Montana – Alberta Joint Initiative on the Sharing of the Waters of the St. Mary and Milk Rivers – Background Information Report

November 2009

Title Page: Rafting down the Milk River. Photo: Larry Dolan

Acknowledgements

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Executive Summary

Shared learning is an important part of the Montana – Alberta Joint Initiative. Photo: Paul Azevedo

This report is a comprehensive description of the relevant technical and administrative elements relating to Alberta and Montana's management and sharing of the waters of the St. Mary and Milk Rivers. As outlined in the **Introduction** (Chapter 1), these rivers have been jointly managed for more than a century. Concerns that neither jurisdiction has been able to take and use its full share of the water led to the formation of the Montana-Alberta Joint Initiative Team.

The purpose of the Team is to examine and report on water management opportunities of mutual benefit that would allow each jurisdiction to take and use more of its share of water. The Team, recognizing the value of a common knowledge base, asked that a group of technical experts from both jurisdictions be assembled to develop a "Joint Background Information" report. This report will be used by the Joint Initiative Team to develop a shared understanding of the factors affecting and guiding water management of the St. Mary and Milk Rivers including hydrology, climate, agreements and compacts, water rights, water management infrastructure and irrigation practices within both jurisdictions and both basins.

In Chapter 2, brief **Basin Descriptions** of the St. Mary and Milk Rivers and other aspects of basin geography and water management infrastructure are provided. The St. Mary River is a tributary of the Saskatchewan River which flows north into Hudson Bay. The Milk River is a tributary of the Missouri-Mississippi River system which flows south to the Gulf of Mexico. These two rivers are joined by the U.S. St. Mary Canal which diverts water from the St. Mary River into the Milk River.

To better understand its impact on the hydrological cycle and hence, water supply and its management, Chapter 3 provides an overview of the **Climate** of the Milk and St. Mary River Basins. Temperatures, precipitation and evaporative losses are discussed. As irrigated agriculture is a significant economic activity in the region, details on growing season and crop water requirements are also provided.

Chapter 4 takes a more detailed look at the **Hydrology** of the Milk and St. Mary River Basins, including the quantity, timing and variability of flows. The influence of tributaries, storage and diversions for irrigation are explained. "Observed" flows are compared to "natural" flows, where the influence of man-made activities is removed.

Management of the Milk and St. Mary Rivers is guided by several water-sharing **Agreements and Compacts** including the 1909 *Boundary Waters Treaty*. Chapter 5 describes these agreements including how they may influence any future arrangements. It also describes how apportionment under the *1909 Boundary Waters Treaty* is administered.

Chapter 6 provides a general understanding of **Water Rights, Allocation and Use** including water rights acquisition, enforcement and management processes in both Montana and Alberta, particularly during times of shortage. Details on the purposes for which water rights can be obtained, and the total water that has been allocated under each purpose, are provided.

Chapter 7 provides a general understanding of the planning processes used in each jurisdiction to establish **Instream and Ecosystem Flows.** This includes water quantity and quality rights or objectives for water that must be left in the stream to meet aquatic ecosystem requirements. These minimum “instream” or “ecosystem” flows may be set for a river reach or a tributary stream.

Chapter 8 provides a description of **Water Management Infrastructure and Irrigation** including the operation and condition of dams, reservoirs and other irrigation works. It also provides information on the amount of water being diverted, area being irrigated, the actual quantity being applied to the land and return flows.

Chapter 9 provides a general understanding of **Water Supply and Management Models**. It provides a description of hydrologic or water supply management investigations that have been carried out to date. It identifies what was looked at, what model was used and what hydroclimatic data was available at the time.

Chapter 10 provides a general description of **Past and Ongoing Structural and Water Management Investigations** such as storage or diversion projects, evaluated by Montana and Alberta, as well as other United States or Canadian agencies. This includes the reason why they were looked at and the result of the investigation. This information is intended to provide insight to the Joint Initiative Team in order to prioritize projects/options that it may undertake in the future.

Throughout its discussions, the Joint Initiative Team members raised a number of additional questions about water entitlements, losses and various management options and issues. In chapter 11 (**Additional Information**), the technical team addresses these outstanding questions. **In Closing**, chapter 12 provides a brief overview of key learning’s, information gaps and potential future areas of joint work.

Finally, a **Glossary** and several **Appendices** provide additional information including the Joint Initiative Team’s terms of reference; additional temperature, precipitation and streamflow information; the 1921 Order of the International Joint Commission; and the 2001 Letter of Intent.

Several members of the Joint Initiative Team, technical team and other support staff. Photo: Paul Azevedo

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U.S. Units	Abbr.		Metric Equivalent	Abbr.
acre	ac.		0.407 hectares	ha
acre-feet	ac-ft		1233.5 cubic meters	m^3
acre-feet	ac-ft		1.2335 cubic decameter	dam^3
cubic foot/second	cfs		0.0283 cubic meters/sec	cms
foot	ft		0.305 meters	m
inch	in		25.4 millimeters	mm
inch	in		2.54 centimeters	cm
mile	mi		1.609 kilometers	km
square mile	mi^2		2.59 square kilometers	km^2
hectare	ha		2.471 acres	ac
cubic meter/sec	cms (m^3/sec)		35.31 cubic feet/sec	cfs (ft^3/sec)
cubic decameter	dam^3		0.811 acre-feet	ac-ft
cubic decameter	dam^3		1000 cubic meters	m^3
millimeter	mm		0.03937 inches	in
centimeter	cm		0.3937 inches	in
kilometer	km		0.621 miles	mi
Square kilometer	sq. km. (km^2)		0.386 square mile	sq. mi.

List of Acronyms and Abbreviations

AARD	Alberta Agriculture and Rural Development
AENV	Alberta Environment
BNWR	Bowdoin National Wildlife Refuge
EC	Environment Canada
GOA	Government of Alberta
IJC	International Joint Commission
MRTWG	Milk River Technical Working Group
MRWCC	Milk River Watershed Council Canada
Montana DFWP	Montana Department of Fish, Wildlife and Parks
Montana DNRC	Montana Department of Natural Resources and Conservation
Montana RWRCC	Montana Reserved Water Rights Compact Commission
PFRA	Prairie Farm Rehabilitation Administration (Government of Canada)
SSRB	South Saskatchewan River Basin
U.S.	United States
USBR	United States Bureau of Reclamation
USBIA	United States Bureau of Indian Affairs
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USNRCS	United States Natural Resource Conservation Service

1.0 Introduction

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To set the stage for this report, chapter one provides an overview of the historical agreements and more recent discussions leading up to formation of the Montana-Alberta Joint Initiative Team. It also provides a description of the report purpose and objectives.

1.1 Background

Quick Facts

- **The waters of the St. Mary and Milk Rivers have been shared by Alberta and Montana for nearly a century.**
- **Alberta and Montana have formed a "Joint Initiative Team" to investigate and make recommendations on ways to improve each jurisdiction's access to its share of these waters.**

The waters of the St. Mary and Milk Rivers, joined by the United States St. Mary Canal, have been shared by Alberta and Montana under Article VI of the *Boundary Waters Treaty (1909)* and the *1921 Order of the International Joint Commission*, for nearly 100 years. While these waters are an important resource to both jurisdictions, Alberta has been unable to take and utilize a significant portion of its share of the Milk River and Montana has been unable to take and utilize a significant portion of its share of the St. Mary River.

In April 2003, Montana Governor Judy Martz requested that the International Joint Commission (IJC) undertake a review of the *1921 Order* pursuant to Article VI of the *Boundary Waters Treaty*, regarding the sharing of water between Canada and the United States. The IJC responded by holding a number of public meetings in Canada and the United States to gather information. They also formed the *St. Mary / Milk Rivers Administrative Measures Task Force* to investigate issues and their potential solutions.

In April 2006, the Task Force issued a final report without finding a mutually acceptable means for the two jurisdictions to increase the share of water they are able to take and utilize. As a result, the IJC suggested that Montana and Alberta begin high level, cross-border discussions regarding the use and management of these shared waters. Specifically, Montana and Alberta would seek opportunities to:

> *"…explore the fundamental and interrelated issues of collaboration on the use and management of transboundary waters, cooperation on the rehabilitation of the St. Mary Canal and future arrangements for increasing the ability of each country to better access the full amount of water available to it under the current apportionment."*

The United States has authorized the rehabilitation of the U.S. St. Mary Canal and Diversion Works. This represents a one-time opportunity for Montana and Alberta to work cooperatively in improving the water infrastructure that connects the St. Mary and Milk Rivers. Further, Montana and Alberta believe there are opportunities for the two jurisdictions to work together to improve access to these shared waters. Hence, each jurisdiction's respective water management agencies have been instructed by their governments to explore opportunities and to make recommendations for the consideration of both jurisdictions.

Towards this goal, Alberta and Montana have formed a “Joint Initiative Team” to review the current situation and make recommendations to the two governments on options to increase the ability of each jurisdiction to better access the shared waters of the St. Mary and Milk River systems. The “Joint Initiative Team” has created a Terms of Reference (Appendix A) which defines the purpose, scope, principles, objectives, membership, code of conduct and related process matters to guide the efficient functioning of the team.

1.2 Objectives

In their initial discussions, members of the Joint Initiative Team recognized that the gathering and sharing of information was critical to the development of a common knowledge base. This shared understanding could inform the Team in the development and evaluation of potential solutions and, therefore, was imperative to the success of this initiative. To facilitate the information gathering and sharing requirement, a team of technical experts from Montana and Alberta was assembled and requested to develop a “Joint Background Information Package”. Specific areas for which information was requested include:

- General understanding of the St. Mary and Milk River Basins,
- Climate of the St. Mary and Milk River Basins,
- Hydrology of the basins,
- Agreements and impacts that govern water sharing in the basins,
- Water rights, allocations and use,
- In-stream and ecosystem flow requirements,
- Irrigations practices and requirements,
- Water management infrastructure and operations,
- Existing hydrologic and water management modeling, and
- Past and ongoing water management investigations.

Quick Facts

- **This report will provide the Joint Initiative Team background on the physical setting of the Milk and St. Mary River Basins.**
- **It will describe how the water is used and managed by Montana and Alberta within both basins.**

The purpose of this report is to gather, assemble and share relevant background information on the Milk and St. Mary River Basins, on both sides of the Canada-United States border. This report will serve as a Joint Background Information Package to be used to develop a common understanding among the Joint Initiative Team of water and water management in the two basins. It will also be used to develop a better understanding of the similarities and differences in how Montana and Alberta manage water. Information will be presented for the St. Mary River to its confluence with the Oldman River; the Milk River to its confluence with the Missouri River; and for the St. Mary River Irrigation Project in Alberta for the purpose of understanding use of St. Mary River water in Alberta.

2.0 Basin Descriptions

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Werner Herrera, P.Eng. Hydrologist, Southern Region, Alberta Environment

The waters of the St. Mary and Milk Rivers are joined by the United States St. Mary Canal. This canal diverts water from the St. Mary River into the Milk River upstream of its western crossing into Canada. Although linked through this inter-basin transfer, the St. Mary and Milk Rivers each retain their own unique characteristics. This section further describes each basin in relation to its source, major tributaries, storage infrastructure and other aspects of its geography.

2.1 St. Mary River Basin

Quick Facts

- **The St. Mary River originates in western Montana and flows northward into Canada. It then joins the Oldman River, which drains into Hudson Bay.**
- **The St. Mary River drains an area of about 1,360 mi^2.**
- **Two storage facilities are maintained in the St. Mary River Basin: Lake Sherburne in the U.S. and St. Mary Reservoir in Canada.**
- **At its confluence with the Oldman River, the St. Mary River carries a mean annual flow of about 700,000 ac-ft.**

The St. Mary River originates in western Montana within the high mountain areas of Glacier National Park. From its source, it flows northward into St. Mary and Lower St. Mary Lakes (Map 2.1).

Swiftcurrent Creek is one of the major tributaries of the St. Mary River within Montana. It originates in the high elevation areas of Mount Grinnell and flows northeasterly into Lake Sherburne. Lake Sherburne is the only major storage facility (storage capacity approximately 67,850 ac-ft) in the United States (U.S.) headwaters of the St. Mary River.

Exiting from Lake Sherburne, Swiftcurrent Creek flows in an easterly direction for a distance of about five miles. It then empties into Lower St. Mary Lake where it joins with the St. Mary River. The U.S. St. Mary Canal diverts water from the St. Mary River (immediately downstream of the Lower St. Mary Lake outlet) and conveys it across into the Milk River.

Exiting from Lower St. Mary Lake, the St. Mary River flows north and is joined by Kennedy Creek and Boundary Creek, before flowing across the International Boundary into Canada. In Canada, the St. Mary River flows north for a distance of about 30 miles before emptying into the St. Mary Reservoir (storage capacity approximately 320,900 ac-ft). Prior to it emptying into the reservoir, the St. Mary River is joined by the tributaries of Rolph and Lee Creeks which have their source in Montana.

Exiting from the reservoir, the St. Mary River continues flowing in a northerly direction for a distance of about 36 miles before it empties into the Oldman River. The Oldman River is part of the Saskatchewan River system which flows from Alberta across Saskatchewan and Manitoba, into Lake Winnipeg, and ultimately, into Hudson Bay.

At its crossing of the Montana-Alberta Boundary, the St. Mary River has drained a total area of about 463 mi^2 and carries a mean annual flow volume of about 640,000 ac-ft. At its confluence with the Oldman River, the St. Mary River has drained a total area of about 1,360 mi^2 and carries a mean annual flow volume of about 700,000 ac-ft.

2.2 Milk River Basin

The South Fork Milk River (or Milk River) and North Fork Milk River (or North Milk River) originate within the foothills areas of the Blackfeet Indian Reservation of western Montana and flow in a northeasterly direction into Canada. Prior to its entry, the North Fork Milk River flow is supplemented by U.S. St. Mary River diversions. Once in Canada, the North Milk River swings into an easterly course for about 25 miles. It then joins the South Fork River, approximately 12 miles west of the Town of Milk River, to form the Milk River.

After the confluence of the South and North Forks, the Milk River continues in an easterly direction, about 6-10 miles north of the Canada-U.S. border, for an additional distance of about 90 miles. It then changes into a southeasterly direction and flows back across the International Boundary into eastern Montana. At the Eastern Crossing into Montana, the Milk River has drained an area of about 2,500 mi^2 and carries a mean annual natural flow of about 120,000 ac-ft. In addition, it also carries about 170,000 ac-ft of U.S. St. Mary diversions, which it has conveyed over a distance of more than 105 miles across southern Alberta.

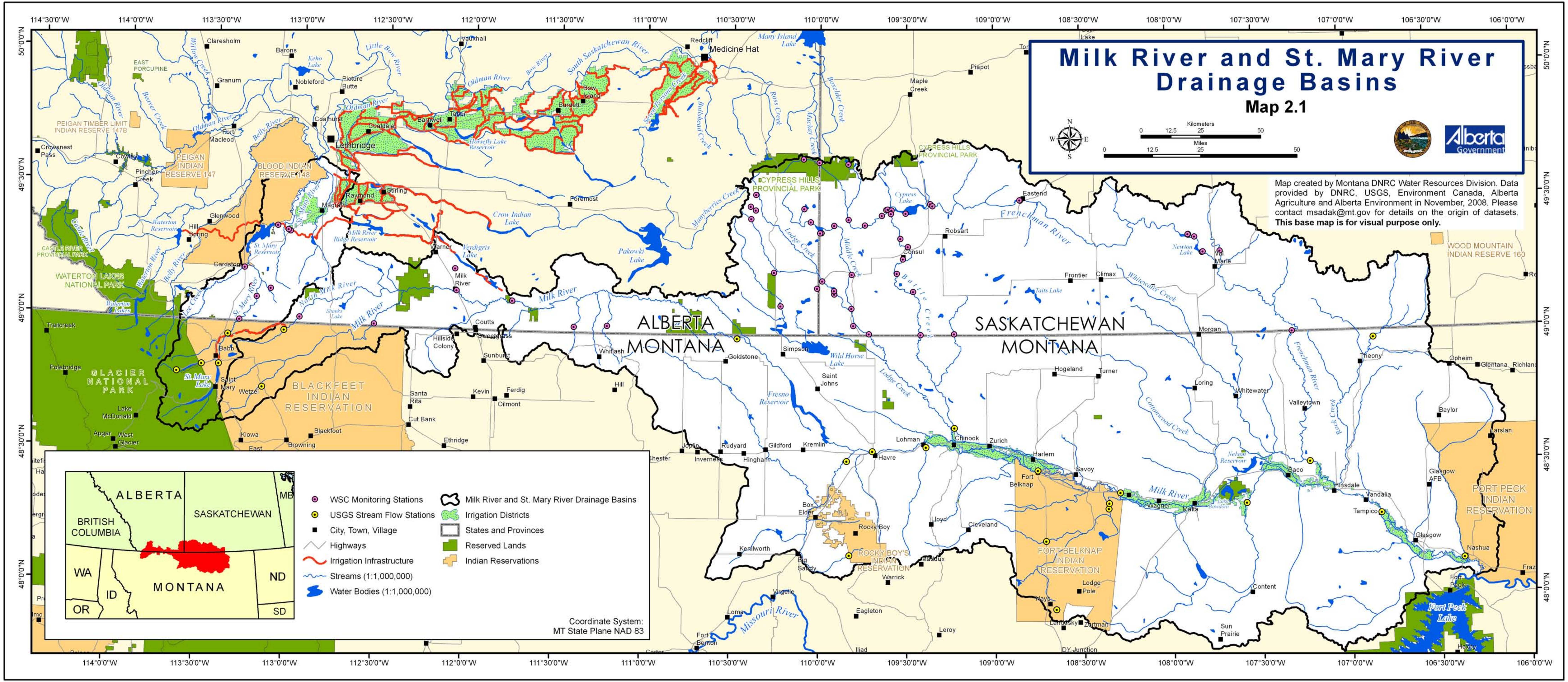
Beyond the International Boundary, the Milk River flows south and east towards its confluence with the Missouri River, about 490 miles downstream near Glasgow. Numerous tributaries enter the Milk River from both the north and south. The larger northern tributaries include Lodge Creek, Battle Creek, Rock Creek and the Frenchman River, which originate in Alberta and Saskatchewan. Some of the tributaries that enter from the South, such as Peoples Creek and Beaver Creek, originate in the relatively higher elevations of the Bears Paw and Little Rocky Mountains. A segment of the Milk River forms the northern boundary of the Fort Belknap Indian Reservation.

Fresno Dam, which is about 50 miles downstream of the Canada-U.S boundary, is the major on-stream storage reservoir on this system. Major irrigation diversions from the river begin just below Havre. A number of irrigation diversion dams and pumping stations along the river supply water to about 145,000 acres of agricultural lands. One of these diversions - the Dodson South Canal near Malta - supplies water to Nelson Reservoir (an off-stream storage reservoir) and Lake Bowdoin National Wildlife Refuge. The drainage area of the Milk River at its mouth is about 23,000 mi^2 and its average annual recorded flow (including the effects of St. Mary Canal diversions, reservoir operations and consumptive use by irrigation) near the mouth at Nashua is about 464,000 ac-ft.

Quick Facts

- **The Milk River also originates in western Montana and flows northward into Canada. However, it then turns southeast, back into eastern Montana and the Fresno Reservoir, before ultimately emptying into the Missouri River.**
- **At its confluence with the Missouri River, the Milk River has a drainage area of 23,000 mi^2 and carries a mean annual flow of 464,000 ac-ft.**

Lower St. Mary Lake.
Photo: John Sanders



Milk River and St. Mary River Drainage Basins
Map 2.1
Kilometers
0 12.5 25 50
Miles
0 12.5 25 50
Alberta Government
Map created by Montana DNRC Water Resources Division. Data provided by DNRC, USGS, Environment Canada, Alberta Agriculture and Alberta Environment in November, 2008. Please contact msadak@mt.gov for details on the origin of datasets. This base map is for visual purpose only.
ALBERTA
MONTANA
SASKATCHEWAN
MONTANA
Medicine Hat
Lethbridge
Milk River
St. Mary River
Frenchman River
Battle Creek
Missouri River
Fort Peck Lake
GLACIER NATIONAL PARK
BLACKFEET INDIAN RESERVATION
FORT BELKNAP INDIAN RESERVATION
ROCKY BOY'S INDIAN RESERVATION
FORT PECK INDIAN RESERVATION
BLOOD INDIAN RESERVE 148
PEIGAN INDIAN RESERVE 147
WOOD MOUNTAIN INDIAN RESERVE 160
CYPRESS HILLS PROVINCIAL PARK
WATERTON LAKES NATIONAL PARK
ALBERTA
BRITISH COLUMBIA
SASKATCHEWAN
MB
WA
ID
MONTANA
ND
OR
SD
WSC Monitoring Stations
USGS Stream Flow Stations
City, Town, Village
Highways
Irrigation Infrastructure
Streams (1:1,000,000)
Water Bodies (1:1,000,000)
Milk River and St. Mary River Drainage Basins
Irrigation Districts
States and Provinces
Reserved Lands
Indian Reservations
Coordinate System:
MT State Plane NAD 83

Both the Milk and St. Mary Rivers originate in Western Montana and flow into Canada.
Photo: Paul Azevedo

3.0 Climate

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Marcus Sadak, GIS Supervisor, Montana Department of Natural Resources and Conservation

This section provides an overview of temperatures, precipitation and evaporative losses across the Milk and St. Mary River Basins. These characteristics impact the hydrological cycle and hence, water supply and its management in these basins. As irrigated agriculture is a significant economic activity in this region, growing season and crop water requirements are also discussed.

