was monitored. Alberta Environment and Parks led an irrigation water monitoring study from 2007 to 2012, which employed remotely monitored metering systems installed on farmers' irrigation diversion points, and were operational throughout the irrigation season. The six years of relatively continuously recorded water use data provided a good assessment of monthly and annual irrigation consumptive water use from the Milk River in Alberta.

While the currently active irrigated areas in the Alberta portion of the study area appear to be significantly higher than the historic irrigated area, the current irrigation consumptive water use is less than the historic estimate. This is likely the result of increased use of pivot irrigation systems currently, which are more water use efficient than flood and wheel roll sprinkler irrigation systems. This results in reduced volumes of water being diverted from the river to supply crop needs. Thompson (1986) estimated that 34% of the historic irrigated area in the study area was by flood irrigation, while the current flood irrigation percentage is only about 8%.

8.0 Conclusions

The Milk River Basin is the most northern river basin that drains into the Missouri/Mississippi river system. The Milk River originates in the Montana foothills and eastern slopes of the Rocky Mountains. Its total length is about 1,170 km (700 miles), and runs northeast from Montana into Alberta, and roughly parallels the International Boundary in Alberta before returning to Montana and joining up with the Missouri River southeast of Glasgow, Montana.

The Milk River Basin is relatively dry, and drought is a constant threat. Agricultural production is generally restricted to native rangeland and low water use crops. Even irrigation cannot be considered a wholly reliable option because the intermittent natural flow of the Milk River. By the very nature of its origins in the Montana foothills, the annual flow in the Milk River is almost as unpredictable as the weather.

The Milk River has had a storied history since irrigation development began in both the United States and Canada in the late 1800s, and has continued with Montana and Alberta. There have been ongoing examples of co-operation and disagreement between these jurisdictions regarding their respective rights to the flow of this relatively small river system. However, the apportionment of the Milk River between the United States and Canada, as set out by the 1921 Order of the International Joint Commission, has been effectively managed by the United States and Canada since it came into effect.

This project assessed both historic and current consumptive water use by irrigation, municipal and domestic water users to support the desire by both Montana and Alberta to more effectively identify and address the demands and use of the Milk River water. The focus of the project was in the selected study area that contributed to the natural flow of the Milk River at the eastern crossing. This was the area that was originally assessed by Thompson (1986). It encompasses the headwaters of the Milk River Basin, plus the southern tributary streams that originate in Montana, and includes the portion of the Milk River Basin that contributes flow to the river at the eastern crossing.

8.1 Irrigation Consumptive Water Use

- **Irrigation** - Historically and currently, irrigation is by far the largest consumptive user of Milk River water in both the Montana and Alberta portions of the study area.
    - In the Montana portion of the Milk River Basin, irrigation accounts for about 99% of the total historic water use, and about 98% of the current total water use.
    - In the Alberta portion of the Milk River Basin, irrigation accounts for about 93% of the total historic water use and about 92% of the current total water use.

- **Comparison of Current and Historic Water Use -** The current water use assessment provides a more accurate estimate of actual water use when compared with the historic water use assessment carried out by Thompson (1986).

- The Thompson (1986) study estimated irrigation consumptive use largely on the basis of crop water requirements in both the Montana and Alberta portions of the study area. The current consumptive use assessment utilized information from actual water measurement studies carried out in both Montana and Alberta. The Montana study spanned a two-year period of time (2008 – 2009), and the Alberta study spanned a six-year period of time (2007 – 2012). These monitoring projects provided the most accurate information to date regarding irrigation water use.

- Continuing these types of initiatives would provide very useful data to assist with apportionment of the flows of the Milk River. However, to implement a long-term monitoring program similar to the one developed in the Alberta portion of the Milk River Basin study area would require significant upgrading of the monitoring equipment to make the system robust enough to withstand the rigours of the ambient environment. Development of this upgraded monitoring system could range from $250,000 to $400,000 (CDN$). Annual operating costs are also expected to be high because of the relatively remote nature of the irrigation systems and monitoring infrastructure.