3.1 Temperature and Precipitation

Quick Facts

- **The Milk and St. Mary Rivers originate in the mountains and foothills of western Montana where winters are cold and snowy and the summers are cool.**
- **As they flow east, these rivers cross the prairies where winters are typically cold and summers are warm and dry.**
- **Mean annual precipitation tends to decrease from west to east, with 40-50 inches in the mountainous west declining to less than 15 inches in semi-arid eastern Montana.**

The St. Mary River originates in the mountains and foothills of Glacier National Park and the Blackfeet Indian Reservation in Montana. Winters in the mountains are cold and snowy, and the summers are cool. Precipitation in the highest elevations can exceed 80 inches per year. However, about 40-to-50 inches is more representative of the mean annual precipitation in the mountains, much of which comes in the form of snow.

From the mountains and foothills in Montana, the St. Mary River crosses into Alberta where moderate hills and flat prairie-like slopes dominate. The winters are typically cold, while summers are warm and dry. The mean annual precipitation in the basin decreases in a west to east direction and from higher elevations to lower elevations. The mean annual precipitation for the St. Mary River Basin in Alberta ranges from 16 to 22 inches.

The headwaters of the Milk River are primarily in the foothills region of the Blackfeet Indian Reservation and Glacier National Park in Montana, with the highest elevation being at about 9,500 feet. The Babb, Montana weather station is representative of the climate of the upper portions of the Milk River and the lower portions of the St. Mary River watersheds in the United States (U.S). Hence, it is used to characterize temperature and precipitation in these areas.

From the headwaters in Montana, the Milk River crosses into Alberta and flows east prior to re-entering Montana. Flat prairie slopes dominate the landscape of the Milk River Basin in Alberta. This region is typically characterized by cold winters and warm, dry summers. The mean annual precipitation of the Milk River Basin in Alberta decreases from west to east - from 16 inches in the west to about 12 inches in the east. The St. Mary Irrigation District, slightly to the north of the Milk River Basin, has similar climate characteristics to those in the Alberta portion of the Milk River Basin.

The majority of U.S. irrigation with St. Mary and Milk River waters occurs in the Milk River Basin downstream of Fresno Reservoir: from Havre to the Milk River confluence with the Missouri River near Nashua. Elevations within these lower reaches of the Milk River are from about 2,500 feet near Havre to about 2,100 feet near Glasgow. The climate in the Montana portion of the lower Milk River watershed is continental, with warm and often hot summers, and cold winters. The region is semi-arid, with annual precipitation typically below 15 inches.

Figure 3.1 compares the average daily temperatures for stations used in Montana and Alberta that are representative of the Milk and St. Mary River Basins. As indicated, average summer temperatures generally increase from west to east. In winter, temperatures are often a bit warmer to the west, near the mountain front, than they are in the area between Manyberries, Havre and Glasgow. Extremes in temperature beyond those depicted on the graphs occur every year. Temperatures can reach as low as -40^{O} Fahrenheit (F) during the winter, and frequently exceed 100^{O} F in the lower Milk River Basin during the summer. Graphs illustrating typical daily temperatures of some weather stations across both basins are presented in Appendix B.

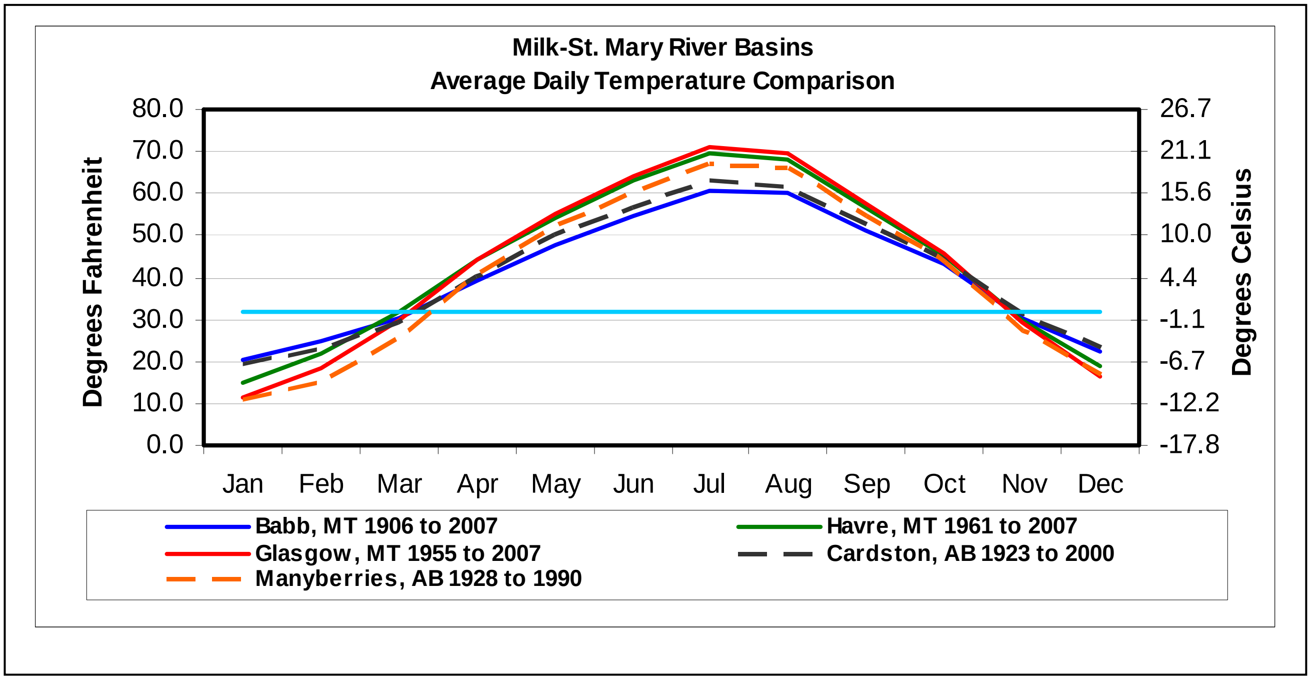


Figure 3.1 – Comparison of average daily temperatures for selected sites within the St. Mary and Milk River Basins.

Precipitation is greatest in the mountainous areas west of Babb to the Continental Divide as illustrated in Maps 3.1 and 3.2 (at the end of this chapter). These maps depict average annual precipitation in the Milk and St. Mary River watersheds. Map 3.3 illustrates the average precipitation in the basins during the April through September irrigation season.

Figures 3.2 through 3.7 describe precipitation in the lower-elevation areas of the St. Mary and Milk River Basins. There is a general decline in precipitation when moving from west to east, although average precipitation amounts are similar, at about 11-12 inches in the Milk River watershed from Havre to Glasgow.

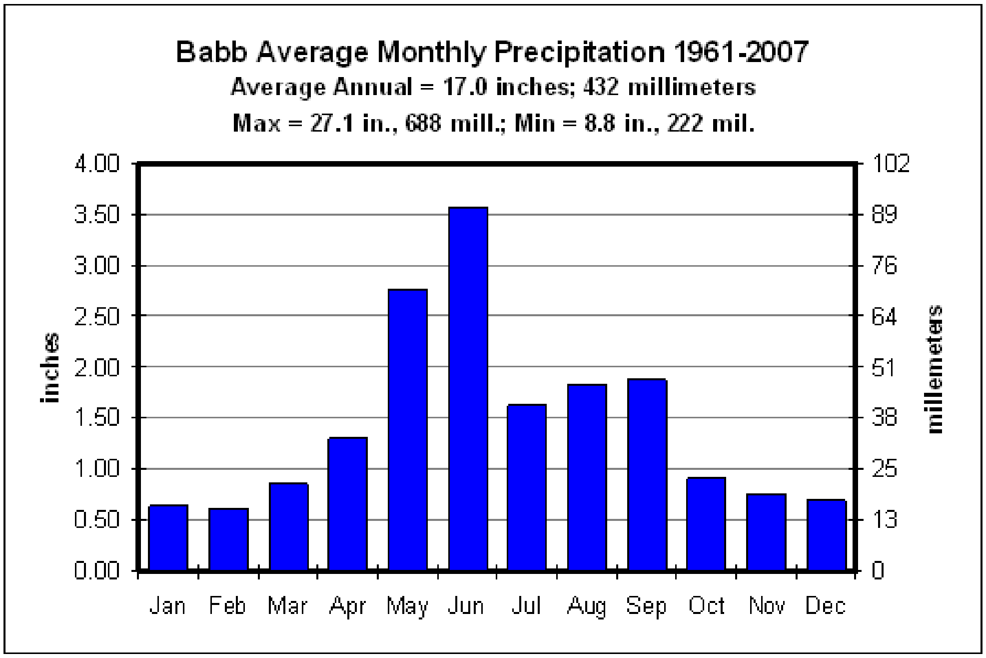


Figure 3.2 – Precipitation summary for Babb, Montana.

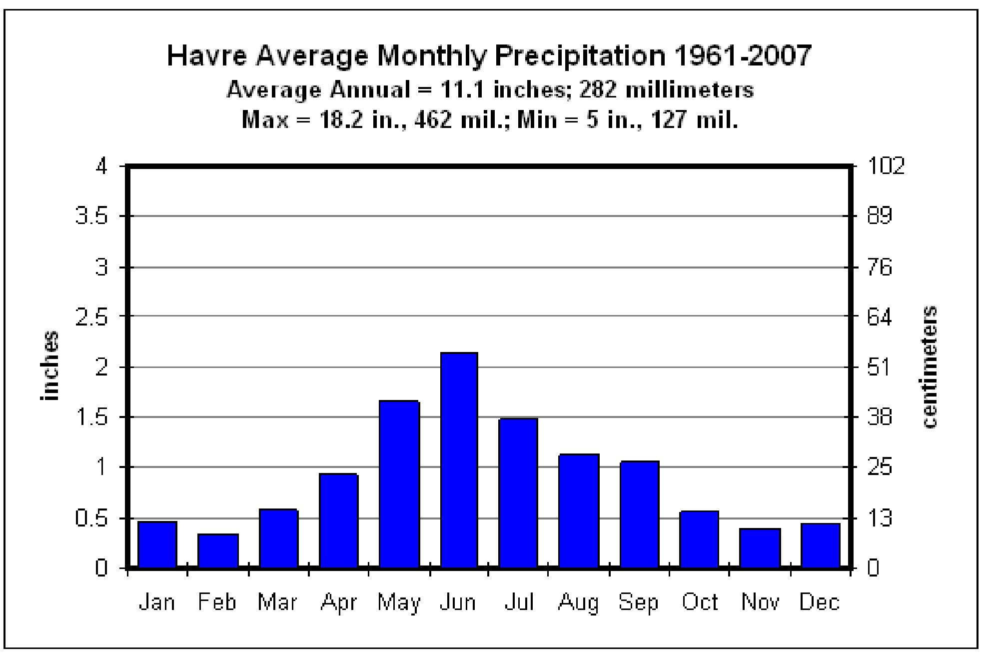


Figure 3.3 – Precipitation summary for Havre, Montana.

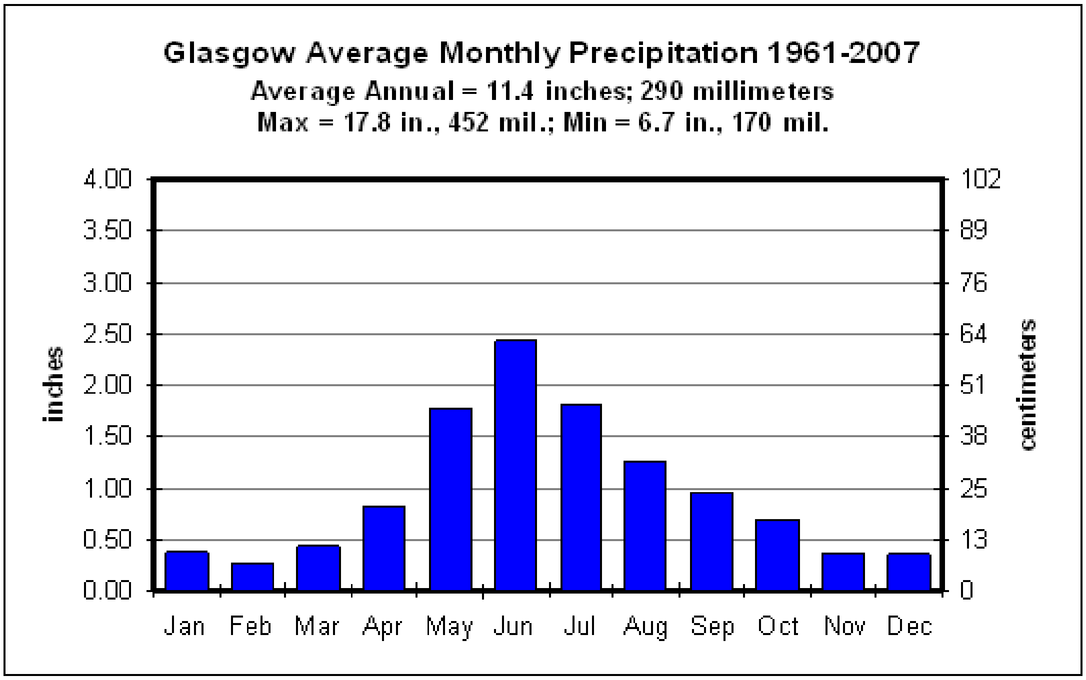


Figure 3.4 – Precipitation summary for Glasgow, Montana.

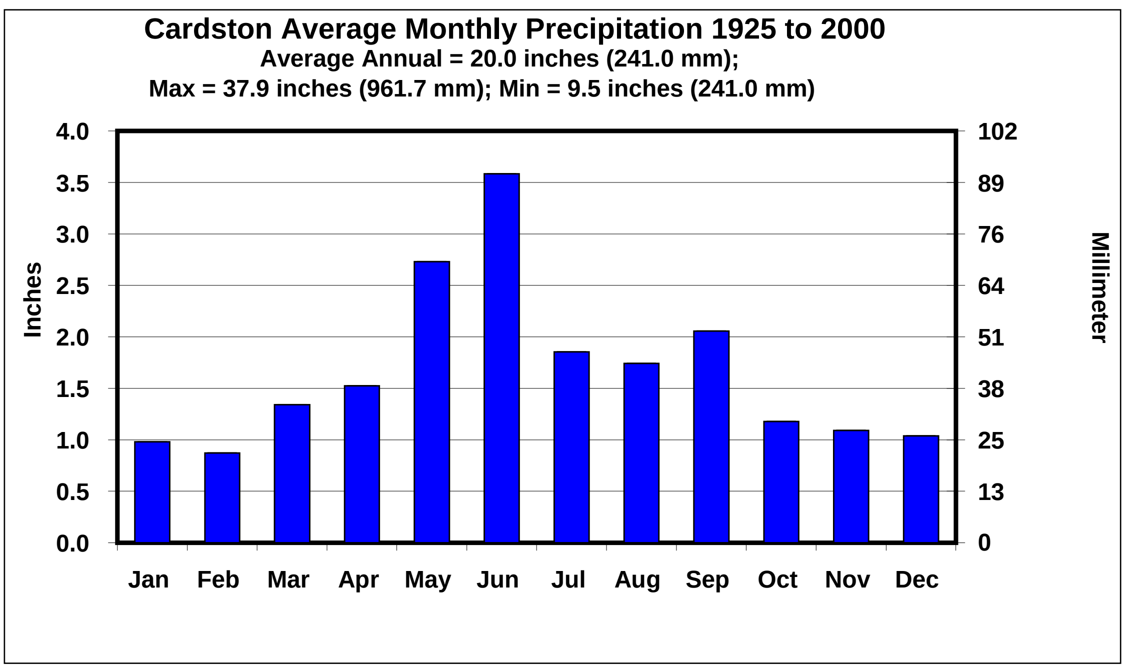


Figure 3.5 – Precipitation summary for Cardston, Alberta.

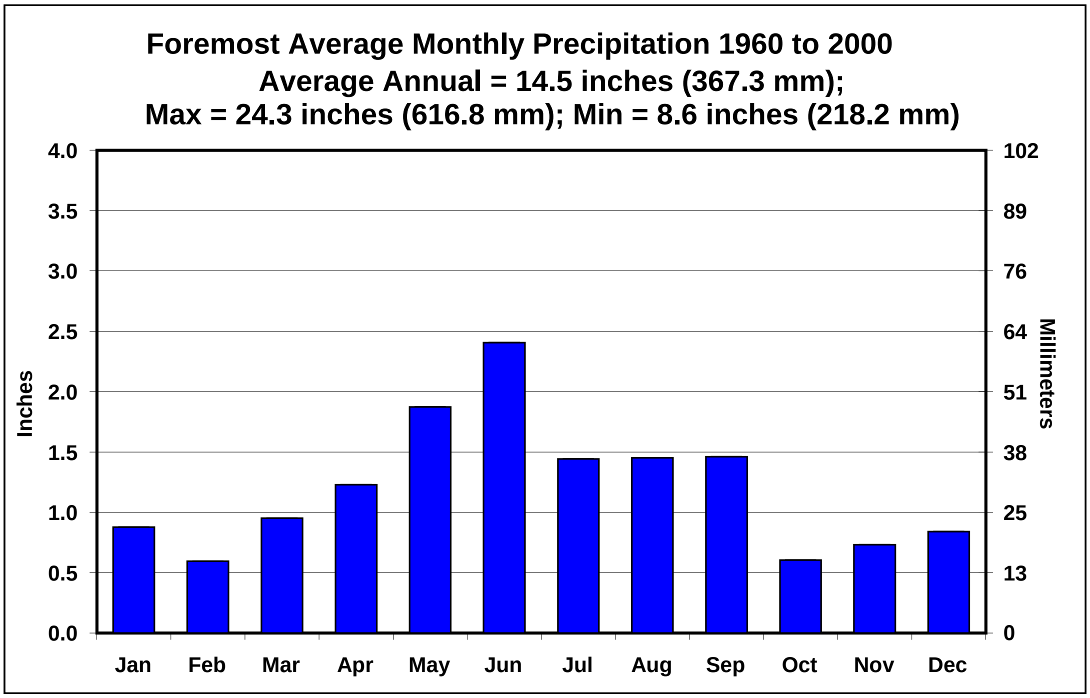


Figure 3.6 – Precipitation summary for Foremost, Alberta.

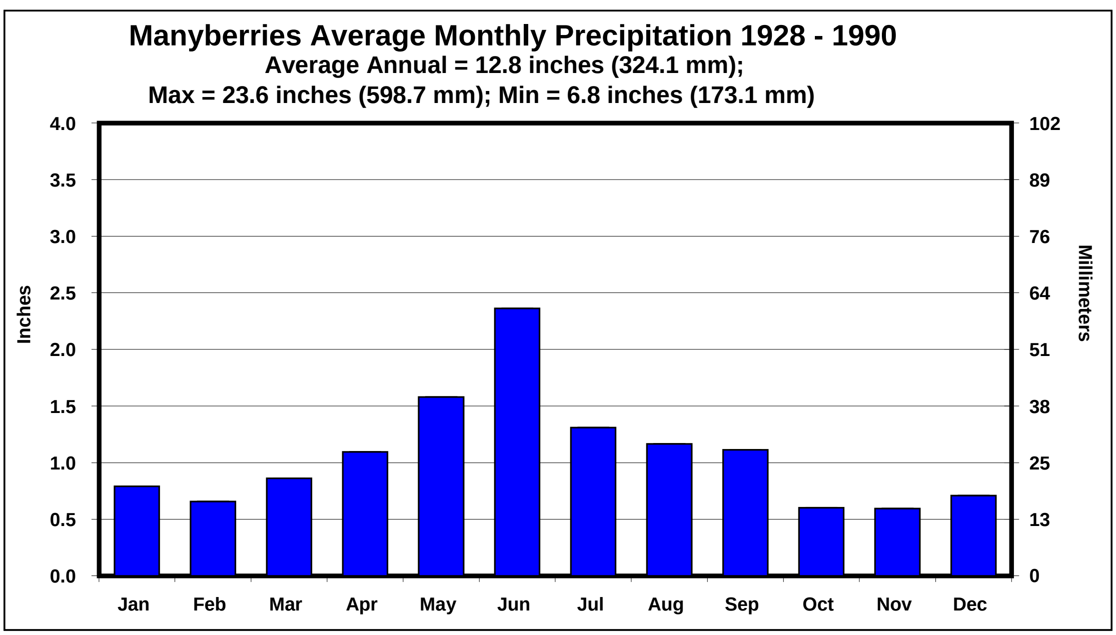


Figure 3.7 – Precipitation summary for Manyberries, Alberta.

Annual and monthly precipitation can be quite variable. Observed maximum annual precipitation is about two times the average and the observed minimum annual precipitation about 50% of the average. Figures B.7 to B.12 and Tables B.1 and B.2 in Appendix B provide a comparison of monthly precipitation, for a high and a low precipitation year, to the long term average.

3.2 Lake Evaporation

Evaporative losses, particularly from large plains area reservoirs and from the Milk River, can account for a significant quantity of water. Evaporation estimates for the U.S. Milk River Basin were taken from the United States Geological Survey (USGS) scientific investigations report 2004-5223 (Cannon and Johnson, 2004). These estimates are based on the free water surface evaporation (hereafter referred to as lake evaporation) for each location derived from National Oceanic and Atmospheric Administration data (1982). Net annual evaporation was calculated by accounting for location specific precipitation inputs based on a period of record from 1961-1990 (Oregon Climate Service, 1998).

Quick Fact

- **Net evaporative losses from reservoirs and other waterbodies range from 11 inches in the west to 20 inches in the east.**

Table 3.1 displays reported evaporation estimates for three water bodies within the Milk River Basin and an additional six representative water bodies immediately south of the basin. Average annual gross evaporation for these nine water bodies ranged from 30 to 40 inches. Net annual evaporation, computed as gross evaporation less precipitation, has ranged from zero to 28 inches with the lowest evaporation rates in the upper end of the Milk River Basin. The greatest evaporation is in the lower end of the basin. While the USGS report did not include monthly evaporation estimates, it can be assumed that peak evaporation occurs in the months of July and August.

Within Alberta, a modified Priestley-Taylor potential evaporation equation was used to calculate monthly gross lake evaporation losses for Southern Alberta. Observed precipitation data from Southern Alberta was applied to a Gridded Prairie (McGinn and Akinremi) map to establish monthly precipitation throughout Southern Alberta. Monthly net lake evaporation data for 49 reservoirs located in southern Alberta's South Saskatchewan River Basin was developed for the growing season (April to October) for the 1969 to 1992 period. This was done by subtracting monthly grid estimates of precipitation from monthly gross lake evaporation. Data for 28 reservoirs is shown in Table 3.2.

Net evaporation losses ranged from 11 to 20 inches. Net evaporation results from independent studies in both Alberta and Montana were used to develop Map 3.4 - mean annual net evaporation for the entire St. Mary and Milk River watershed (at the end of this chapter).

Table 3.1 – Average annual and net lake evaporation in the Milk River Basin, Montana.

Water Body Name	Surface Area (acres)	Surface Area (hectares)	Annual Evaporation (in)	Annual Evaporation (mm)	Annual Precipitation (in)	Average Annual Precipitation (mm)	Average Annual Net Evaporation (in)	Annual Net Evaporation (mm)
Fresno Reservoir	5757	2330	35	889	12	305	23	584
Lake Sherburne	1730	700	30	762	25	635	5	127
Nelson Reservoir	4560	1845	35	889	12	305	23	584
Fort Peck Reservoir *	245000	99149	40	1016	12	305	28	711
Four Horns Lake *	897	363	30	762	16	406	14	356
Lake Francis *	5300	2145	30	762	14	356	16	406
Lower Two Medicine Lake	806	326	30	762	30	762	0	0
Mission Lake *	1024	414	30	762	14	356	16	406
Tiber Reservoir *	22180	8976	35	889	12	305	23	584

* Water body is located south of Milk River watershed, but represents values associated with the watershed.

Nelson Reservoir. Photo: Montana DNRC

Table 3.2 – Average April-October net lake evaporation for 28 reservoirs in Southern Alberta.

Location	Resevoir	Surface area at FSL (ha)	Surface area at FSL (acres)	Net Evaporation (dam3)	Net Evaporation (mm)	Net Evaporation (inches)
T011R05W4	Bullshead	13	32	65	500	20
T008R17W4	Chin	1590	3929	7060	444	17
T004R27W4	Cochrane Lake	90	222	310	344	14
T005R20W4	Corner Lake	15	37	64	427	17
T006R19W4	Craddock	13	32	55	423	17
T005R20W4	Cross Coulee	85	210	361	425	17
T006R20W4	Factory Lake	29	72	123	424	17
T010R15W4	Fincastle	185	457	821	444	17
T008R11W4	Forty Mile	745	1841	3703	497	20
T012R08W4	Grassy Lake	410	1013	2038	497	20
T009R16W4	Horsefly	565	1396	2509	444	17
T004R22W4	Jensen	200	494	688	344	14
T011R22W4	Keho	2350	5807	9870	420	17
T005R20W4	Milk River Ridge	1415	3496	6014	425	17
T010R07W4	Murray	1665	4114	8442	507	20
T010R20W4	North East	210	519	932	444	17
T007R01W5	Oldman River	2425	5992	6645	274	11
T010R22W4	Park Lake	85	210	357	420	17
T002R28W4	Payne Lake	240	593	658	274	11
T011R21W4	Picture Butte Lake	100	247	420	420	17
T005R20W4	Raymond	60	148	255	425	17
T012R08W4	Sauder	1245	3076	6412	515	20
T010R07W4	Seven Persons	60	148	304	507	20
T004R24W4	St. Mary	3765	9303	12952	344	14
T008R18W4	Stafford	490	1211	2176	444	17
T010R16W4	Taber	405	1001	1798	444	17
T004R28W4	Waterton	1095	2706	3000	274	11
T010R12W4	Yellow	1105	2730	5492	497	20

3.3 Crop Water Deficit

Agriculture is an important economic consideration in the St. Mary and Milk River Basins. Hence knowing the amount of water available for crop production, and conversely, the crop water deficit, is important. The crop water deficit is the amount of additional water required to meet the requirements of a crop for optimum growth and production. It is equal to the evapotranspiration (ET) of a crop minus the effective precipitation available to the crop over the growing season. Alfalfa was chosen as the reference crop for this analysis due to the availability of water use data. In addition, alfalfa has the highest seasonal water demand of any commonly grown hay crop in the Milk River Basin.

Quick Fact

- **Impacting agriculture in the Milk and St. Mary River Basins, average annual crop water deficits range from 11.6 inches in the west to 23.8 inches in the southeast.**

3.3.1 Montana Crop Water Requirement

The National Resources Conservation Services computer program *Irrigation Water Requirements* (IWR) was used to calculate the seasonal alfalfa ET requirement for 28 weather stations within the U.S. portion of the Milk River Basin. IWR estimates net monthly and seasonal ET requirements based on crop needs, effective precipitation and the growing season length. Effective precipitation was calculated by IWR from the individual weather station data. The period of record was from 1970-2000.

The ET requirement was computed using the Blaney-Criddle method, which is the only IWR methodology applicable to the data collected at all 28 weather stations. This method was compared with other ET methods by the USGS. Their results indicate Blaney-Criddle produces acceptable predictability (Cruff and Thompson, 1967). Other methods such as the modified Penman-Monteith may produce results that are more accurate but the data required for the equation are not readily available for the Milk River Basin. The crop water deficit was then calculated using the ET and effective precipitation results from IWR.

As seen in Table 3.3, crop water deficits throughout the Milk River Basin ranged from 11.6 inches at the East Glacier weather station to 23.8 inches at the Glasgow weather station (see also Map 3.5 at the end of this chapter). The growing season within the basin generally begins in early May and ends in late September. Monthly graphs of crop water deficit for five weather stations within the basin are shown in Figures 3.8 through 3.12.

Deficits in crop moisture requirements are calculated from precipitation and evapotranspiration.
Photo: Alberta Tourism

Table 3.3 – Alfalfa crop water deficit for 28 weather stations in the Milk River Basin.

Station Name	Elevation	Latitude	Longitude	Total Deficit (in)	Total Deficit (mm)	Season Start	Season End
Babb 6 NE	4300	48.933	-113.367	12.7	323	22-May	14-Sep
Big Sandy	2700	48.167	-110.117	21.8	553	27-Apr	22-Sep
Chester	3132	48.510	-110.970	19.8	503	4-May	20-Sep
Chinook	2420	48.590	-109.230	21.1	536	29-Apr	21-Sep
Content 3 SSE	2340	47.983	-107.550	21.9	555	30-Apr	23-Sep
Cut Bank	3855	48.600	-112.370	16.5	420	15-May	23-Sep
Del Bonita	4340	49.000	-112.783	15.1	384	16-May	19-Sep
East Glacier	4810	48.450	-113.217	11.6	295	27-May	15-Sep
Fort Assinniboine	2613	48.500	-109.800	22.7	577	28-Apr	26-Sep
Glasgow Airport	2293	48.210	-106.620	23.8	604	30-Apr	3-Oct
Gold Butte	3498	48.980	-111.400	16.8	426	8-May	17-Sep
Guilford	2820	48.583	-110.300	20.0	508	3-May	22-Sep
Harlem 4 W	2362	48.550	-108.860	22.0	559	29-Apr	22-Sep
Havre Airport	2585	48.540	-109.760	21.5	545	1-May	25-Sep
Hinsdale 4 SW	2670	48.350	-107.150	22.2	565	29-Apr	5-Oct
Joplin	3300	48.567	-110.767	19.5	496	6-May	19-Sep
Malta	2262	48.360	-107.870	21.9	556	28-Apr	23-Sep
Malta 35 S	2650	47.833	-107.967	20.6	524	2-May	21-Sep
Opheim	2950	48.850	-106.410	17.2	436	10-May	18-Sep
Opheim 10 N	2878	49.000	-106.380	16.6	422	9-May	11-Sep
Port of Morgan	2830	49.000	-107.830	20.4	519	1-May	25-Sep
Saco US-2 M	2180	48.450	-107.300	20.6	523	2-May	25-Sep
Simpson 6 N	2815	49.000	-110.210	20.2	512	3-May	18-Sep
St. Mary	4560	48.730	-113.430	14.4	365	18-May	20-Sep
Sunburst 8 E	3610	48.900	-111.733	19.1	485	4-May	29-Sep
Sweetgrass	3466	49.000	-111.960	18.3	465	4-May	1-Oct
Tiber Dam	2850	48.317	-111.083	23.4	595	29-Apr	28-Sep
Zortman	4660	47.920	-108.550	14.7	373	13-May	18-Sep

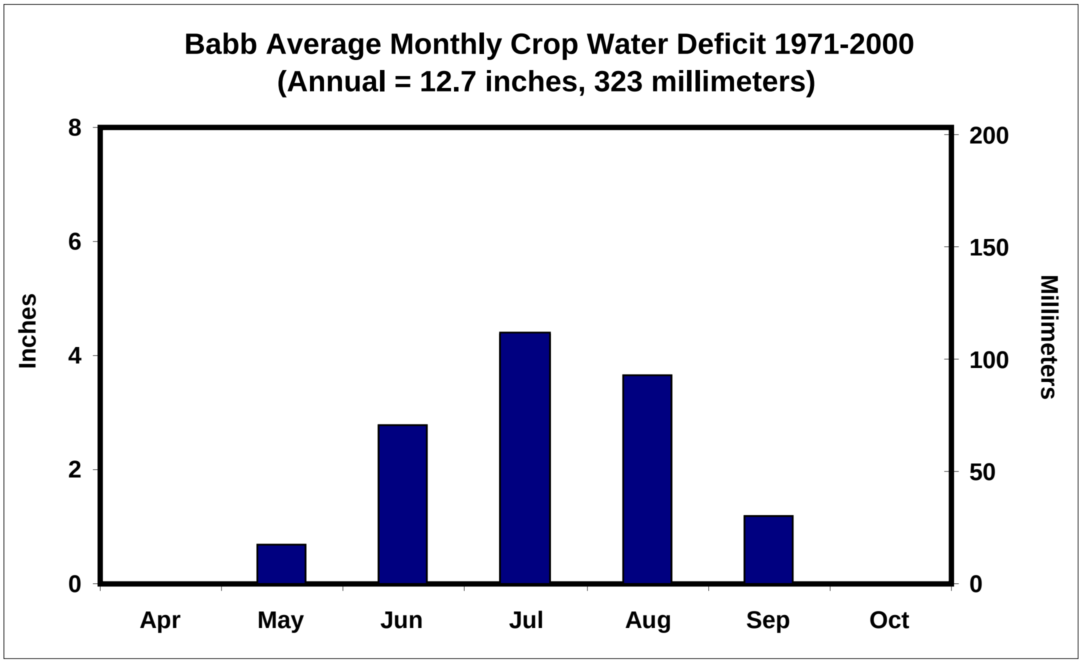


Figure 3.8 – Average monthly alfalfa crop water deficit for Babb weather station.

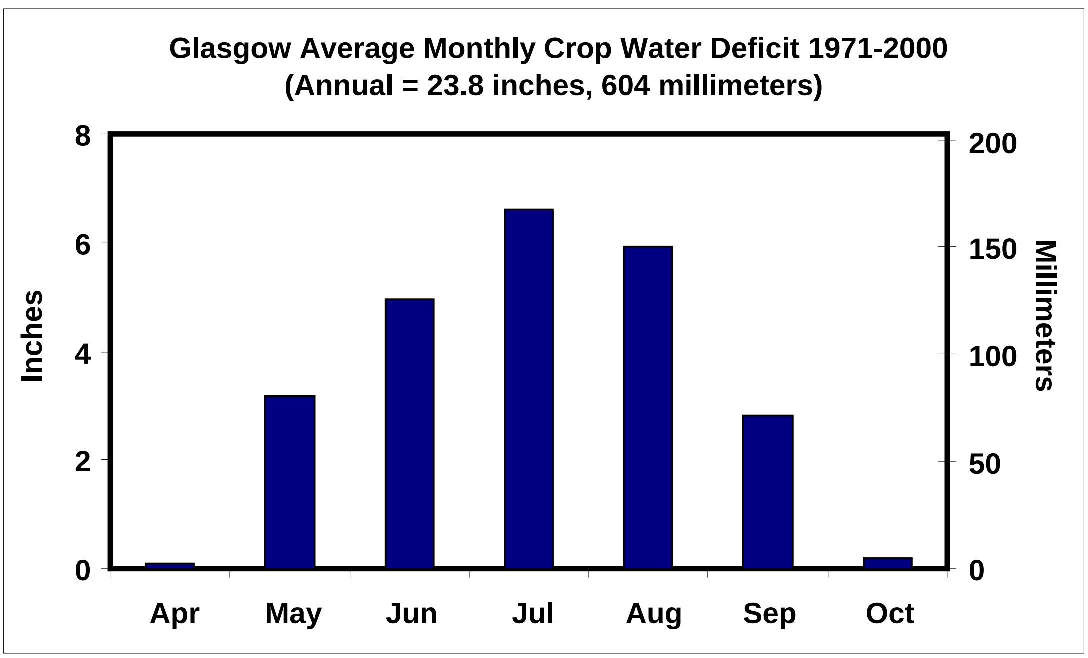


Figure 3.9 – Average monthly alfalfa crop water deficit for Glasgow weather station.

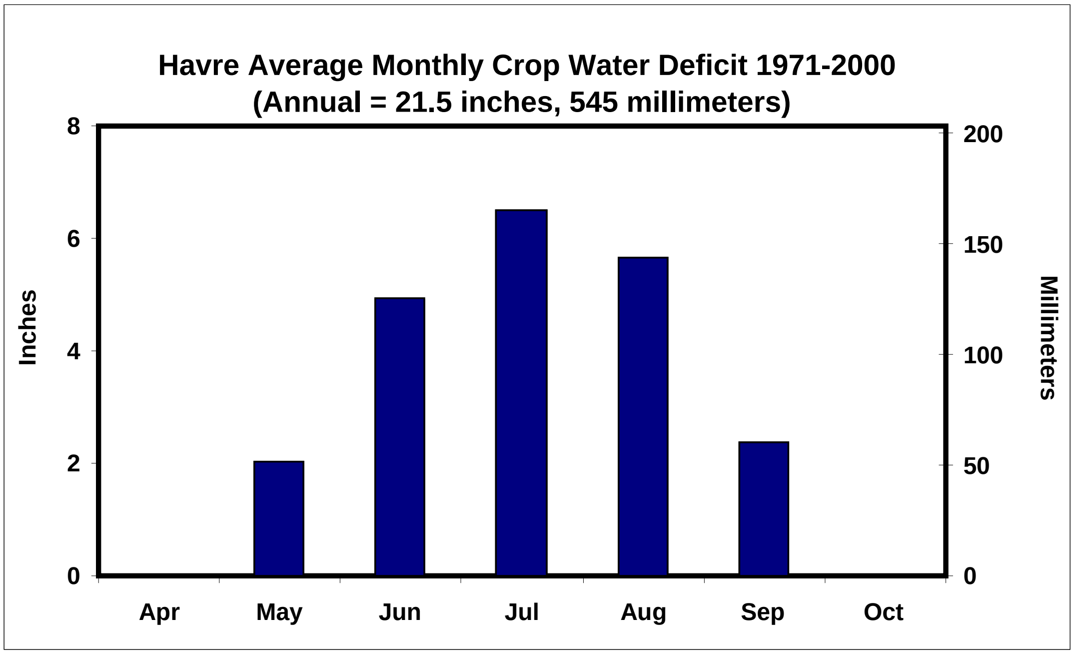


Figure 3.10 – Average monthly alfalfa crop water deficit for Havre weather station.

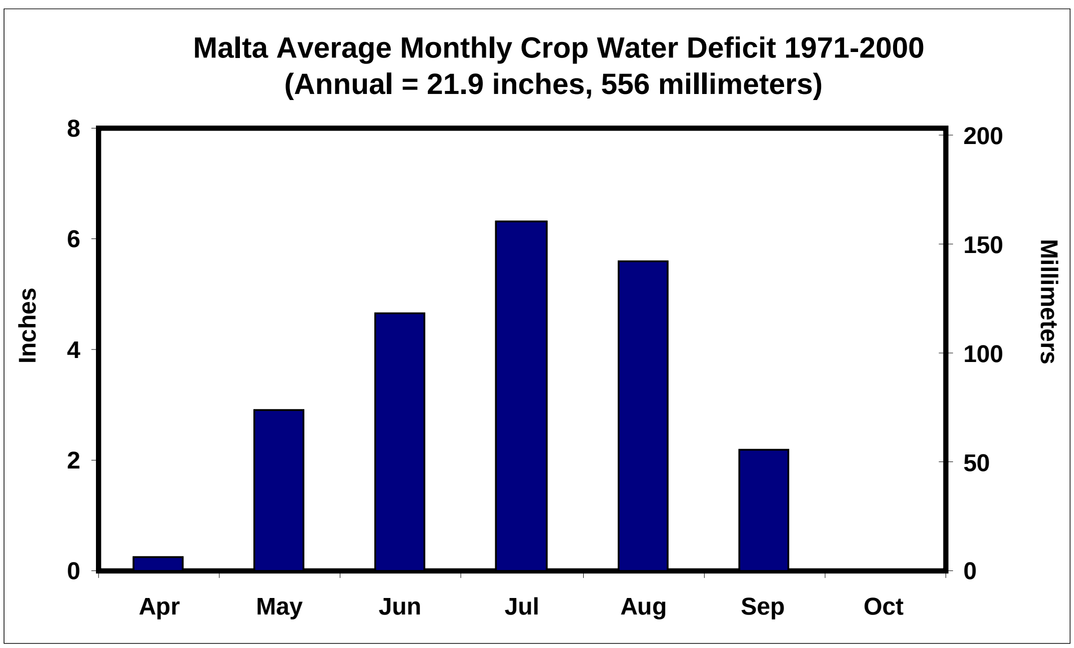


Figure 3.11 – Average monthly alfalfa crop water deficit for Malta weather station.

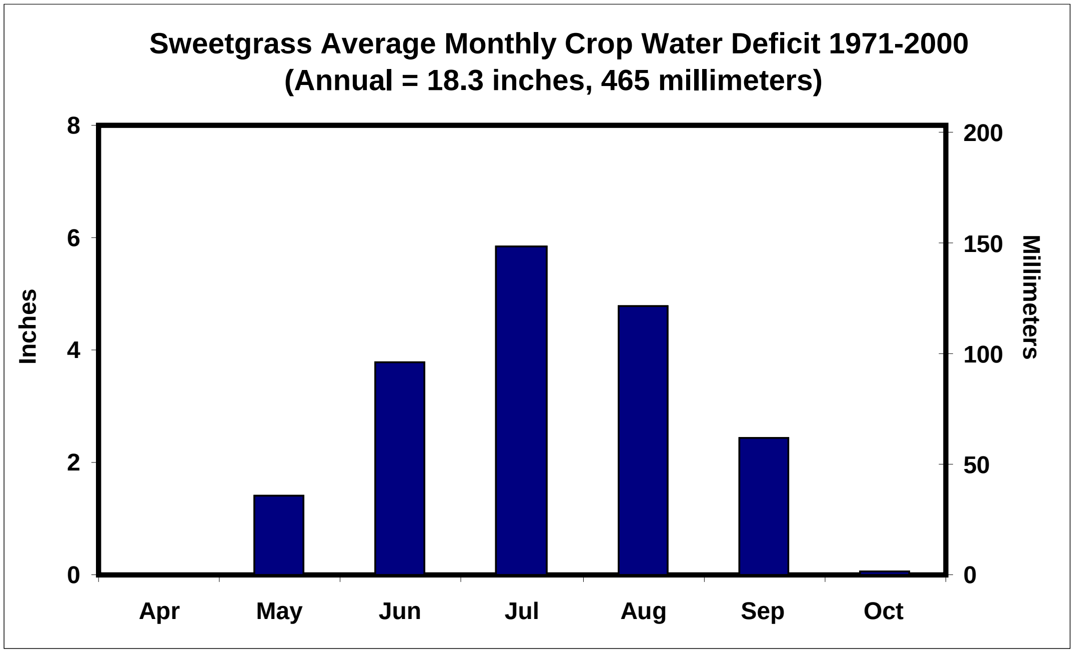


Figure 3.12 – Average monthly alfalfa crop water deficit for Sweetgrass weather station.

3.3.2 Alberta Crop Water Requirement

In Alberta, the crop water deficit is calculated using the difference between crop water use (actual evapotranspiration [AET]) and precipitation for the crop growing season. In southern Alberta, a modified Priestley-Taylor equation is used to calculate potential evapotranspiration (PET). Crop coefficients developed for southern Alberta are then used to calculate the AET. Precipitation is from the province township weather data set. This weather data is an interpolation of data from various weather stations located throughout Alberta with daily values from 1900 to 2006.

Using a subset of years (1971 to 2000), average monthly crop water deficits of alfalfa were computed for two selected areas; Cardston to the west and Manyberries to the east. Table 3.4 and Figure 3.13 show the computed average monthly crop water deficits at the two sites and the over year variability. The 30 year average crop water deficit is 13.3 inches at Cardston and 19.4 inches at Manyberries. The maximum annual crop water deficit is 22.3 inches at Cardston and 27.3 inches at Manyberries. The minimum annual deficit is 1.3 inches at Cardston and 8.8 inches at Manyberries.

Table 3.4 – Average monthly crop water deficit for Alfalfa (3 cut system) for Cardston and Manyberries, Alberta.