- **Irrigation Area Assessment** - Both the Thompson (1986) and current consumptive water estimates were based on irrigation area estimates through the use of ground monitoring and aerial surveys. These methods appear to reasonably identify the areas irrigated by sprinkler (pivot and wheel move) systems because of the visibility of the irrigation infrastructure and more delineated evidence of crop growth. Accurate identification of flood (back flood) irrigated areas on tributary streams continues to be more difficult because irrigation is usually only carried out once in the spring, and only if runoff water is available. Depending on weather patterns, irrigation may not take place for several years.

- **Current Water Use: Montana** – Current irrigation consumptive water use is significantly less than historic consumptive water use estimates, and appears to be related to the reduced area currently being irrigated. The historic total irrigated area in the Montana portion of the study area was estimated to about 2,000 hectares (4,942 acres) in 1982, while the current irrigated area is estimated to about 1,477 hectares (3,650 acres). The difference appears to be related to irrigation area changes in the headwaters areas of the Montana portion of the Milk River Basin.

- **Current Water Use: Alberta -** For the Alberta portion of the Milk River Basin study area, current irrigation water use estimates are about 910 dam^3 (738 acre feet) less than the historic irrigation water use estimate. However, the current irrigated area estimate of 3,237 hectares (8,000 acres) is significantly higher than the historic irrigated area estimate of 1,810 hectares (4,473 acres), which would suggest that water use should be higher. The reduced irrigation water use is likely the result of a significant increase in the

use of advanced pivot irrigation systems, which are more water-use efficient than historic irrigation systems.

8.2 Municipal Water Use

Municipal water use represents a very small part of the total water use in both the Montana and Alberta portions of the study area.
Montana - Historically municipal water use represented <1% of the total water use in the Montana portion of the study area. Sweetgrass was the only community to receive water from the Milk River, and it did so through the works of the Village of Coutts, Alberta. It used about 23 dam^3 (19 acre-feet) of water annually.

Currently, the community of Sweetgrass is still the only municipal water user to receive water from the Milk River in the Montana portion of the study area. It continues to obtain its water supply from the Village of Coutts, and currently uses about 16 dam^3 (13 acre-feet) per year, which is almost 35% less than its historic use.

Alberta – Historically, municipal water use from the Milk River in the Alberta portion of the study area was higher than for the Montana portion, representing about 7% of the total water used. The Town of Milk River and the Village of Coutts were the two communities that received their water from the Milk River, and their historic combined water use was about 396 dam^3 (321 acre-feet) per year. Currently, the combined total water use for the Town of Milk River and Village of Coutts are calculated to be 313 dam^3 (254 acre-feet). This represents a reduction of about 21% from historic levels.

8.3 Domestic and Agriculture Water Use

- **Domestic -** Historic and current information regarding domestic water use from the Milk River is not readily available for either the Montana or the Alberta portions of the study area. In the Alberta portion of the study area, groundwater is considered to be main source of domestic water use. Domestic surface water represents a very small portion of total water use in both jurisdictions, and is not expected to have any measurable impact on the flow of the Milk River.

- **Agriculture –** In the Montana portion of the study area, agricultural water use was not assessed, either historically or currently. It is considered to represent a very small part of the total water use, with no measurable impact on the flow of the Milk River. In the Alberta portion of the study area, agricultural water use was not measured historically, and was also considered to have no measurable impact on the flow of the Milk River. Based on livestock numbers in the Milk River Basin, the total agricultural water use related to the main stem of the Milk River is currently estimated at about 59 dam^3 (48 acre-feet) per year. This represents about 1.3% of the total water use in Alberta portion of the Milk River Basin.

9.0 Recommendations

1. **Monitoring and Reporting –** Irrigation is the single largest consumptive user of water in the Montana and Alberta portions of the Milk River Basin study area, representing 98% and 92%, respectively, of the total water use. Accurate and timely monitoring of the consumptive water use by the irrigation sector, combined with regular reporting, is recommended to effectively and accurately assess the Milk River flows at the western and eastern boundary crossings.

   It is recommended that a joint Montana/Alberta task team be assembled to develop a practical, cost-effective water monitoring and reporting system that can be applied in both the Montana and Alberta portions of the study area.