Month	Cardston	Manyberries
	inches	inches
April	-1.1	-0.2
May	2.1	3.7
June	3.0	4.2
July	4.8	5.6
August	2.6	3.4
September	1.9	2.7
Irrigation Season Total	**12.4**	**19.4**

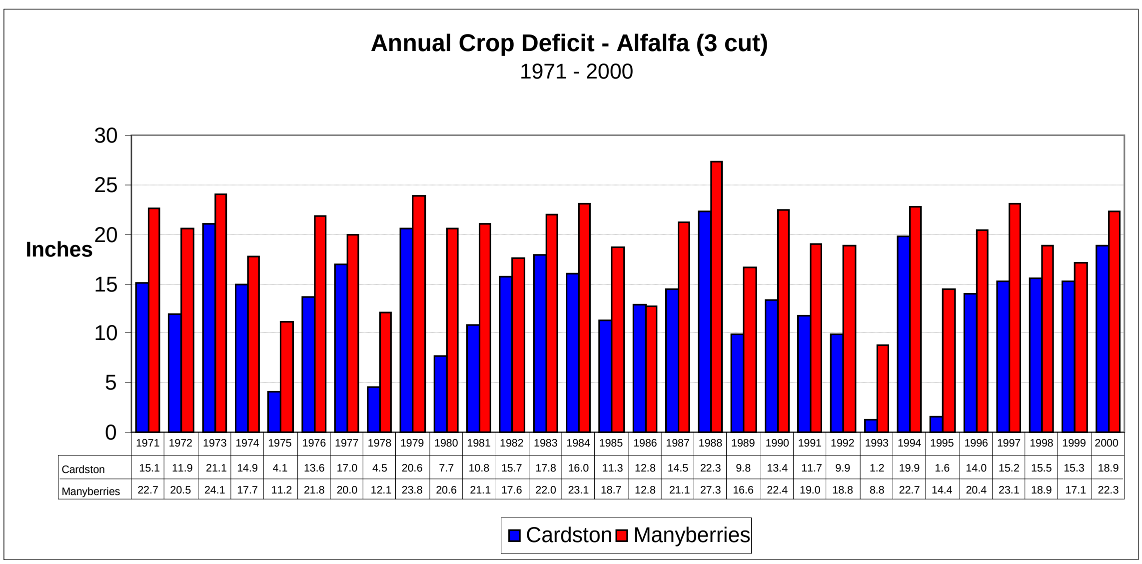
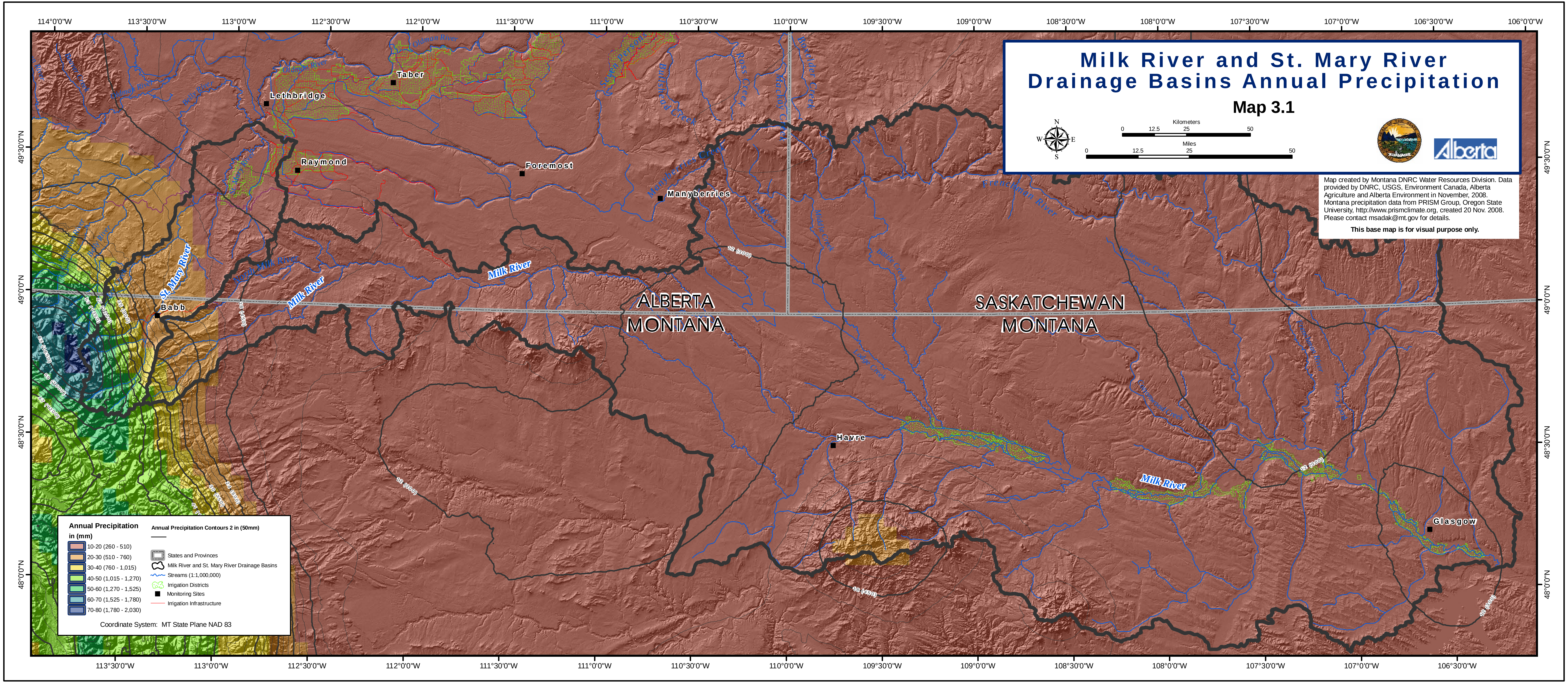


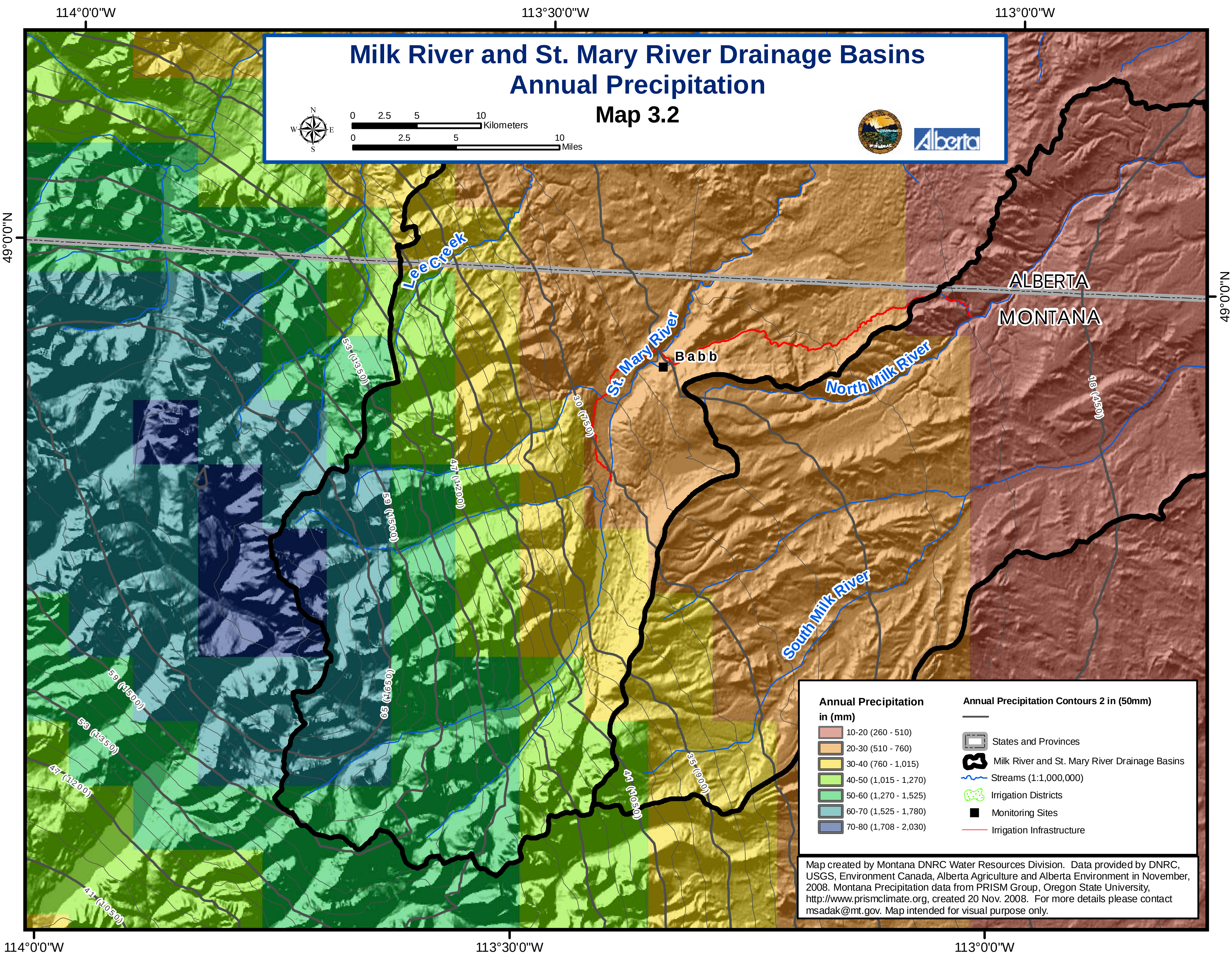
Figure 3.13 – Yearly crop water deficit (inches) for Cardston and Manyberries, Alberta.

Literature Cited

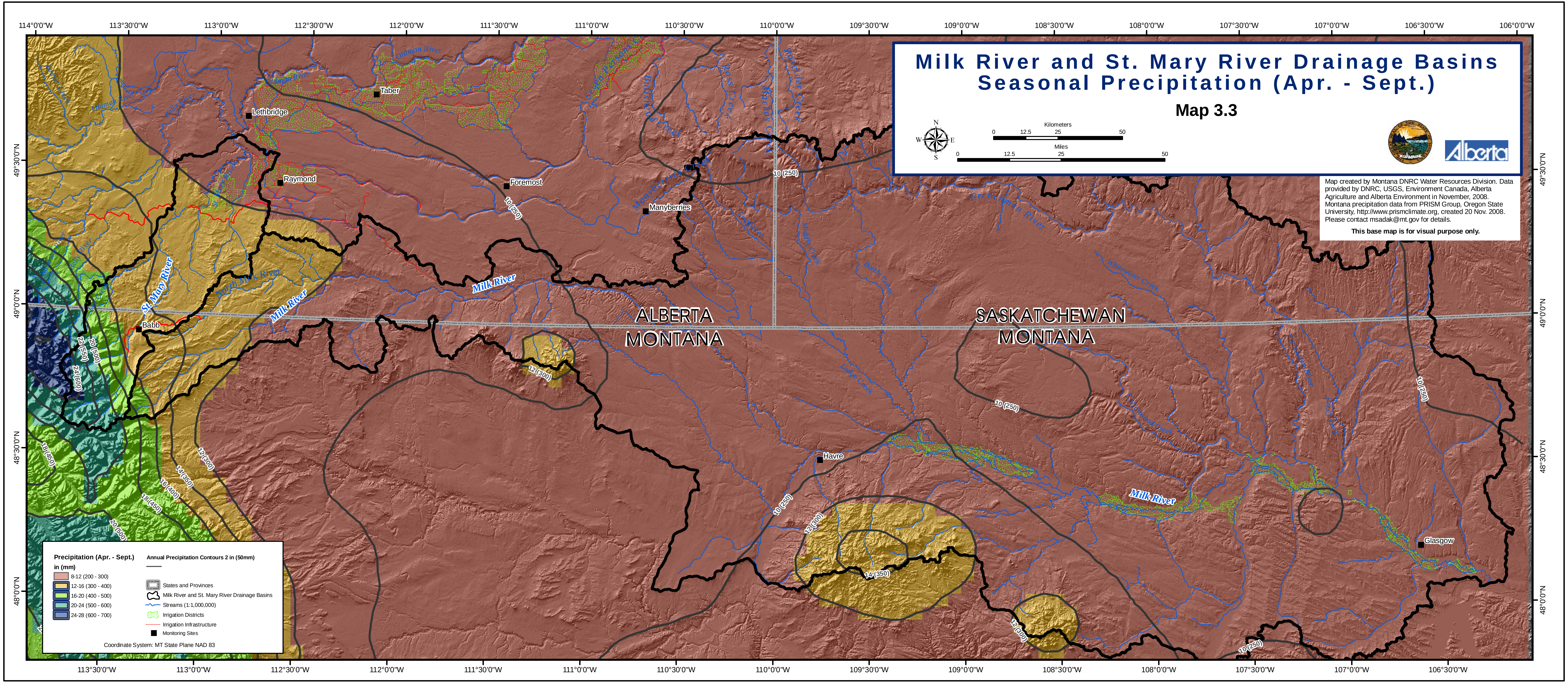
1. National Oceanic and Atmospheric Administration, 1982, Evaporation atlas for the contiguous 48 United States: NOAA Technical Report NWS 33, 26 p.
2. Oregon Climate Service, 1998, Montana average annual precipitation, 1961-1990; digital precipitation map, accessed April 1, 2003, at *http://nris.state.mt.us/gis/mtmaps.html.*
3. Cannon, M.R. and D.R. Johnson. 2004. *Estimated water use in Montana 2000: Scientific investigations report 2004-5223*. United States Geological Survey. 50 pg.
4. South Saskatchewan River Basin. Irrigation in the 21st Century. Volume 3: Conveyance Water Management. Evaporation losses from irrigation canals and reservoirs in southern Alberta. Pages 1 – 26. Alberta Irrigation Projects Association, Lethbridge, AB.
5. McGinn, S.M., Akinremi, O.O., and Barr, A.G., Description of the Gridded Prairie Climate Database (GRIPCD) for years 1960 – 1989. Agriculture and Agri-Food Canada, Lethbridge, AB.
6. Cruff, R. W., and T. H Thompson. 1967. A comparison of methods of estimating potential evapotranspiration from climatological data in arid and subhumid environments. USGS Water Supply Paper 1839-M. 28 p.



Milk River and St. Mary River
Drainage Basins Annual Precipitation
Map 3.1
Kilometers
0 12.5 25 50
Miles
0 12.5 25 50
Map created by Montana DNRC Water Resources Division. Data provided by DNRC, USGS, Environment Canada, Alberta Agriculture and Alberta Environment in November, 2008. Montana precipitation data from PRISM Group, Oregon State University, http://www.prismclimate.org, created 20 Nov. 2008. Please contact msadak@mt.gov for details.
This base map is for visual purpose only.
ALBERTA
MONTANA
SASKATCHEWAN
MONTANA
Lethbridge
Taber
Raymond
Foremost
Manyberries
Babb
Havre
Glasgow
Milk River
St. Mary River
114°0'0"W
113°30'0"W
113°0'0"W
112°30'0"W
112°0'0"W
111°30'0"W
111°0'0"W
110°30'0"W
110°0'0"W
109°30'0"W
109°0'0"W
108°30'0"W
108°0'0"W
107°30'0"W
107°0'0"W
106°30'0"W
106°0'0"W
49°30'0"N
49°0'0"N
48°30'0"N
48°0'0"N
Annual Precipitation in (mm)
10-20 (260 - 510)
20-30 (510 - 760)
30-40 (760 - 1,015)
40-50 (1,015 - 1,270)
50-60 (1,270 - 1,525)
60-70 (1,525 - 1,780)
70-80 (1,780 - 2,030)
Annual Precipitation Contours 2 in (50mm)
States and Provinces
Milk River and St. Mary River Drainage Basins
Streams (1:1,000,000)
Irrigation Districts
Monitoring Sites
Irrigation Infrastructure
Coordinate System: MT State Plane NAD 83



Milk River and St. Mary River Drainage Basins
Annual Precipitation
Map 3.2
0 2.5 5 10 Kilometers
0 2.5 5 10 Miles
114°0'0"W
113°30'0"W
113°0'0"W
49°0'0"N
ALBERTA
MONTANA
Lee Creek
St. Mary River
Babb
North Milk River
South Milk River
53 (1350)
30 (750)
47 (1200)
59 (1500)
65 (1650)
41 (1050)
35 (900)
18 (450)
Annual Precipitation in (mm)
10-20 (260 - 510)
20-30 (510 - 760)
30-40 (760 - 1,015)
40-50 (1,015 - 1,270)
50-60 (1,270 - 1,525)
60-70 (1,525 - 1,780)
70-80 (1,708 - 2,030)
Annual Precipitation Contours 2 in (50mm)
States and Provinces
Milk River and St. Mary River Drainage Basins
Streams (1:1,000,000)
Irrigation Districts
Monitoring Sites
Irrigation Infrastructure
Map created by Montana DNRC Water Resources Division. Data provided by DNRC, USGS, Environment Canada, Alberta Agriculture and Alberta Environment in November, 2008. Montana Precipitation data from PRISM Group, Oregon State University, http://www.prismclimate.org, created 20 Nov. 2008. For more details please contact msadak@mt.gov. Map intended for visual purpose only.



Milk River and St. Mary River Drainage Basins
Seasonal Precipitation (Apr. - Sept.)
Map 3.3
N
S
E
W
Kilometers
0
12.5
25
50
Miles
0
12.5
25
50
Alberta
Map created by Montana DNRC Water Resources Division. Data provided by DNRC, USGS, Environment Canada, Alberta Agriculture and Alberta Environment in November, 2008. Montana precipitation data from PRISM Group, Oregon State University, http://www.prismclimate.org, created 20 Nov. 2008. Please contact msadak@mt.gov for details.
This base map is for visual purpose only.
Precipitation (Apr. - Sept.) in (mm)
8-12 (200 - 300)
12-16 (300 - 400)
16-20 (400 - 500)
20-24 (500 - 600)
24-28 (600 - 700)
Annual Precipitation Contours 2 in (50mm)
States and Provinces
Milk River and St. Mary River Drainage Basins
Streams (1:1,000,000)
Irrigation Districts
Irrigation Infrastructure
Monitoring Sites
Coordinate System: MT State Plane NAD 83
ALBERTA
MONTANA
SASKATCHEWAN
MONTANA
Lethbridge
Taber
Raymond
Foremost
Manyberries
Babb
Havre
Glasgow
Milk River
St. Mary River
North Milk River
Oldman River
10 (250)
12 (300)
14 (350)
16 (400)
18 (450)
20 (500)
22 (550)
24 (600)
114°0'0"W
113°30'0"W
113°0'0"W
112°30'0"W
112°0'0"W
111°30'0"W
111°0'0"W
110°30'0"W
110°0'0"W
109°30'0"W
109°0'0"W
108°30'0"W
108°0'0"W
107°30'0"W
107°0'0"W
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49°0'0"N
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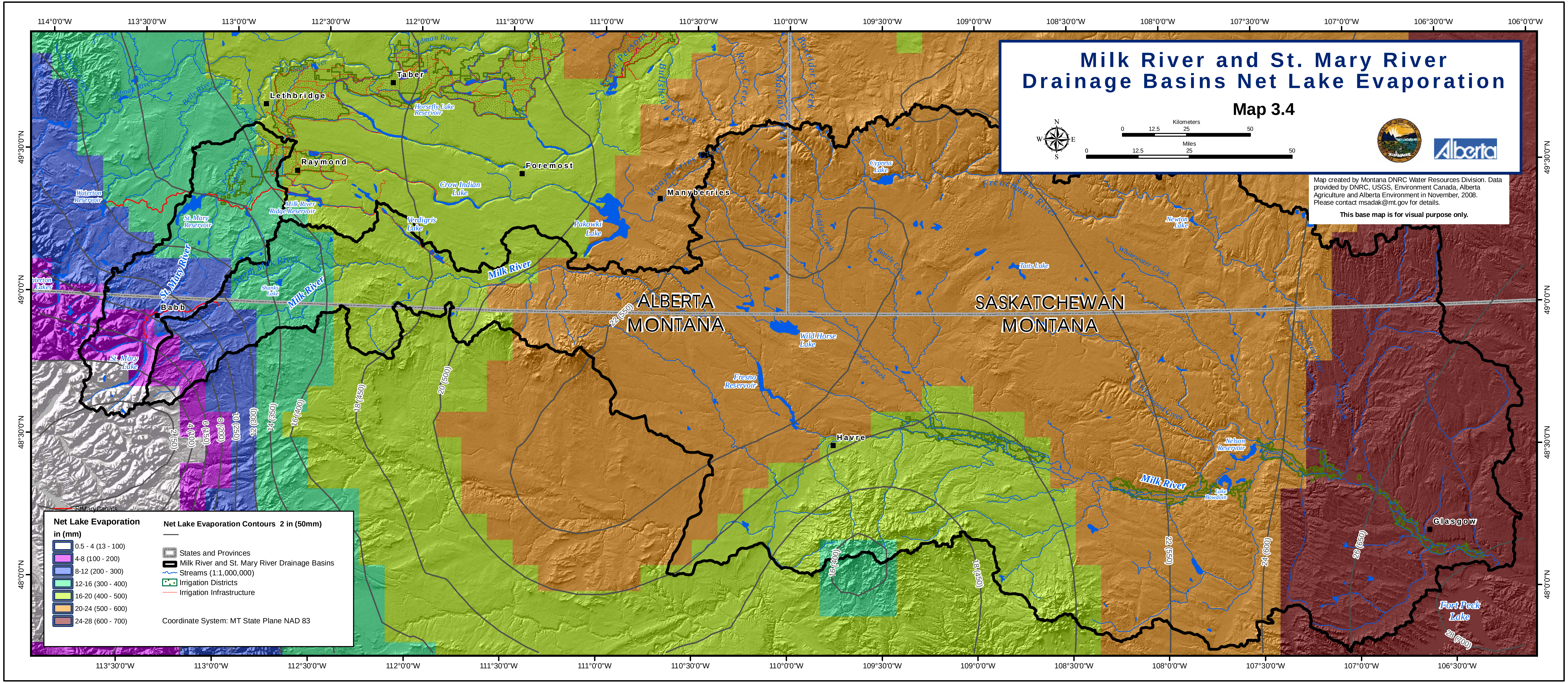
48°0'0"N


Milk River and St. Mary River
Drainage Basins Net Lake Evaporation
Map 3.4
Kilometers
0 12.5 25 50
Miles
0 12.5 25 50
N S E W
Alberta
Map created by Montana DNRC Water Resources Division. Data provided by DNRC, USGS, Environment Canada, Alberta Agriculture and Alberta Environment in November, 2008. Please contact msadak@mt.gov for details.
This base map is for visual purpose only.
Net Lake Evaporation in (mm)
0.5 - 4 (13 - 100)
4-8 (100 - 200)
8-12 (200 - 300)
12-16 (300 - 400)
16-20 (400 - 500)
20-24 (500 - 600)
24-28 (600 - 700)
Net Lake Evaporation Contours 2 in (50mm)
States and Provinces
Milk River and St. Mary River Drainage Basins
Streams (1:1,000,000)
Irrigation Districts
Irrigation Infrastructure
Coordinate System: MT State Plane NAD 83
StMaryCanals
ALBERTA
MONTANA
SASKATCHEWAN
MONTANA
Lethbridge
Taber
Raymond
Foremost
Manyberries
Babb
Havre
Glasgow
Milk River
St. Mary River
Frenchman River
Waterton Reservoir
St. Mary Reservoir
Milk River Ridge Reservoir
Crow Indian Lake
Verdigris Lake
Pakowki Lake
Cypress Lake
Newton Lake
Taits Lake
Wild Horse Lake
Fresno Reservoir
Nelson Reservoir
Lake Bowdoin
Fort Peck Lake
St. Mary Lake
Horsefly Lake Reservoir
Shanks Lake
Waterton Lakes
Oldman River
Belly River
2 (50)
4 (100)
6 (150)
8 (200)
10 (250)
12 (300)
14 (350)
16 (400)
18 (450)
20 (500)
22 (550)
24 (600)
26 (650)
28 (700)
114°0'0"W
113°30'0"W
113°0'0"W
112°30'0"W
112°0'0"W
111°30'0"W
111°0'0"W
110°30'0"W
110°0'0"W
109°30'0"W
109°0'0"W
108°30'0"W
108°0'0"W
107°30'0"W
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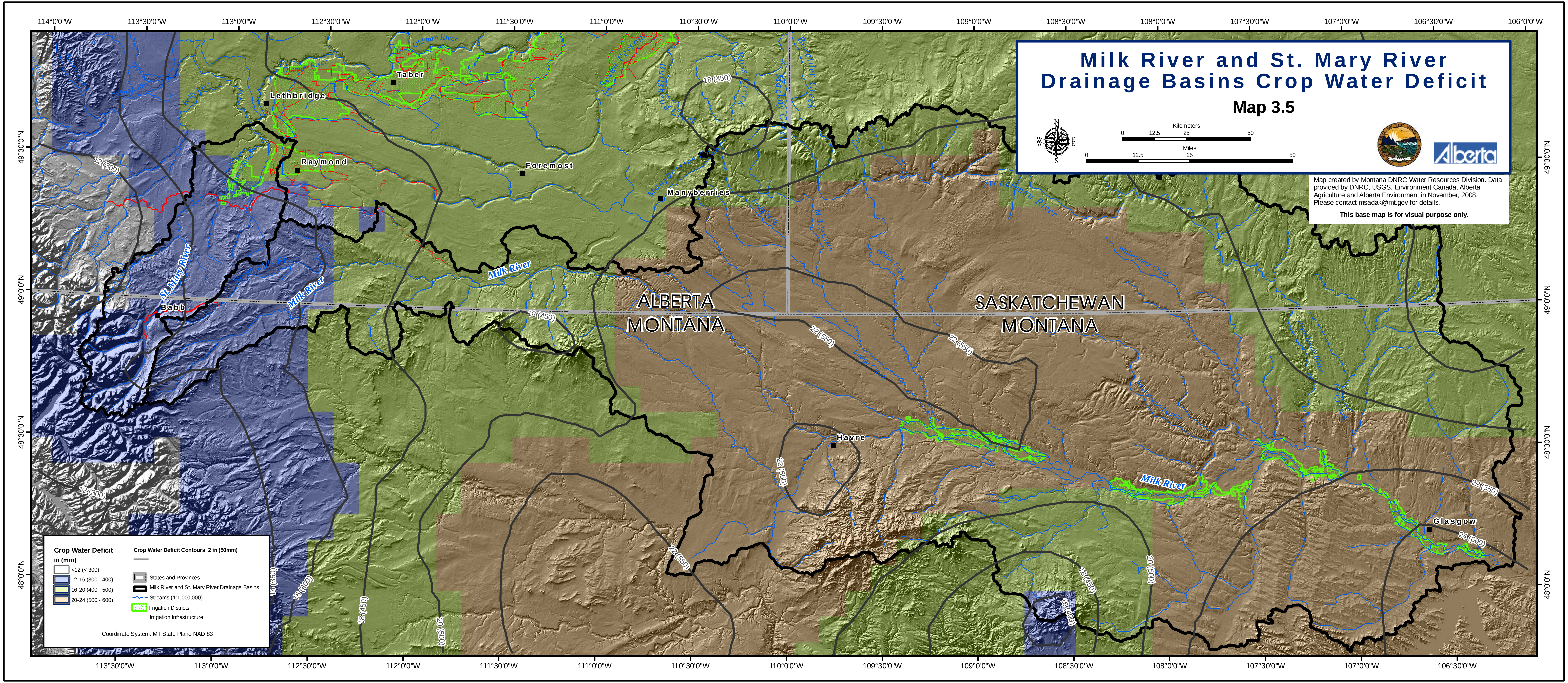
48°0'0"N


Milk River and St. Mary River Drainage Basins Crop Water Deficit
Map 3.5
Kilometers
0 12.5 25 50
Miles
0 12.5 25 50
Map created by Montana DNRC Water Resources Division. Data provided by DNRC, USGS, Environment Canada, Alberta Agriculture and Alberta Environment in November, 2008. Please contact msadak@mt.gov for details.
This base map is for visual purpose only.
Crop Water Deficit in (mm)
<12 (< 300)
12-16 (300 - 400)
16-20 (400 - 500)
20-24 (500 - 600)
Crop Water Deficit Contours 2 in (50mm)
States and Provinces
Milk River and St. Mary River Drainage Basins
Streams (1:1,000,000)
Irrigation Districts
Irrigation Infrastructure
Coordinate System: MT State Plane NAD 83
ALBERTA
MONTANA
SASKATCHEWAN
MONTANA
Lethbridge
Taber
Raymond
Foremost
Manyberries
Babb
Havre
Glasgow
Milk River
St. Mary River
Oldman River
Frenchman River
12 (300)
14 (350)
16 (400)
18 (450)
20 (500)
22 (550)
24 (600)
114°0'0"W
113°30'0"W
113°0'0"W
112°30'0"W
112°0'0"W
111°30'0"W
111°0'0"W
110°30'0"W
110°0'0"W
109°30'0"W
109°0'0"W
108°30'0"W
108°0'0"W
107°30'0"W
107°0'0"W
106°30'0"W
106°0'0"W
49°30'0"N
49°0'0"N
48°30'0"N
48°0'0"N

4.0 Hydrology

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Taking a more detailed look at the hydrology of the Milk and St. Mary River Basins, this chapter provides insight into the quantity, timing and variability of flows. It also compares "observed" flows to "natural" flows, where the influence of man-made activities is removed.

4.1 St. Mary River Basin

Quick Facts

- **Primary tributaries to the St. Mary River include the Swift Current and Kennedy Creeks in the U.S. and Lee Creek in Canada.**
- **Flow of the St. Mary River at the International Boundary is influenced by operations of Lake Sherburne Reservoir and U.S. St. Mary Canal.**
- **Once in Canada, flow is influenced by operations of St. Mary Reservoir as well as diversions for irrigation.**

As mentioned previously, the headwaters of the St. Mary River Basin originate in Glacier National Park and the Blackfeet Indian Reservation in Montana. The drainage area of the basin at the International Boundary is about 465 mi^2. The two primary tributaries to the St. Mary River in the United States are Swift Current Creeks and Kennedy Creek.

The St. Mary River to the International Boundary produces about 640,000 ac-ft of natural flow on average. Due to diversions by the U.S. St. Mary Canal, the observed (gauged) flow at the Boundary is about 465,000 ac-ft, a reduction or diversion of about 175,000 ac-ft.

Figure 4.1 compares the median naturalized flows (the river flow that would have occurred in the absence of any man-made effects) of the Upper St. Mary River to that of Swift Current Creek, its largest tributary. It demonstrates that the unregulated upper St. Mary River is the larger water producer.

Figure 4.2 shows the monthly 20 percentile, 50 percentile (median), and 80 percentiles of recorded monthly flows for the St Mary River at the International Boundary. These include the effects of storage in Lake Sherburne and diversions by the U.S. St. Mary Canal. As indicated, monthly flows for the St. Mary River can be quite variable.

Most of the flow of the St. Mary River comes from precipitation in the higher elevation mountains, with much of it being melting snow. The river generally peaks during late May to early June. Peak flows are typically from about 3,000 to 6,000 cfs, but have been as high as 40,000 cfs, and as low as 1,000 cfs.

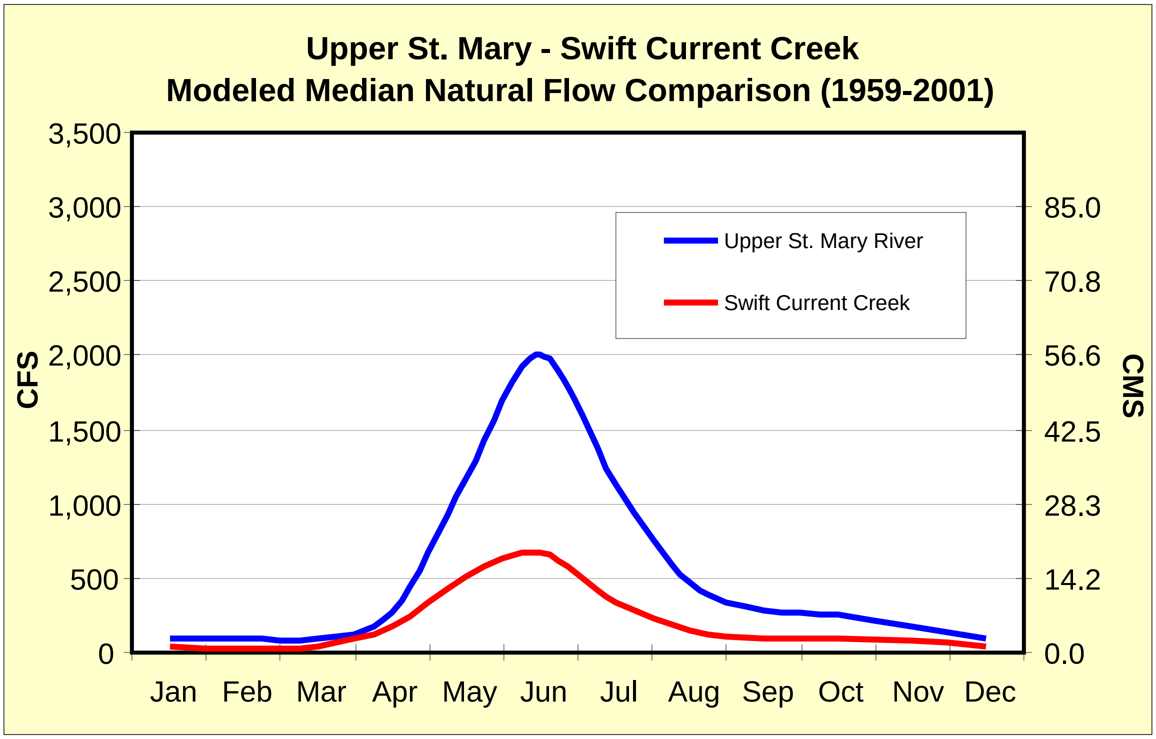

Figure 4.1 – Median naturalized monthly flow for the Upper St. Mary River and Swift Current Creek.

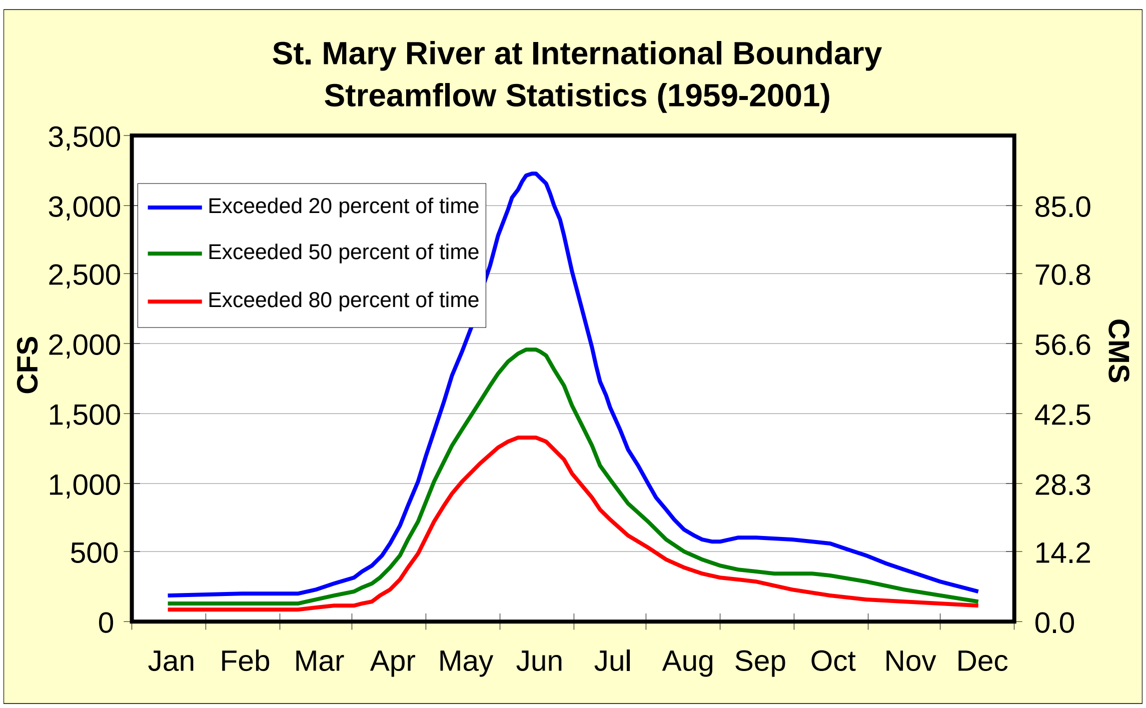

Figure 4.2 – St. Mary River at the International Boundary monthly recorded flow statistics.

The operations of Lake Sherburne Reservoir (capacity of about 67,850 ac-ft) can substantially reduce the peak flow of the St. Mary River by capturing runoff from Swift Current Creek. Flows in the St. Mary River at the International Boundary are heavily influenced by the operations of both the U.S. St. Mary Canal and Lake Sherburne Reservoir. Figure 4.3 compares the observed hydrographs, which include the effects of all upstream human activities, for the St. Mary River at the International Boundary for a representative wet, median, and dry year.

During the fall through winter period, flows in the St. Mary River at the International Boundary will be somewhat lower than natural. This is because the U.S. is storing water in Lake Sherburne Reservoir. During the early spring and again during the irrigation season, observed flows at the International Boundary will be lower than natural due to diversions down the U.S. St. Mary Canal and operations of Lake Sherburne Reservoir.

Figure 4.4 compares median monthly observed and naturalized flows for the St. Mary River at the International Boundary. This figure shows the effects of the operations of St. Mary Canal and Lake Sherburne Reservoir. Further details on these operations are provided in Chapter 8.

Sherburne Lake Reservoir
Photo: John Sanders

Water is diverted for irrigated agriculture.
Photo: Larry Dolan

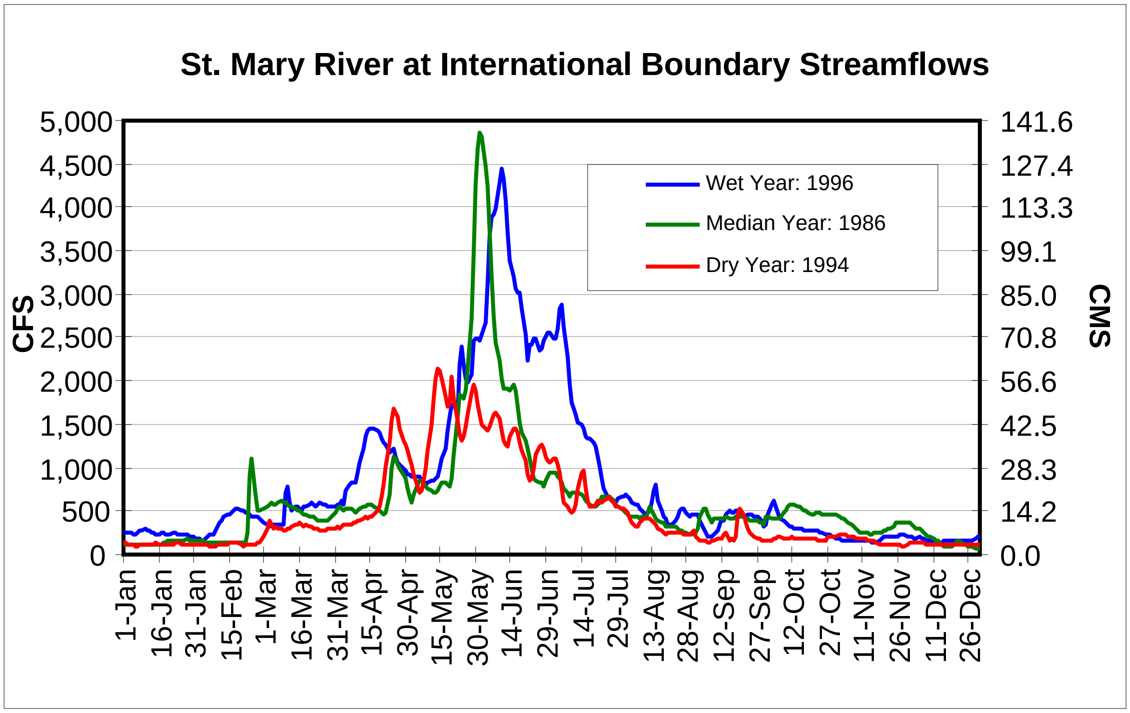

Figure 4.3 – Recorded St. Mary River flows for a wet, median and dry year (Source: USGS).

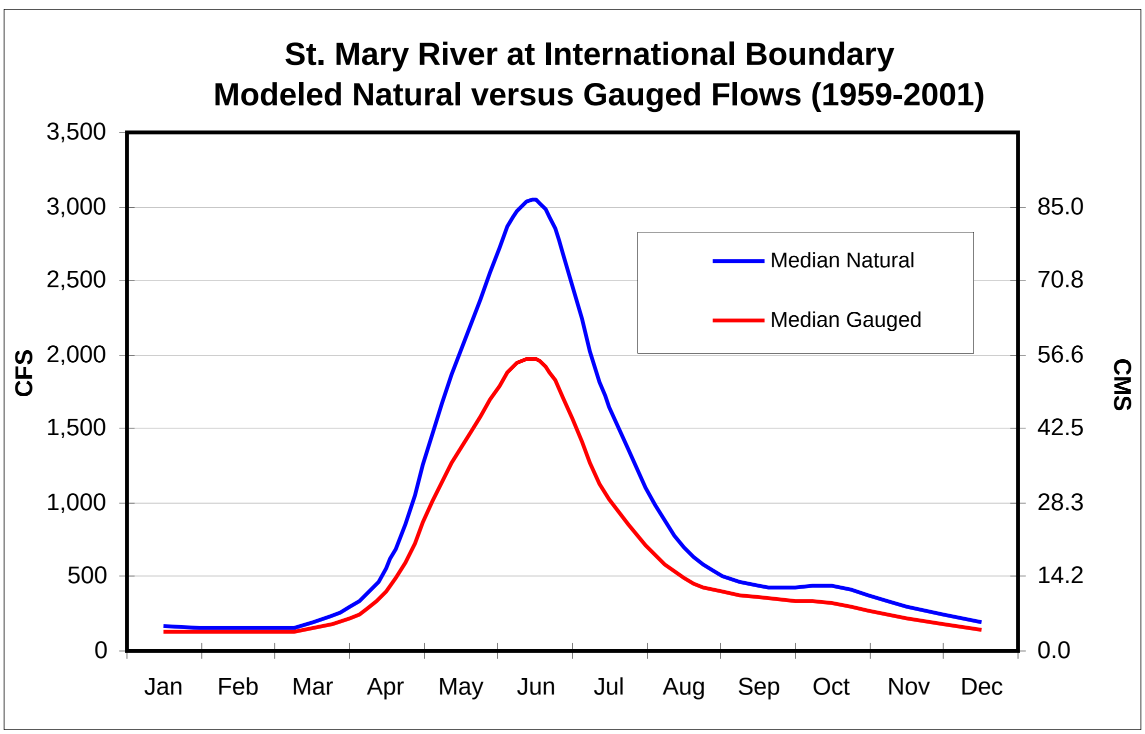

Figure 4.4 – St. Mary River recorded (gauged) flows compared to St. Mary River estimated naturalized flows.

> ***Quick Facts***
>
> - **Water from the Waterton and the Belly Rivers is also diverted into the St. Mary Reservoir.**
> - **Both at the International Boundary and Lethbridge, recorded flows of the St. Mary River are lower than naturalized flows due to reservoir operations and diversions for irrigation.**

From the U.S.-Canada border, the St. Mary River flows north into the St. Mary Reservoir and subsequently into the Oldman River. Lee Creek, which joins the St. Mary River upstream of the St. Mary Reservoir, is the main tributary of the St. Mary River in Canada. It has a median annual volume of about 39,000 ac-ft. Figure 4.5 compares the naturalized and recorded flows of the St. Mary River at the International Boundary and near Lethbridge. As indicated, the local runoff contribution from the incremental drainage area between the International Boundary and Lethbridge is minimal. It is about 65,000 ac-ft per year (or about 10 percent of flow), while the gross drainage area increases by 897 mi^2 or about 192 percent.