2. **Irrigation Area Assessment –** It is recommended that an assessment be carried out every five years to more accurately identify and map the location and size of actively operating irrigation projects in both the Montana and Alberta portions of the study area. This assessment should include both sprinkler and flood (back flood) irrigation projects, and be linked to a monitoring and reporting program, if established. This information would be valuable to better identify and understand potential irrigation impacts on specific reaches of the Milk River and its tributaries, and supplement data collected through a monitoring and reporting program.

3. **Rural Water Co-operatives** – There are several rural water co-operatives operating within the Alberta portion of the Milk River Basin. Two of the water co-operatives obtain water from the Milk River through the works of the Town of Milk River, and their annual water use is included within the town's water use monitoring. Most of these utilize groundwater sources for their water supply, and accurate information regarding the water source, allocation and annual consumptive water use by the rural water co-operatives is not readily available.

   It is recommended that Alberta Environment and Parks take steps to ensure that existing rural water co-operatives in the Milk River Basin comply with existing requirements to annually post information related to water source, water licence allocation, and water use.

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Appendix A-1: Mean Monthly Historic Irrigation Use for Crops in the Milk River Basin Study Area

Table A-1.1 Summary of historic irrigation crop and irrigation water consumptive use for the Milk River Basin Study Area.

		US Headwaters			US South Tribs			Canada				
		Flood	Sprinkler	Total	Flood	Sprinkler	Total	Flood	Sprinkler	Total		
	Area (ac)	1900	800	2700	1300	950	2250	1500	2900	4400	Total	
	days	Application (inches)		ac ft	Application (inches)		ac ft	Application (inches)		ac ft	ac ft	cfs
May 16-31	16	4	1.2	713	4	1.2	528	4	1.2	790	2,032	64.0
Jun 1-15	15	4	1.2	713	4	1.2	528	4	1.2	790	2,032	68.3
Jun 16-30	15		1.2	80		1.2	95		1.2	290	465	15.6
July	31		4.7	313		4.7	372		4.7	1136	1,821	29.6
Aug	31		3.7	247		3.7	293		3.7	894	1,434	23.3
Sept 1-15	15		1.2	80		1.2	95		1.2	290	465	15.6
	123	8	13.2	2147		13.2	1912		13.2	4190	8,248	
	days	Application (mm)		dam^3	Application (mm)		dam^3	Application (mm)		dam^3	dam^3	m^3/s
May 16-31	16	102	30	880	102	30	651	102	30	974	2,505	1.812
Jun 1-15	15	102	30	880	102	30	651	102	30	974	2,505	1.812
Jun 16-30	15		30	99		30	117		30	358	573	0.415
July	31		119	386		119	459		119	1401	2,246	1.624
Aug	31		94	304		94	361		94	1103	1,768	1.279
Sept 1-15	15		30	99		30	117		30	358	573	0.415
Totals	123	203	335	2647	203	335	2,357	203	335	5166	10,171	

Source: Derived from Thompson, 1986

Appendix A-2: Metered Consumptive Water Use on the Main Stem Milk River in Alberta (2007 – 2012)

Table A-2.1a. Alberta Milk River consumptive water use - total (2007).*

		March		April		May		June		July		August		Sept		October		
Reach	Allocation (ac-ft)	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-30	1-15	16-31	Total Used
North Milk	1602	0	0	0	0	0	0	0	0	0	201	0	0	0	0	0	0	201
Milk ab North Milk	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milk ab Milk River Townsite	3222	0	0	12	16	17.7	146	146	63.9	471	317	226	168	0	0	0	0	1583.1
Milk below Milk River Townsite	6856	0	0	0	4	50	228	399	363	1013	932	657	396	0	0	0	0	4042.1
CDN metered use by div.period to date	5826.15	0	0	12	20	67.7	374	545	427	1484	1450	883	564	#N/A	#N/A	#N/A	#N/A	5826.2
	Total																	
Milknat CDN Consumptive use estimates	4181	0	0	0	0	0	793	774	298	536	571	446	446	317	0	0	0	4181
Milknat USA Consumptive use estimates	4102	0	0	0	0	0	1301	1220	179	327	349	268	268	190	0	0	0	
Accumulated MilkNat CDN CU		0	0	0	0	0	793	1567	1864	2400	2971	3418	3864	4181	4181	4181	4181	
Accumulated MilkNat USA CU		0	0	0	0	0	1301	2521	2700	3027	3376	3644	3911	4102	4102	4102	4102	
Accumulated Metered CDN CU		0	0	12	32	99.7	473	1018	1445	2929	4379	5262	5826	#N/A	#N/A	#N/A	#N/A	

*Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

Table A-2.1b. Alberta Milk River consumptive water use – municipal (2007).*

Water User	Allocation (ac-ft)	March	April	May	June	July	August	Sept	Oct	Total
		Water Use (ac-ft)								
Village of Coutts	200	0	0	0	0	0	0	0	0	**0**
Town of Milk River	382	0	24	28	38	72	35	0	0	**197**
Milk River Golf Course	53	0	0	10	9	16	14	0	0	**48**
Total	635	0	24	38	47	88	49	0	0	**245**

*Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

Table A-2.2a. Alberta Milk River Consumptive Water Use - total (2008).*

Reach	Allocation (ac-ft)	March		April		May		June		July		August		Sept		October		Total Used
		1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-30	1-15	16-31	
North Milk River	1602	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milk Upstream of North Milk	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milk Upstream of Milk River Towns	3222	8	10	7	8	11	171	70	184	132	209	192	96	33	0	0	0	1131
Milk below Milk River Townsite	6856	0	0	0	0	0	131	17	132	550	853	498	268	61	0	0	0	2510
CDN metered use by div.period to date	3641	8	10	7	8	11	302	87	316	682	1062	690	364	94	#N/A	#N/A	#N/A	3641
	Total																	
Milknat CDN Consumptive use estimates	4181	0	0	0	0	0	793	774	298	536	571	446	446	317	0	0	0	4181
Milknat USA Consumptive use estimates	4102	0	0	0	0	0	1301	1220	179	327	349	268	268	190	0	0	0	
Accumulated MilkNat CDN CU		0	0	0	0	0	793	1567	1864	2400	2971	3418	3864	4181	4181	4181	4181	
Accumulated MilkNat USA CU		0	0	0	0	0	1301	2521	2700	3027	3376	3644	3911	4102	4102	4102	4102	
Accumulated Metered CDN CU		8	18	25	33	44	346	433	749	1431	2493	3183	3547	3641	#N/A	#N/A	#N/A	

Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

Table A-2.2b. Alberta Milk River consumptive water use – municipal (2008.)*

Water User	Allocation (ac-ft)	March	April	May	June	July	August	Sept	Oct	Total
		Water Use (ac-ft)								
Village of Coutts	200	3	4	7	9	34	39	16	0	**112**
Town of Milk River	382	14	11	17	31	54	43	15	0	**186**
Milk River Golf Course	53	0	0	0	12	23	17	2		**54**
Total	635	17	15	23	52	111	99	33	0	**352**

*Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

Table A-2.3a. Alberta Milk River Consumptive Water Use - total (2009).*

Reach	Allocation (ac-ft)	March		April		May		June		July		August		Sept		October		Total Used
		1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-30	1-15	16-31	
North Milk River	1602	0	0	0	0	0	0	0	0	84	192	0	0	0	0	0	0	276
Milk Upstream of North Milk	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milk Above Milk River Townsite	0	0	0	2	3	101	107	132	343	301	342	72	76	81	0	0	0	1560
Milk below Milk River Townsite	6856	0	0	0	0	159	190	287	397	528	723	357	288	217	0	0	0	3146
CDN metered use by div.period to date	4982	0	0	2	3	260	297	419	740	913	1257	429	364	298	#N/A	#N/A	#N/A	4982
	Total																	
Milknat CDN Consumptive use estimates	4181	0	0	0	0	0	793	774	298	536	571	446	446	317	0	0	0	4181
Milknat USA Consumptive use estimates	4102	0	0	0	0	0	1301	1220	179	327	349	268	268	190	0	0	0	
Accumulated MilkNat CDN CU		0	0	0	0	0	793	1567	1864	2400	2971	3418	3864	4181	4181	4181	4181	
Accumulated MilkNat USA CU		0	0	0	0	0	1301	2521	2700	3027	3376	3644	3911	4102	4102	4102	4102	
Accumulated Metered CDN CU		0	0	2	5	265	562	981	1721	2634	3891	4320	4684	4982	#N/A	#N/A	#N/A	

Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

Table A-2.3b. Alberta Milk River consumptive water use – municipal (2009).*

Water User	Allocation (ac-ft)	March	April	May	June	July	August	Sept	Oct	Total
		Water Use (ac-ft)								
Village of Coutts	200	0	0	7	7	15	13	5	0	**47**
Town of Milk River	382	0	4	29	44	31	45	24	0	**177**
Milk River Golf Course	53	0	1	6	11	12	10	11	0	**44**
Total	635	0	5	42	62	58	68	40	0	**268**

*Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

Table A-2.4a. Alberta Milk River Consumptive Water Use – total (2010).*

		March		April		May		June		July		August		Sept		October		
Reach	Allocation (ac-ft)	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-30	1-15	16-31	Total Used
North Milk River	1602	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milk Above North Milk River	123	0	0	0	0	0	0	0	1	1	2	3	2	0	0	0	0	9
Milk Above Milk River Townsite	0	5.25	4.65	5.2	7.11	45.2	59.3	110	33.78	123	224	66.9	60.4	20.6	8.2	0	0	772.57
Milk Below Milk River Townsite	6856	0	0	0	0	3.66	11.6	3.07	1.53	10.7	271	281	85.8	28.5	1.51	0	0	698.64
CDN metered use by div.period to date	1480.21	5.25	4.65	5.2	7.11	48.9	70.9	113	36.31	134	497	351	148	49	9.71	#N/A	#N/A	1480.2
	Total																	
Milknat CDN Consumptive use estimates	4181	0	0	0	0	0	793	774	298	536	571	446	446	317	0	0	0	4181
Milknat USA Consumptive use estimates	4102	0	0	0	0	0	1301	1220	179	327	349	268	268	190	0	0	0	
Accumulated MilkNat CDN CU		0	0	0	0	0	793	1567	1864	2400	2971	3418	3864	4181	4181	4181	4181	
Accumulated MilkNat USA CU		0	0	0	0	0	1301	2521	2700	3027	3376	3644	3911	4102	4102	4102	4102	
Accumulated Metered CDN CU		5.25	9.9	15.1	22.21	71.1	142	255	291	425	922	1273	1421	1471	1480	#N/A	#N/A	

Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

Table A-2.4b. Alberta Milk River consumptive water use – municipal (2010).*

Water User	Allocation (ac-ft)	March	April	May	June	July	August	Sept	Oct	Total
		Water Use (ac-ft)								
Village of Coutts	200	0	10.4	10.4	10.35	7.19	10	7.5	0	**56**
Town of Milk River	382	9.9	1.91	20.82	17.45	40	10	6.52	0	**107**
Milk River Golf Course	53	0	0	1	4	9	7	2.15	0	**23**
Total	635	9.9	12.31	32.22	31.8	56.19	27	16.17	0	**175**

*Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

Table A-2.5a. Alberta Milk River Consumptive Water Use Report - total (2011).*

		March		April		May		June		July		August		Sept		October		
Reach	Allocation (ac-ft)	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-30	1-15	16-31	Total Used
North Milk River	1602	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milk Above North Milk	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milk Above Milk River Townsite	3222	8	10	7	8	11	54.3	21	50	92.3	243.5	214	88.8	61.9	0	0	0	869.6
Milk below Milk River Townsite	6856	0	0	0	0	0	35	0	52	155	406.4	358	262.3	224	0	0	0	1492.1
CDN metered use by div.period to date	2361.7	8	10	7	8	11	89.3	21	102	247	649.9	572	351.1	286	#N/A	#N/A	#N/A	2361.7
	Total																	
Milknat CDN Consumptive use estimates	4181	0	0	0	0	0	793	774	298	536	571	446	446	317	0	0	0	4181
Milknat USA Consumptive use estimates	4102	0	0	0	0	0	1301	1220	179	327	349	268	268	190	0	0	0	
Accumulated MilkNat CDN CU		0	0	0	0	0	793	1567	1864	2400	2971	3418	3864	4181	4181	4181	4181	
Accumulated MilkNat USA CU		0	0	0	0	0	1301	2521	2700	3027	3376	3644	3911	4102	4102	4102	4102	
Accumulated Metered CDN CU		8	18	25	33	44	133	154	256	504	1153	1725	2076	2362	#N/A	#N/A	#N/A	

Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

Table A-2.5b. Alberta Milk River consumptive water use – municipal (2011).*

Water User	Allocation (ac-ft)	March	April	May	June	July	August	Sept	Oct	Total
		Water Use (ac-ft)								
Village of Coutts	200	3	4	7	9	34	39	15	0	**112**
Town of Milk River	382	15	11	17	31	54	43	15	0	**186**
Milk River Golf Course	53	0	0	0	12	23	17	2	0	**54**
Total	635	18	15	24	52	111	99	32	0	**352**

*Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

Table A-2.6a. Alberta Milk River Consumptive Water Use Report (2012).*

Reach	Allocation (ac-ft)	March		April		May		June		July		August		Sept		October		Total Used
		1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-30	1-15	16-31	
North Milk River	1602	0	0	0	0	0	5	4	2	16	19	11	6	4	0	0	0	67
Milk Above North Milk	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milk Above Milk River Townsite	3222	7	9	7	8	79	53	63	36	157	170	178	127	55	0	0	0	949
Milk below Milk River Townsite	6856	0	0	0	0	162	74	221	92	647	683	553	271	268	0	0	0	2971
CDN metered use by div.period to date	3987	7	9	7	8	241	132	288	130	820	872	742	404	327	#N/A	#N/A	#N/A	3987
	Total																	
Milknat CDN Consumptive use estimates	4181	0	0	0	0	0	793	774	298	536	571	446	446	317	0	0	0	4181
Milknat USA Consumptive use estimates	4102	0	0	0	0	0	1301	1220	179	327	349	268	268	190	0	0	0	
Accumulated MilkNat CDN CU		0	0	0	0	0	793	1567	1864	2400	2971	3418	3864	4181	4181	4181	4181	
Accumulated MilkNat USA CU		0	0	0	0	0	1301	2521	2700	3027	3376	3644	3911	4102	4102	4102	4102	
Accumulated Metered CDN CU		7	16	23	31	272	404	692	822	1642	2514	3256	3660	3987	#N/A	#N/A	#N/A	

Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

Table A-2.6b. Alberta Milk River consumptive water use – municipal (2012).*

Water User	Allocation (ac-ft)	March	April	May	June	July	August	Sept	Oct	Total
		Water Use (ac-ft)								
Village of Coutts	200	3	4	2	8	11	13	4	0	**45**
Town of Milk River**	382	13	11	13	22	26	41	25	0	**151**
Milk River Golf Course	53	0	0	0	0	0	0	0	0	**0**
Total	635	16	15	15	30	37	54	29	0	**196**

*Data Source: Alberta Environment and Parks – Carmen delaChevrotiere (Transboundary Water Specialist).

**Includes water use for golf course.

Appendix A-3: Conversion Factors and Abbreviations

Table A-3.1. Conversion Factors and Abbreviations.

Conversion Factors	Abbreviations and Acronyms
Inches to mm – multiply by 25.40	ha hectare
kilometre to mile – multiply by 0.62137	km kilometre
mile to kilometre – multiply by 1.60934	km^2 square kilometre
m^3/s to ft^3/s – multiply by 35.315	mi mile
acre-ft to dam^3 – multiply by 1.2335	mi^2 square mile
dam^3 to acre-ft – multiply by 0.810701	m^3 cubic metre
acre to $feet^2$ – multiply by 43,560	dam^3 cubic decametre
days to seconds – multiply by 86,400	ac-ft acre feet
mm/ha to inches/acre – multiply by 0.0159	ft^3 cubic foot
inches/acre to mm/ha – multiply by 743.3467	ft^2 square foot