The comparison of recorded flows for the St. Mary River (at the International Boundary) to those near Lethbridge shows a reduction in flow. This is due to the capture and storage of water by the St. Mary Reservoir and the subsequent diversions to the St. Mary, Taber and Raymond Irrigation Districts in Canada. During the summer months, water from the Waterton and the Belly Rivers is also diverted (via the Waterton-Belly and the Belly-St. Mary canals) into the St. Mary Reservoir. It is later delivered to the aforementioned Irrigation Districts. More information on the operation of these diversions and the St. Mary Reservoir is provided in Section 8.2 in this report. Additional statistics on stream flows for stations in the St. Mary River watershed are presented in Appendix C.

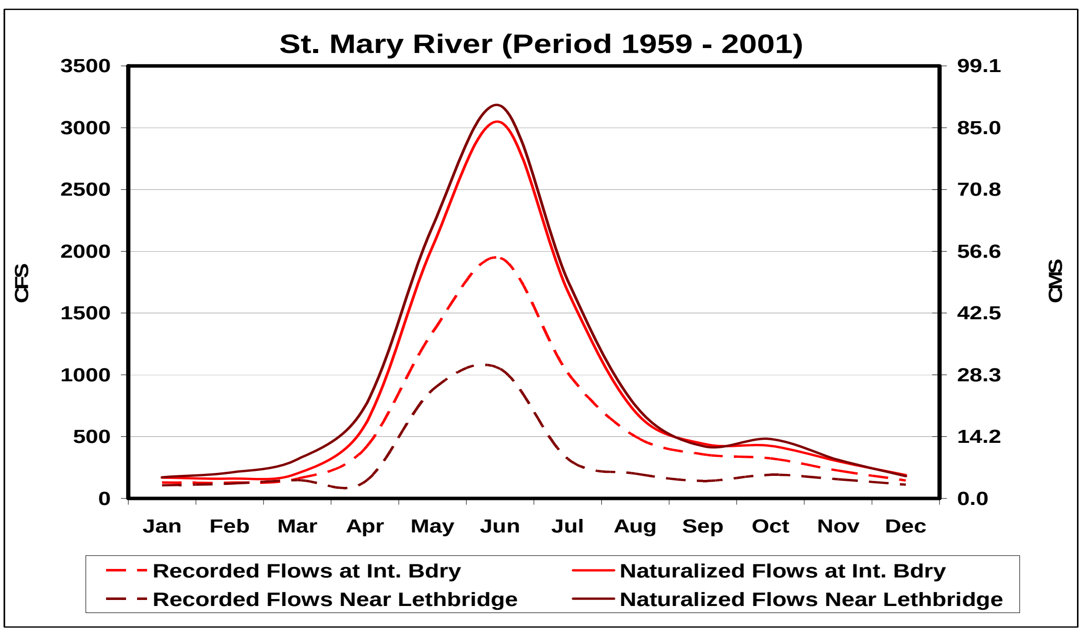

Figure 4.5 – Comparison of recorded flows and naturalized flows for the St. Mary River at the International Boundary and Lethbridge. (Source: Alberta Environment *South Saskatchewan River Basin Historical Weekly Natural Flows 1912 – 2001*, version 3.01, March 2004)

4.2 Milk River Basin

The headwaters of the Milk River in the U.S. are primarily within the Blackfeet Indian Reservation, with a small portion in Glacier National Park. The main tributary streams are the South Fork and Middle Fork, which join in Montana to form the Milk River, and the North Fork Milk River, which joins the Milk River in Canada about 12 miles west of the Town of Milk River. The headwaters of the Milk River Basin are mostly in the foothills area, which receive modest amounts of precipitation and accumulates snow in the higher elevations.

The main stem of the Milk River, including its key tributaries (the South Fork, Middle Fork and Livermore Creeks), has a drainage area of 400 mi^2 at the Western Crossing of the International Boundary into Canada. Flows in the Milk River at the Western Crossing begin to increase in March or April with the melting of snow in the lower elevations. However, most of the flows are contributed by snow melt from higher elevations, which generally peaks in May. Flows usually drop quickly once the snow melts and the rainier spring season ends. During dry years, flows can reach zero by late August and into the fall. The recorded flow for the South Fork includes some depletions by local irrigation.

The North Fork of the Milk River has a different hydrology than the Milk River and its tributaries upstream of the Western Crossing. Overall, the North Fork produces less water than the upper Milk River, but its flow tends to be more consistent – it does not go dry during the late summer. While flows in the South Fork, Middle Fork and upper Milk River rapidly drop after the spring peak, flows in the North Fork drop gradually until August and increase slightly in the fall. In addition, the Milk River and its tributaries above the Western Crossing are generally "losing" streams while the North Fork is generally a "gaining" stream. Figure 4.6 compares the naturalized median monthly flows of the South Fork near Babb to that of the North Fork above the St. Mary Canal.

Quick Facts

- **Upstream of the Eastern Crossing into Montana, flow of the Milk River is primarily influenced by U.S. diversions from the St. Mary River. These diversions tend to stabilize flows during the irrigation season in Alberta.**
- **Downstream of the Eastern Crossing, the Milk River is significantly influenced by irrigation diversions, reservoir storage and a number of major**

North Fork, Milk River. Photo: Larry Dolan

The U.S. St. Mary Canal discharges into the North Fork of the Milk River immediately upstream of its crossing of the International Boundary into Canada. The amount of water contributed by the canal during the March through October season has been about 200,000 ac-ft, which is far greater than the natural flow of the North Fork of the Milk River, as shown in Figure 4.7. The drainage area of the North Fork of the Milk River at the International Boundary is about 92 mi^2.

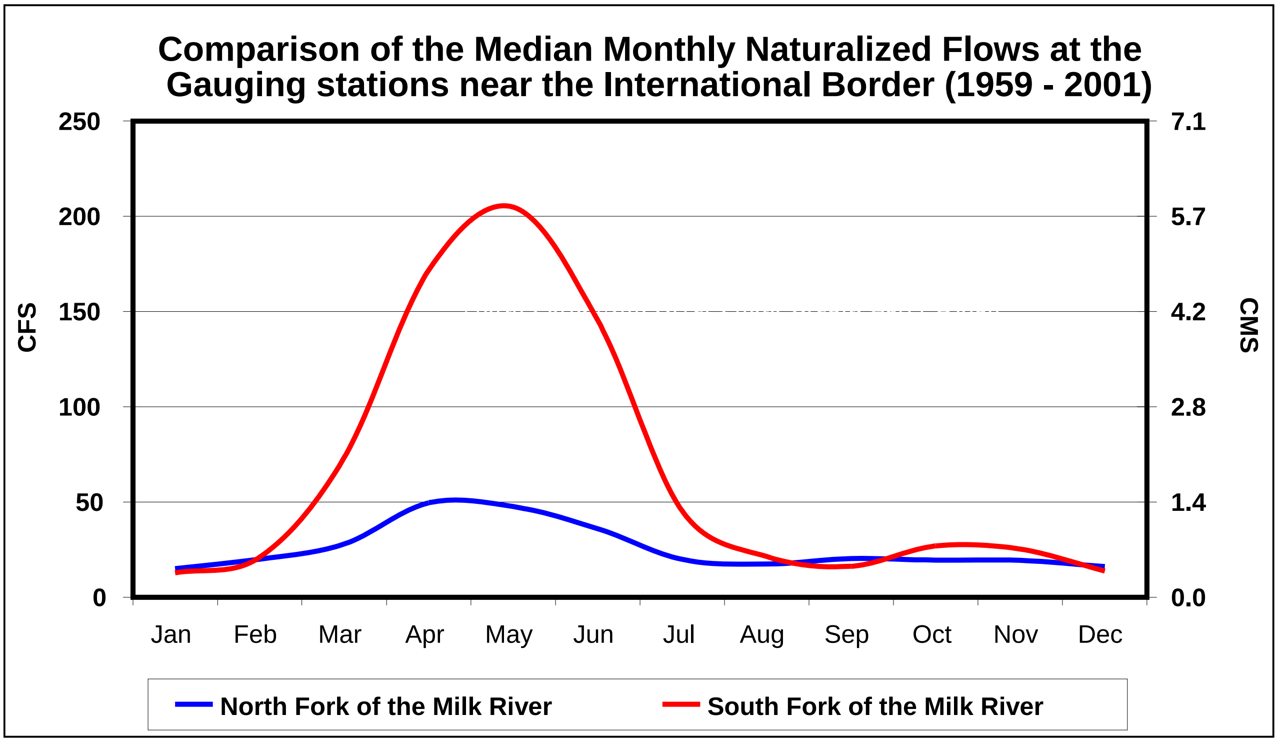

Figure 4.6 – Comparisons of Naturalized Median Monthly Flows for South Fork and North Fork of Milk River. (Data from Alberta Environment *Milk River Natural Flows 1989 Report* and *Milk River Natural Flows 2002*)

The North Fork Milk River (or North Milk) and the Milk River cross the International Boundary independently and join in Canada, about 12 miles west of the Town of Milk River. The computed mean annual natural flow volume during the 1959 to 2001 period was about 18,600 ac-ft for the North Fork at the international gauge, and about 46,900 ac-ft for the Milk River at the Western Crossing, for a total of about 65,500 ac-ft. During the same period, the mean annual natural flow volume for the Milk River at the Town of Milk River (WSC Station #11AA005) was about 73,700 ac-ft. A modest increase in runoff volume of about 8,000 ac-ft comes from the additional 559 mi^2 drainage area between the gauge at the Town of Milk River and the gauges on the Milk River and North Fork Milk River near the International Boundary.

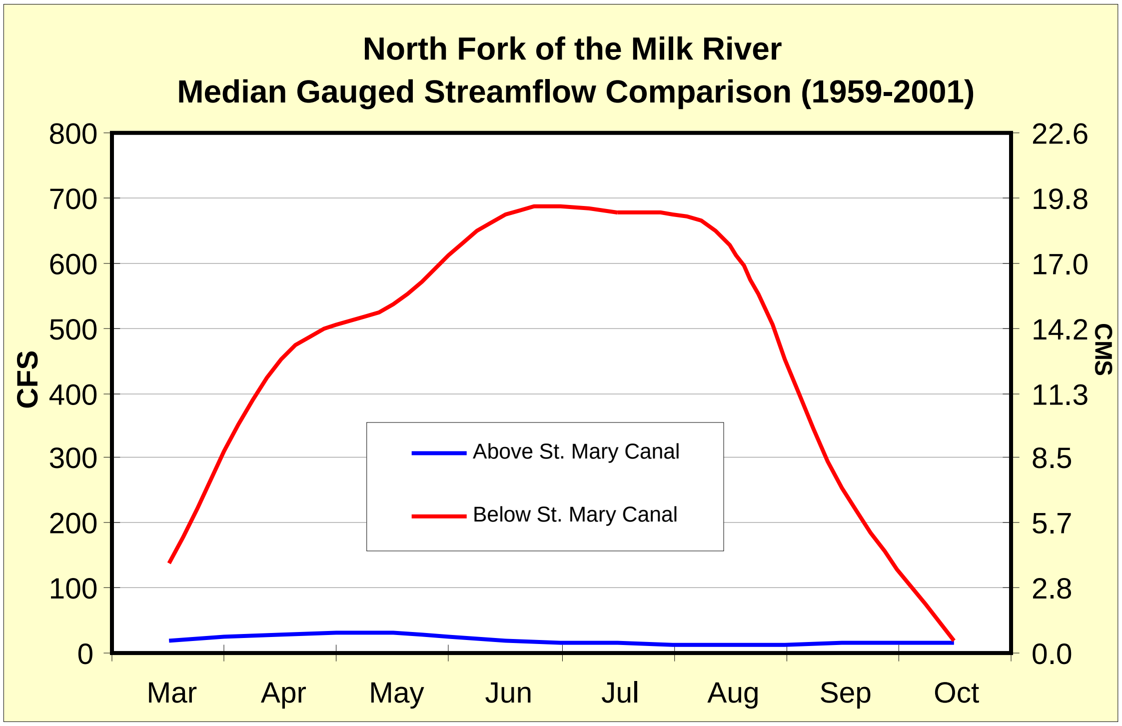

Figure 4.7 – Comparison of recorded flows for North Fork of Milk River above and below the U.S. St. Mary Canal.

From the Town of Milk River, the Milk River flows east and receives runoff from a number of small, intermittent tributaries that originate in the Sweet Grass Hills in Montana. It then swings southeast into Montana just north-west of Havre, Montana. At this "Eastern Crossing", the Milk River (excluding the landlocked Pakowki Lake Basin) has a drainage area of about 2,505 mi^2 versus 1,051 mi^2 at the Town of Milk River, a difference of 1,454 mi^2. While the drainage area increases about 139 percent from the Town of Milk River to the Eastern Crossing, the computed mean annual natural flow volume increases by only 24,400 ac-ft., about 33 percent. Figure 4.8 compares the naturalized monthly median flows for the Milk River at the Town of Milk River and the Milk River at the Eastern Crossing (1959-2001).

At its re-entry into the United States at the Eastern Crossing, the flow of the Milk River will have been influenced by: (1) additional natural inflows from the Canadian portion of the watershed and Sweet Grass Hills in Montana, (2) diversions from the St. Mary Canal and (3) upstream irrigation depletions both within Alberta and Montana. Figure 4.9 depicts gauged flows for the Milk River at the Eastern Crossing for wet, median and dry years. To demonstrate that diversions from the U.S. St. Mary Canal tend to stabilize Milk River flows during the irrigation season, Figure 4.10 compares gauged flows at the Eastern Crossing to naturalized flows for a median year.

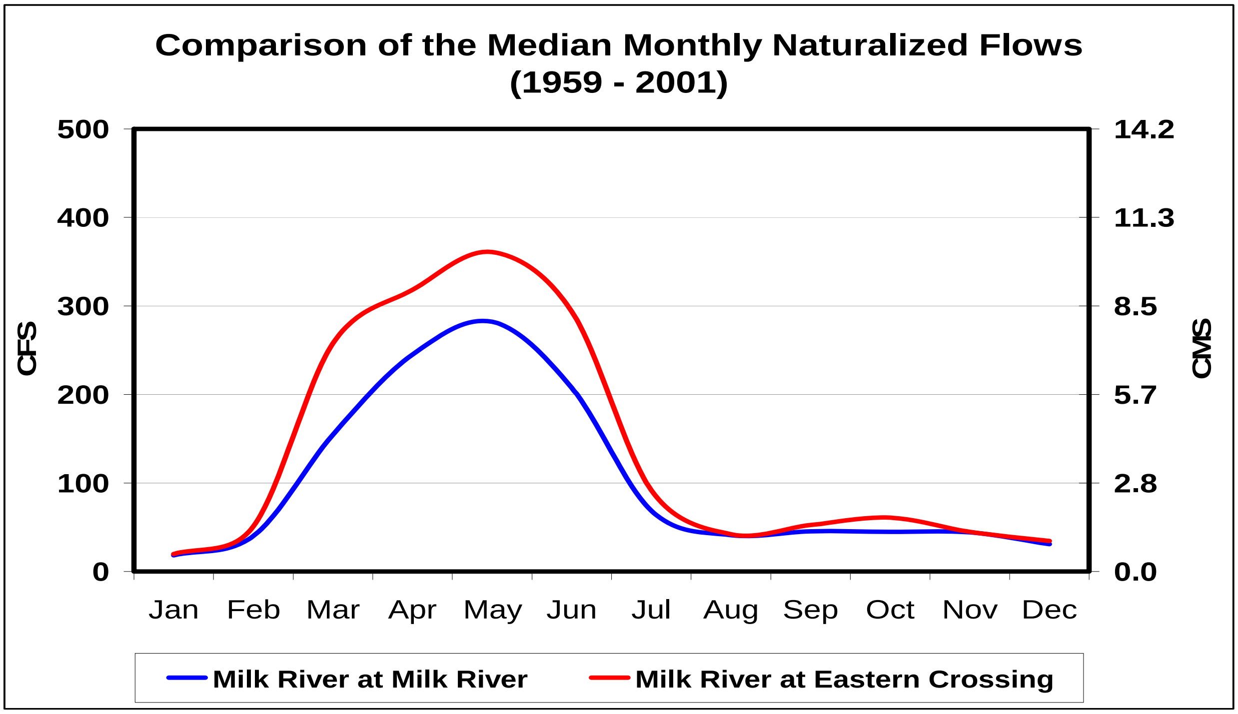

Figure 4.8 – Comparison of Median Monthly Naturalized Flows for Milk River at the Town of Milk River and at Eastern Crossing. (Data from Alberta Environment *Milk River Natural Flows 1989 Report* and *Milk River Natural Flows 2002*.)

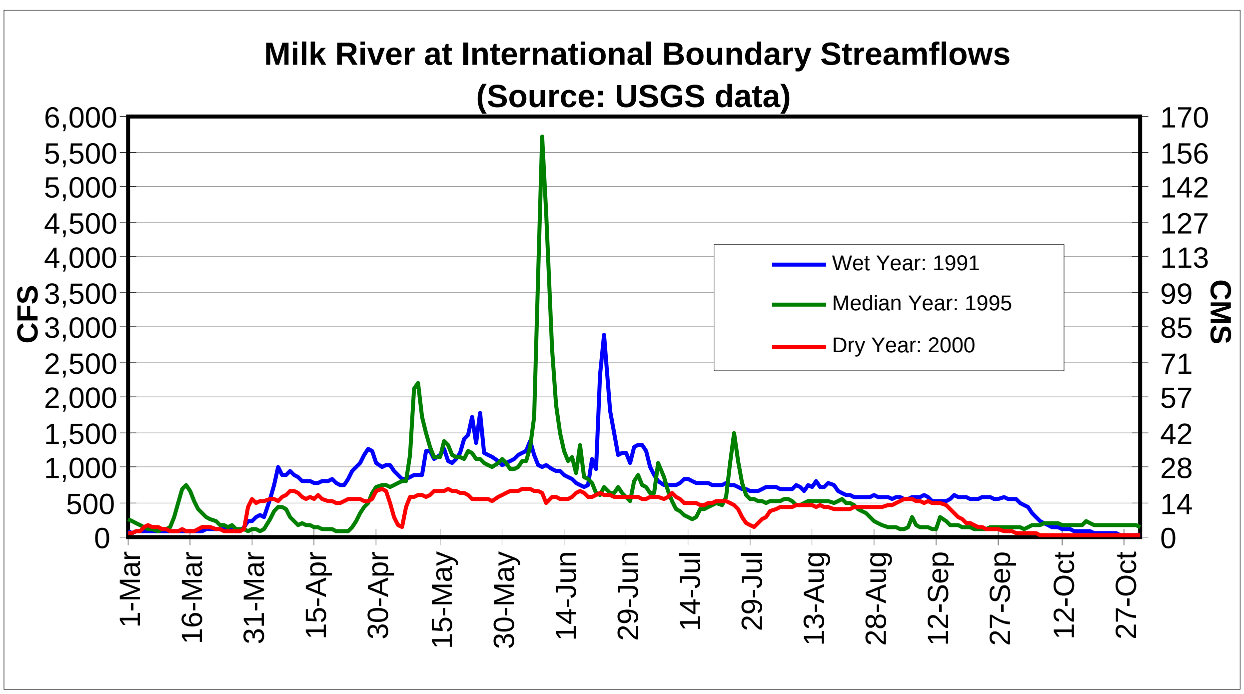

Figure 4.9 – Milk River at Eastern Crossing: Recorded Flows for a wet, median and dry year.

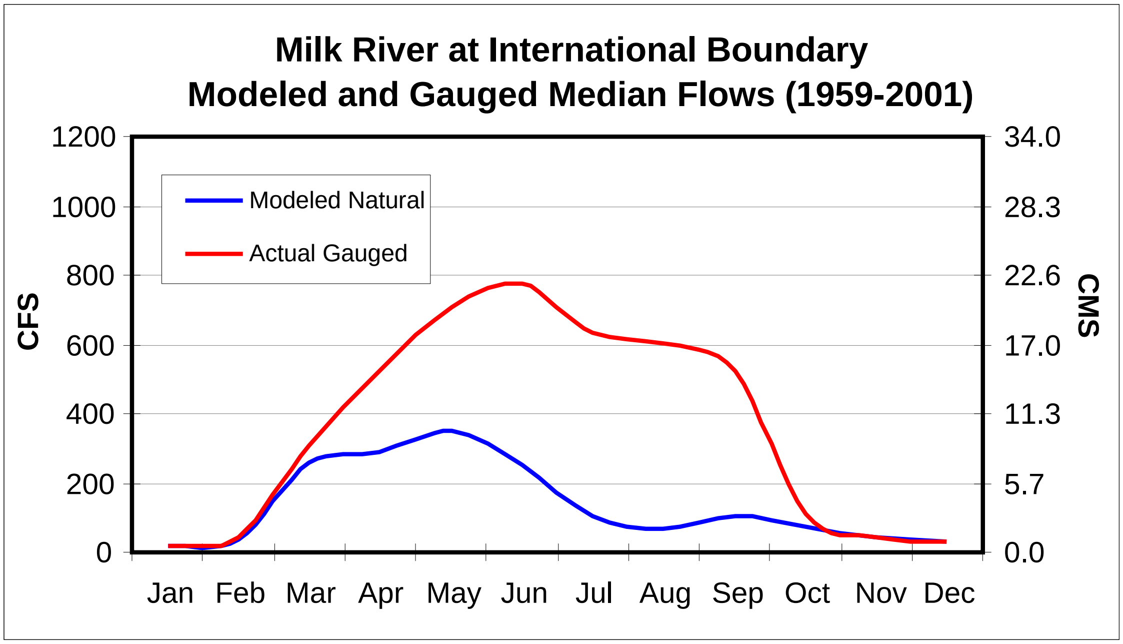

Figure 4.10 – Milk River at Eastern Crossing: Comparison of recorded (gauged) flows to naturalized flows.

Just downstream of the Eastern Crossing, the Milk River enters Fresno Reservoir. The reservoir stores water during the early season, from both Milk River natural flows and flow diverted from the St. Mary River. It then releases that water during the summer irrigation season when demand peaks. Figure 4.11 depicts recorded median flows for the Milk River below Fresno Reservoir and compares them to what median natural flows might be, without the reservoir and without St. Mary Canal diversions.

Downstream of Fresno Reservoir, the hydrology of the Milk River is affected by three key factors. First, water is supplied to about 140,000 acres of irrigation, much of which is consumed by crops. Second, flow from numerous tributaries can add water to the Milk River. Lastly, the operations of Nelson Reservoir and diversions of water to the Lake Bowdoin National Wildlife Refuge affect flows in the lower portions of the river. The effects of the operations of the dams and canals in the U.S. portion of the Milk River are discussed in more detail in Chapter 8 of this report.

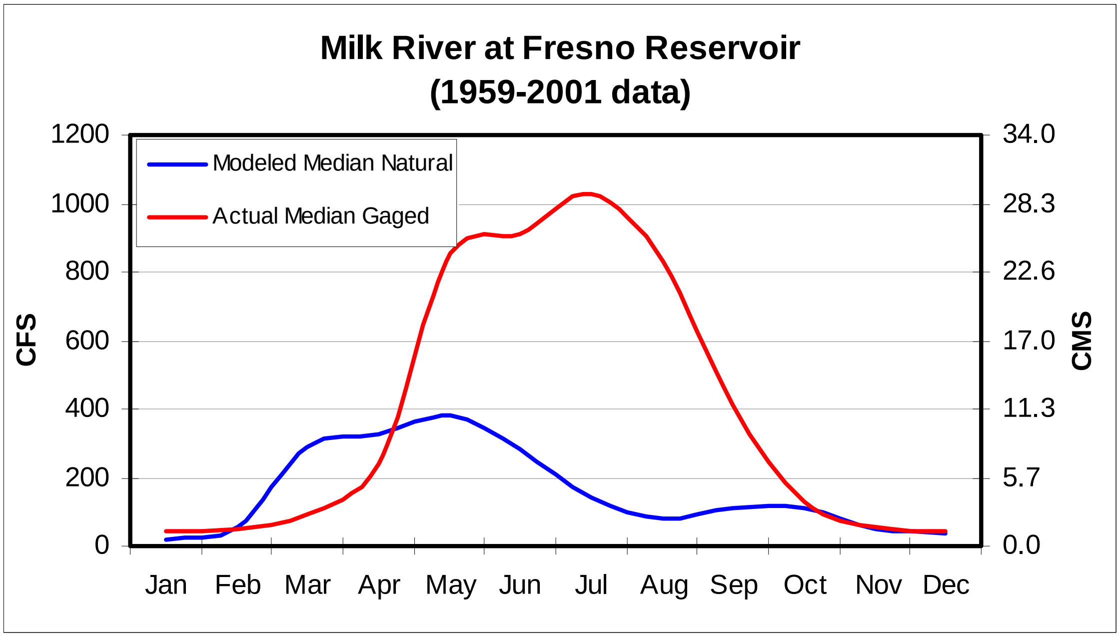

Figure 4.11 – Recorded Median Monthly Flows for the Milk River below Fresno Reservoir compared to estimated median natural flows.

> ***Quick Fact***
>
> - **Northern tributaries which arise in Canada and join the Milk River downstream of the Eastern Crossing include Lodge Creek, Battle Creek and the Frenchman River.**

Major tributaries streams that arise in Canada and enter the Milk River from the north include Lodge, Battle and Rock Creeks and the Frenchman River. Except for Rock Creek upstream of the International Boundary, there is irrigation development on these tributaries. Figure 4.12 depicts the range of monthly flows for Rock Creek near the International Boundary. This is representative of the range of variability in the natural monthly flow for most of these prairie streams. As indicated, there is high variability in monthly flows from the northern tributaries, with the highest variability occurring early in the season. This is when high snowpacks or spring rains on frozen soil can make substantial contribution to flow (the "Exceeded 20 percent of the time" line on Figure 4.12). During most years, however, these tributaries contribute little flow to the system beyond that of early summer.

The major southern tributaries to the Milk River include Big Sandy, Clear, Peoples and Beaver Creeks. Although these streams receive some runoff contributions from the mid-elevation Bear Paw and Little Rocky mountains, their variability in monthly flows patterns are similar to those of the northern tributaries. Figure 4.13 for Peoples Creek near Hayes, which has some upstream irrigation, provides an example. During wetter years, the flow contributions of these southern tributary streams can be modest through mid-summer. During drier years, their contributions generally are minimal.

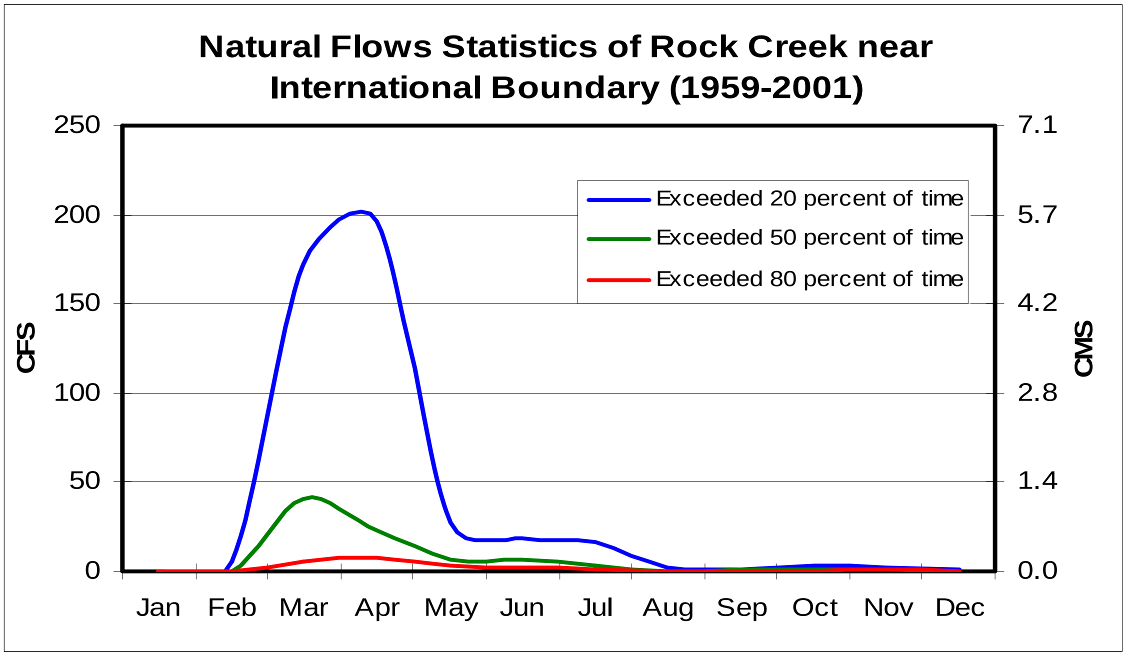

Figure 4.12 – Recorded monthly flow for Rock Creek, near the International Boundary.

The influence of tributary inflows, irrigation depletions and reservoir operations are reflected in the hydrology of the lower Milk River near its mouth at Nashua (Figure 4.14). Contributions of the northern and southern tributaries are especially apparent during wetter years (the line labeled "Exceeded 20 percent of the time"). This is because the drainage area of the Milk River has increased from 2,500 mi^2 at the Eastern Crossing of the International Boundary to about 23,000 mi^2 at its confluence with the Missouri River. All this extra area can add water to the river when there is enough precipitation.

The stabilizing effects of releases from Fresno Reservoir and imported St. Mary River water on summer flows can be seen in the "Exceeded 50 percent of the time" or median flow line in Figure 4.14. During drier years (the line "Exceeded 80 percent of the time"), most of the available water in the river system is consumed and flows at Nashua are low throughout the season. Actual streamflows for the Milk River at Nashua during representative wet, median and dry years are shown in Figure 4.15.

Quick Facts

- **Major southern tributaries of the Milk River include Big Sandy, Clear, Peoples, and Beaver Creeks, which are entirely in Montana.**
- **Tributaries make a significant contribution to Milk River flows in wet years but may be minimal in dry years.**

Water from the St. Mary Canal, and Fresno and Nelson Reservoirs stabilizes late irrigation season flows in the lower Milk River. However, much of this released water and imported St. Mary River water is consumed by irrigated crops. Figure 4.16 depicts drier-year recorded flows of the Milk River at Havre compared to those for the lower river near Nashua. During drier years, April through August releases from Fresno Reservoir, including the water added by the St. Mary Canal, are for the most part consumed before reaching the lower river. Additional statistics on stream flows for stations in the Milk River Basin are presented in Appendix C.

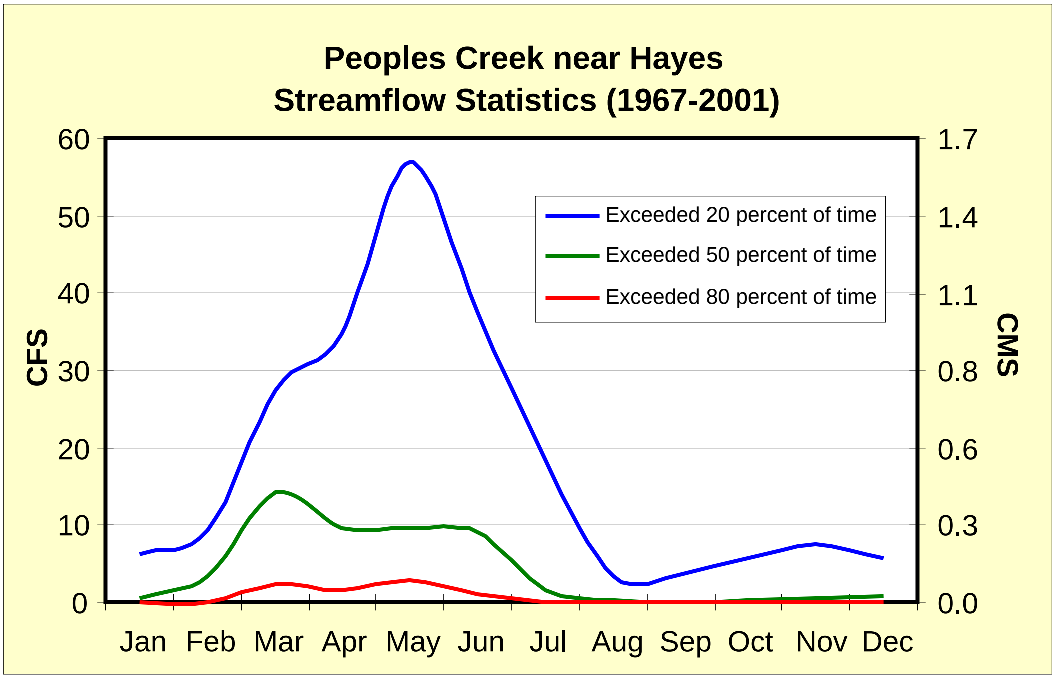

Figure 4.13 – Characteristics of recorded monthly flows for Peoples Creek (a southern tributary to the Milk River) near Hayes.

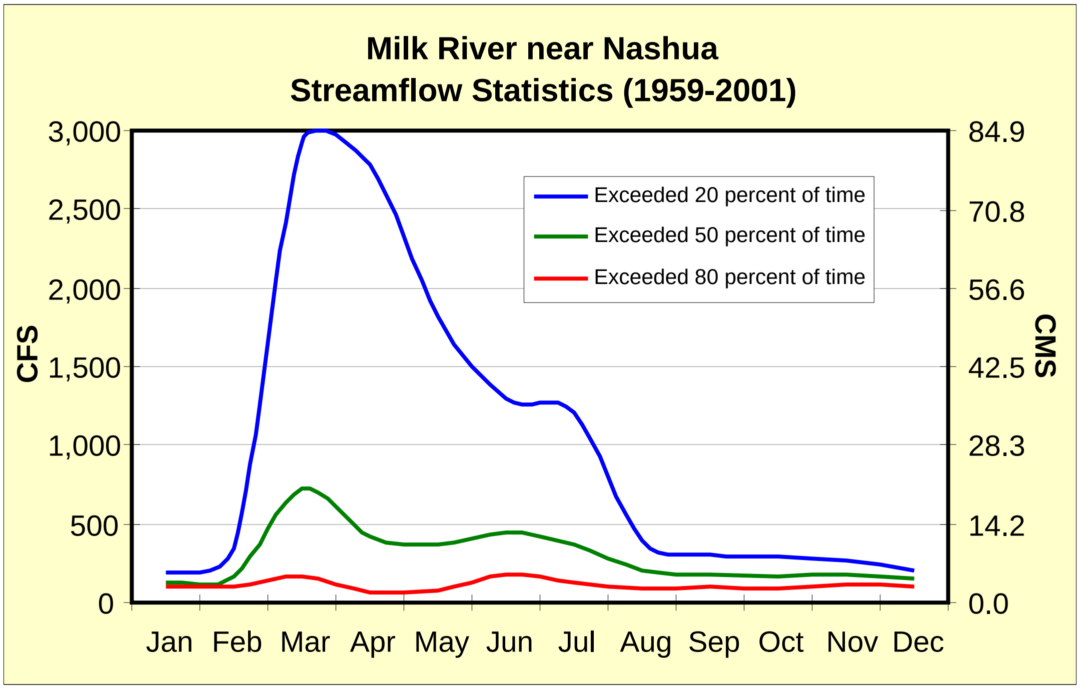

Figure 4.14 – Characteristics of recorded monthly flows for the Milk River near Nashua.

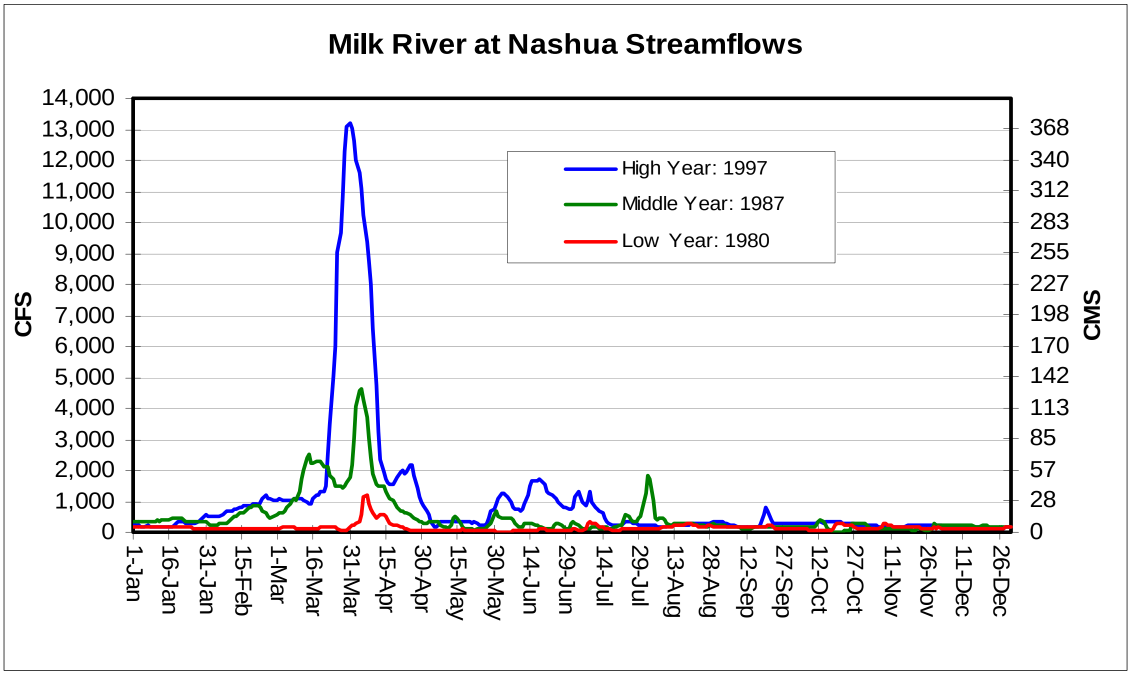

Figure 4.15 – Milk River at Nashua recorded streamflows for a wet, median and dry year.

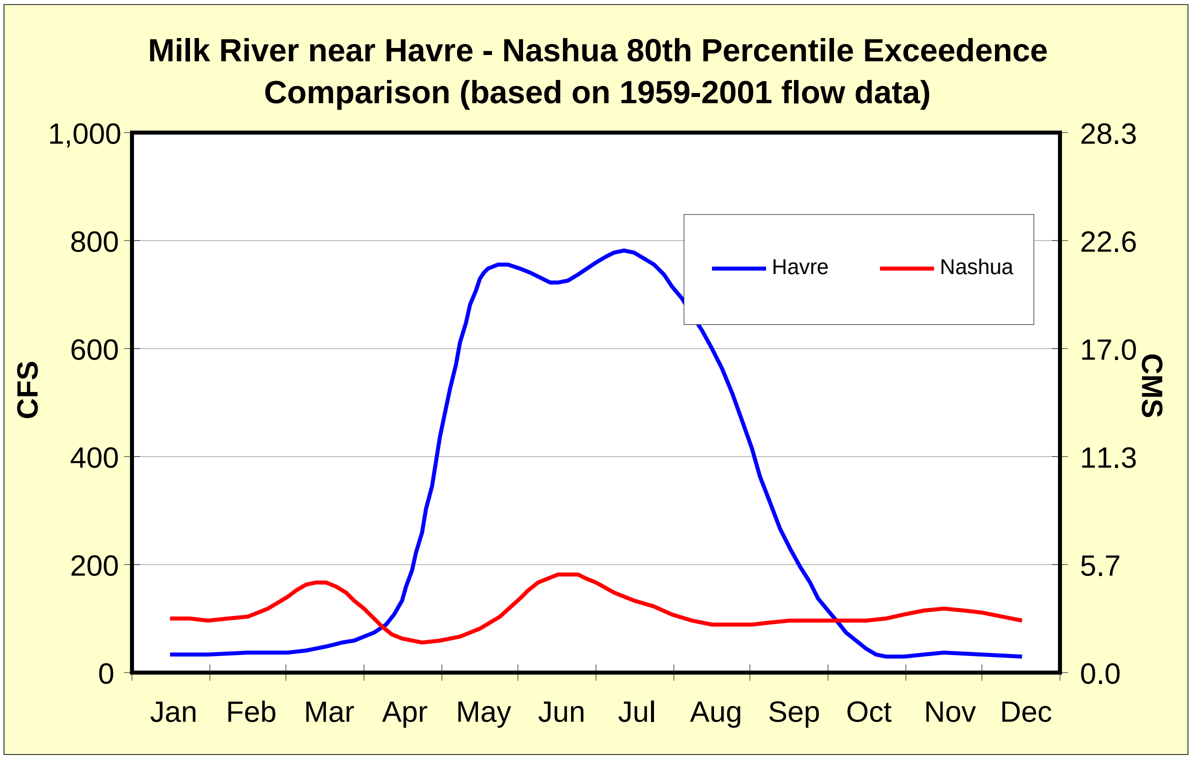

Figure 4.16 – Comparison of upper and lower Milk River drier year recorded flows.

5.0 Agreements and Compacts

Mike Dailey, Hydrologist, Montana Department of Natural Resources and Conservation
Larry Dolan, Hydrologist, Montana Department of Natural Resources and Conservation
Sal Figliuzzi, P.Eng. Section Head, Transboundary Water Policy, Alberta Environment

Management of the Milk and St. Mary Rivers is guided by several agreements and compacts that may ultimately influence any future arrangements. This chapter provides an understanding of the working of these agreements. As such, it discusses the *1909 Boundary Waters Treaty* and the *1921 Order of the International Joint Commission*. It also provides an overview of the processes for administering apportionment. Each jurisdiction also has a number of other local and regional agreements and compacts outside the *1909 Boundary Waters Treaty*.

5.1 International Agreements

Quick Facts

- **The sharing of the waters of the Milk and St. Mary Rivers is governed by Article VI of the *1909 Boundary Waters Treaty*.**
- **The International Joint Commission is the body that oversees the Treaty.**

Management of the Milk and St. Mary Rivers on both sides of the International Boundary has long been guided by agreements and working relationships between Canada and the United States (U.S.).

5.1.1 1909 Boundary Waters Treaty

In September 1885, a resolution was passed by the International Irrigation Congress of the United States at its meeting at Albuquerque, New Mexico asking:

"…for the appointment of an International Commission to act in conjunction with the authorities of Mexico and Canada adjudicating the conflicting rights which have arisen, or may hereafter arise, on streams of an international character…"

In 1909, after many years of negotiations and partial construction of offsetting diversion canals, Canada and the U.S. signed the *Boundary Waters Treaty.* This agreement provided the principles and mechanisms for preventing and resolving disputes concerning water quantity and quality for:

> *"Waters from main shore to main shore of the lakes and rivers and connecting waterways…along which the international boundary between the United States and the Dominion of Canada passes…"*

Among other things, the Treaty established the International Joint Commission:

> *"…composed of six commissioners, three on the part of the United States… three from the Dominion of Canada…to examine and report upon the facts and circumstances of particular*

questions any matters referred, together with such conclusions and recommendations as may be appropriate."

Article VI of the Treaty deals specifically with the St. Mary and Milk Rivers as follows:

ARTICLE VI

The High Contracting Parties agree that the St. Mary and Milk Rivers and their tributaries (in the State of Montana and the Provinces of Alberta and Saskatchewan) are to be treated as one stream for the purposes of irrigation and power, and the waters thereof shall be apportioned equally between the two countries, but in making such equal apportionment more than half may be taken from one river and less than half from the other by either country so as to afford a more beneficial use to each. It is further agreed that in the division of such waters during the irrigation season, between the 1st of April and 31st of October, inclusive, annually, the United States is entitled to a prior appropriation of 500 cubic feet per second of the waters of the Milk River, or so much of such amount as constitutes three-fourths of its natural flow, and that Canada is entitled to a prior appropriation of 500 cubic feet per second of the flow of St. Mary River, or so much of such amount as constitutes three-fourths of its natural flow.

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. The provisions of Article II of this treaty shall apply to any injury resulting to property in Canada from the conveyance of such waters through the Milk River.

The measurement and apportionment of the water to be used by each country shall from time to time be made jointly by the properly constituted reclamation officers of the United States and the properly constituted irrigation officers of His Majesty under the direction of the International Joint Commission.

5.1.2 1921 Order of the International Joint Commission

After the signing of the Treaty, neither Country could agree on the exact meaning of the treaty nor how it was to be implemented. Hence, the matter was referred to the International Joint Commission (IJC). Canada's position on the two primary issues was that:

- Prior appropriations, which represented each country's use prior to the signing of the Treaty, should be taken first, prior to the balance of the flow being shared equally, and
- The calculation of each country's share of the flow should be based on the flow at the mouth of the two rivers (i.e. where the Milk River joins the Missouri River and where the St. Mary joins the Oldman River).

Quick Facts

- **In 1921, the International Joint Commission issued the *1921 Order* which specifies how the St. Mary and Milk Rivers are to be apportioned.**
- **The IJC representatives who drafted the 1921 Order were aware that it would result in Canada receiving a greater proportion of the combined flow of the rivers.**

The United State's position being that:

- Prior appropriations should be included in the equal sharing, and
- The calculation of each country's share of the flow should be based on the flow at the International Boundary for the two rivers (i.e. where the St. Mary River flows north across the International Boundary, and the Milk River at the Eastern Crossing of the International Boundary).

As the two countries could not resolve the issue, the matter was referred to the IJC. To examine the issue, the IJC conducted hearings across Canada and the United States from 1915 to 1921 to gather information. At the same time, they also conducted a complete review of all correspondence made during Treaty negotiations in order to reconstruct the intent of the Treaty. Each year during this period, the IJC issued an Order outlining how the waters of the Milk and St. Mary Rivers were to be shared between Canada and the U.S.

In 1921, after more than six years of hearings and a reconstruction of intent, the IJC reached a consensus decision and issued what has come to be known as the "*1921 Order*" on the measurement and apportionment of the water of the St. Mary and Milk Rivers. The opposite page provides a summary of the 1921 Order. A complete copy of the Order and associated recommendations of the IJC is provided in Appendix D. The rules respecting the apportionment of the flow of the St. Mary River is shown graphically in Figure 5.1. The rules respecting the apportionment of the flow of the Milk River is shown graphically in Figure 5.2.

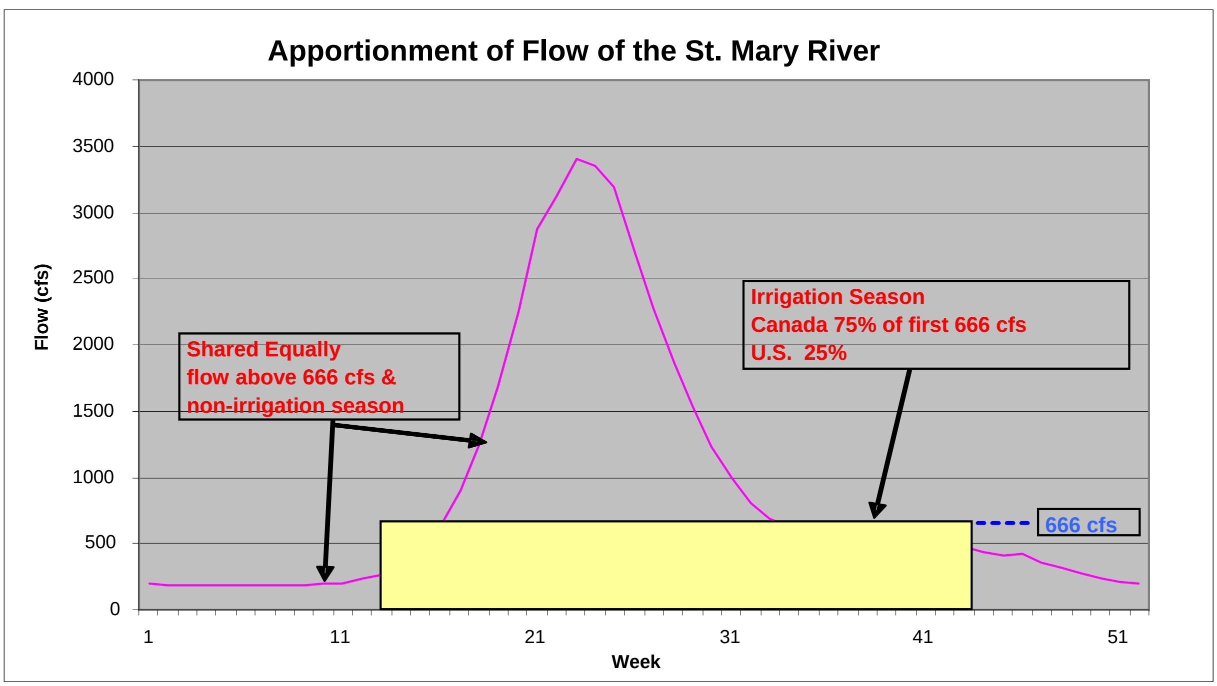

Figure 5.1 – Rules for apportionment of flow of the St. Mary River at the International Boundary.

SUMMARY OF 1921 ORDER

St. Mary River
During April 1 to October 31 Irrigation Season when the natural flow of the St Mary River at the International Boundary is 666 cubic feet per second (cfs) or less, Canada shall be entitled to 75% of the flow of the St. Mary River and the U.S. to 25%.

During April 1 to October 31 Irrigation Season when the natural flow of the St Mary River at the International Boundary is more than 666 cubic feet per second (cfs), Canada is entitled to a prior appropriation of 500 cfs of the first 666 cfs, and any flow above 666 cfs shall be divided equally between Canada and the U.S.

During the non-irrigation season the natural flow of the St. Mary River at the International Boundary shall be divided equally between Canada and the U.S.

Milk River
During April 1 to October 31 Irrigation Season when the natural flow of the Milk River at the Eastern Crossing of International Boundary is 666 cubic feet per second (cfs) or less, the U.S. shall be entitled to 75% of the flow of the Milk River and Canada to 25%.

During April 1 to October 31 Irrigation Season when the natural flow of the Milk River at the Eastern Crossing of the International Boundary is more than 666 cubic feet per second (cfs), the U.S. is entitled to a prior appropriation of 500 cfs of the first 666 cfs, and any flow above 666 cfs shall be divided equally between the U.S. and Canada.

During the non-irrigation season, the natural flow of the Milk River at the Eastern Crossing of the International Boundary shall be divided equally between the U.S. and Canada.

Eastern Tributaries of the Milk River (Lodge Creek, Battle Creek and Frenchman River)
The natural flow of the eastern tributaries of the Milk River, at the points where they cross the International Boundary, shall be divided equally between the United States and Canada.

Water Not Naturally Crossing the International Boundary
Each Country shall be apportioned such waters of the St. Mary and Milk Rivers and of any tributaries that rise in that country, but do not flow across the International Boundary.

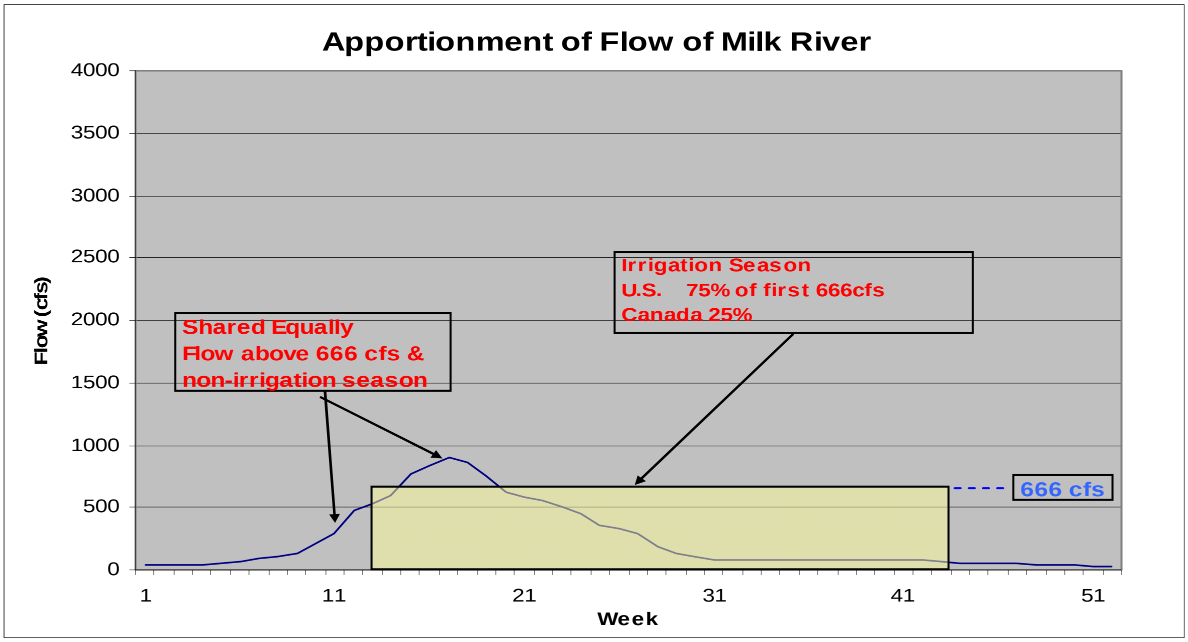

Figure 5.2 – Rules for apportionment of the flow of the Milk River at the International Boundary.

As the Treaty and the Order allocate a prior appropriation to Canada on the St. Mary River and to the U.S. on the Milk River, Canada receives a greater proportion of the flow of the St. Mary River. The United States receives a greater proportion of the flow of the Milk River (See Figures 5.3 and 5.4 based on 1912-2002 data). As indicated, prior appropriation becomes an increasingly greater proportion of the natural flow during dryer years.

Further, as the St. Mary River has flows that are near or above the 666 cfs prior appropriation level for a longer duration than the Milk River, Canada ends up being entitled to a greater proportion of the total combined flow (54.5%) of the St. Mary, Milk and eastern tributaries. The differential is greater during dry years as indicated in Figure 5.5. The IJC representatives who drafted the 1921 Order were aware that the Order would result in Canada receiving a greater proportion of the combined flow of the rivers.

St. Mary Dam and Reservoir. Photo: Government of Alberta

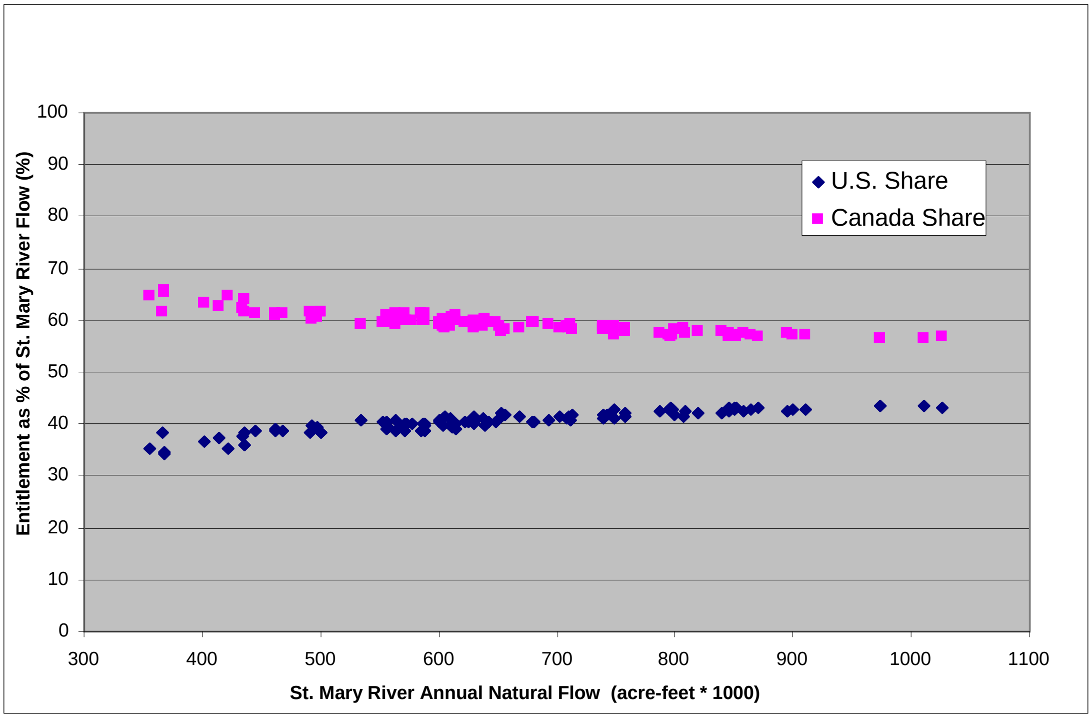

Figure 5.3 – U.S. and Canada entitlements as a percent of the natural flow of the St. Mary River at the International Boundary.

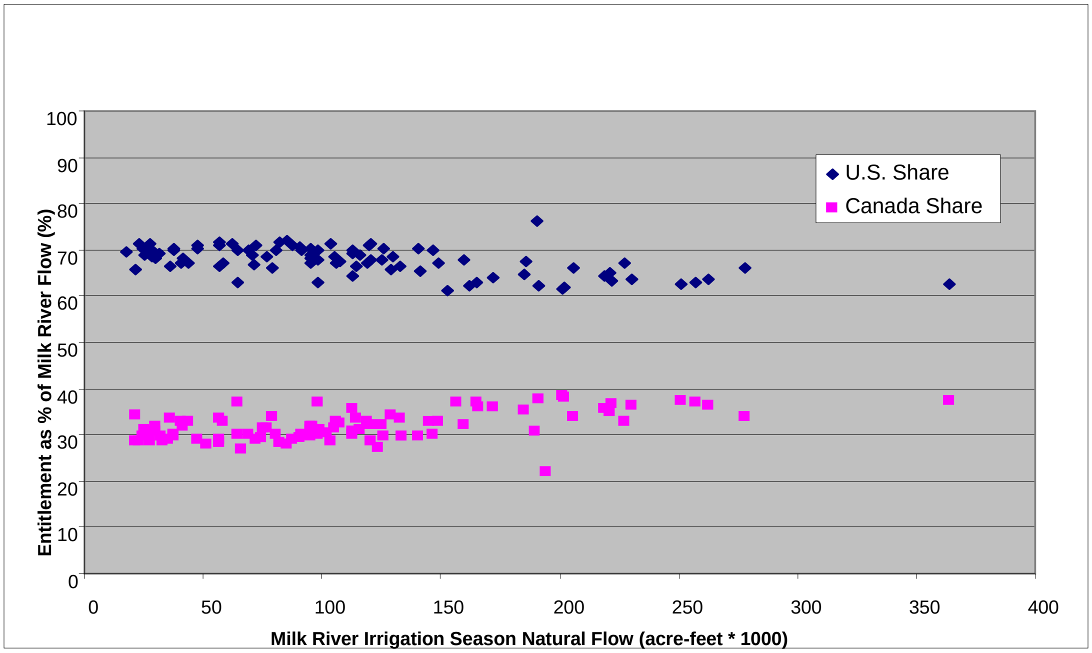

Figure 5.4 – U.S. and Canada entitlements as a percent of the natural flow of the Milk River at the International Boundary.

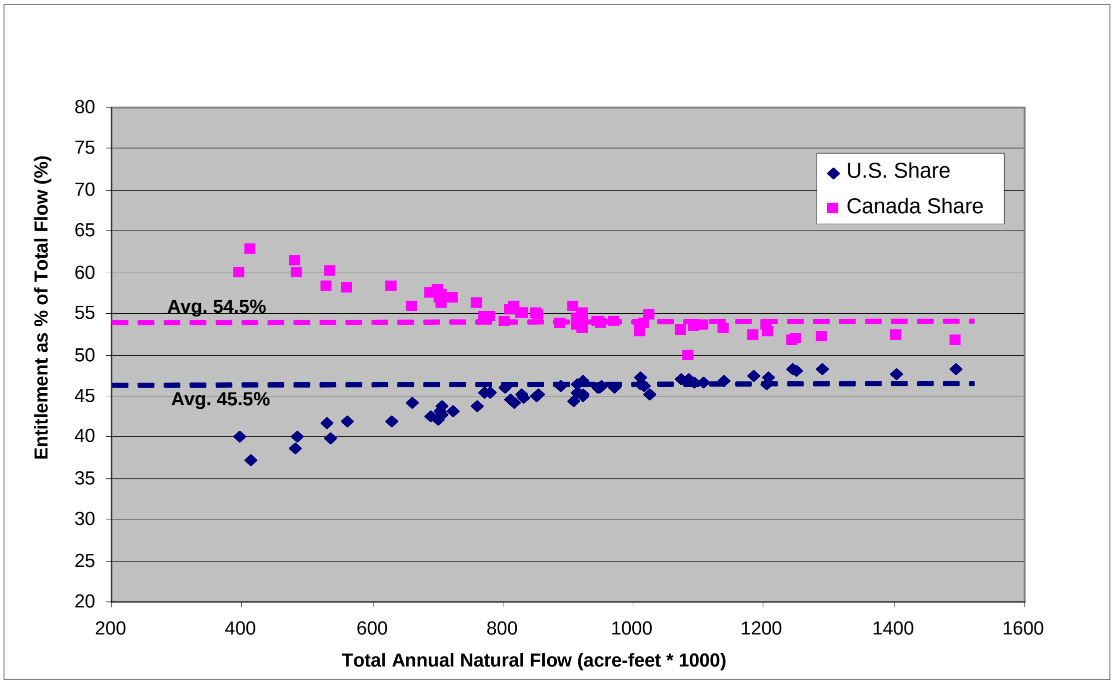

Figure 5.5 – U.S. and Canada entitlements as a percent of the total natural flow at the International Boundary (including the St. Mary, Milk, and Frenchman Rivers and Battle and Lodge Creeks).

The 1921 Order provides detailed information as to how the water of the St. Mary River, the Milk River at the Eastern Crossing, and the eastern tributaries are to be measured and apportioned. However, the 1921 Order does not address the following issues:

1. What, if any, of the natural flow of the South Fork of the Milk River the U.S. is required to deliver to Canada;
2. What, if any, of the natural flow of the southern tributaries (Police Creek, Breed Creek, Bear Creek, Miners Creek) which originate in the U.S. but join the Milk upstream of the Eastern Crossing, is the U.S. required to deliver to Canada; and
3. How are the waters of Lee Creek, a tributary of the St. Mary which crosses the International Boundary independently prior to joining the St. Mary River in Canada, to be shared?

5.1.3 Apportionment Procedures for the Milk and St. Mary Rivers

The computation of Canadian and U.S. entitlements of the flow of the St. Mary River, Milk River and eastern tributaries is administered by the Reclamation and Irrigation Officers (now the Accredited Officers) of the United States and Canada. The monitoring and daily computations of natural flow and entitlements are carried out by the Field Officers and their field staff (Environment Canada and the United States Geological Survey).

Each country's entitlements under the Treaty are based on the natural flow at the International Boundary. However, the actual/observed flow at the boundary has been modified by upstream human activities (storage, diversion, etc.). Thus, it is necessary to compute the natural flow by mathematically removing the effects of upstream human activities prior to determining each country's entitlements.

The procedures, assumptions and approximations used in determining the natural flow have evolved over time. This is in response to factors such as improved measurement technology, better access to monitoring sites and a greater understanding of basin hydrology. Changes to the procedures must always be approved both by the Field Representatives and the Accredited Officers of both the U.S. and Canada. These procedures are documented in a Procedures Manual maintained by Field Officers.

Quick Facts

- **Each country's entitlements under the Treaty are based on the natural flow at the International Boundary.**
- **Each jurisdiction's portion of the shared water is computed daily and balanced bi-monthly.**

St. Mary River Natural Flow Computation

The IJC Field Officer computes the daily natural flows for the St. Mary River at the International Boundary for the period during which the U.S. St. Mary Canal is operational, generally March 1 to October 31. The procedures used for the computations of the natural flows are as follows:

$$QNix(t) = QRix(t)+QRusc(t)+\Delta Sls(t-1)$$

Where **QNix(t)** = the naturalized mean daily flow for the St. Mary River at the International Boundary on day "t",

QRix(t) = the recorded mean daily flow for the St. Mary River at the International Boundary (USGS St. # 5020500) on day "t",

QRusc(t)= the recorded mean daily flow for the U.S. St. Mary Canal at St. Mary Crossing (USGS St. # 5018500) on day "t", and

ΔSls(t-1)= the daily change in storage for Lake Sherburne Reservoir (USGS St. # 5015500) on day "t-1".

Figure 5.6 shows the location of the monitoring sites used in the computation of natural flows for the St Mary River. Table 5.1 shows the natural flow and apportionment computation for the St. Mary River for June 1-15, 2008 period. As indicated in columns 5 and 6, the flow of the St. Mary River can vary significantly over a relatively short period.

In the early days of apportionment, a considerable period of time was required to travel to the monitoring sites, monitor the flow and compute the natural flow. Computations were then relayed to the appropriate water managers in Canada and the U.S. who would regulate the diversion to ensure apportionment was being met. As the time requirements for all of these activities made it impossible to manage apportionment on a daily basis, a practice was developed in which apportionment was computed on a daily basis but was balanced twice monthly (the 15th and end of each month). The bimonthly balancing period also provides operational flexibility by allowing deficits to be carried over and made up during the next balancing period.

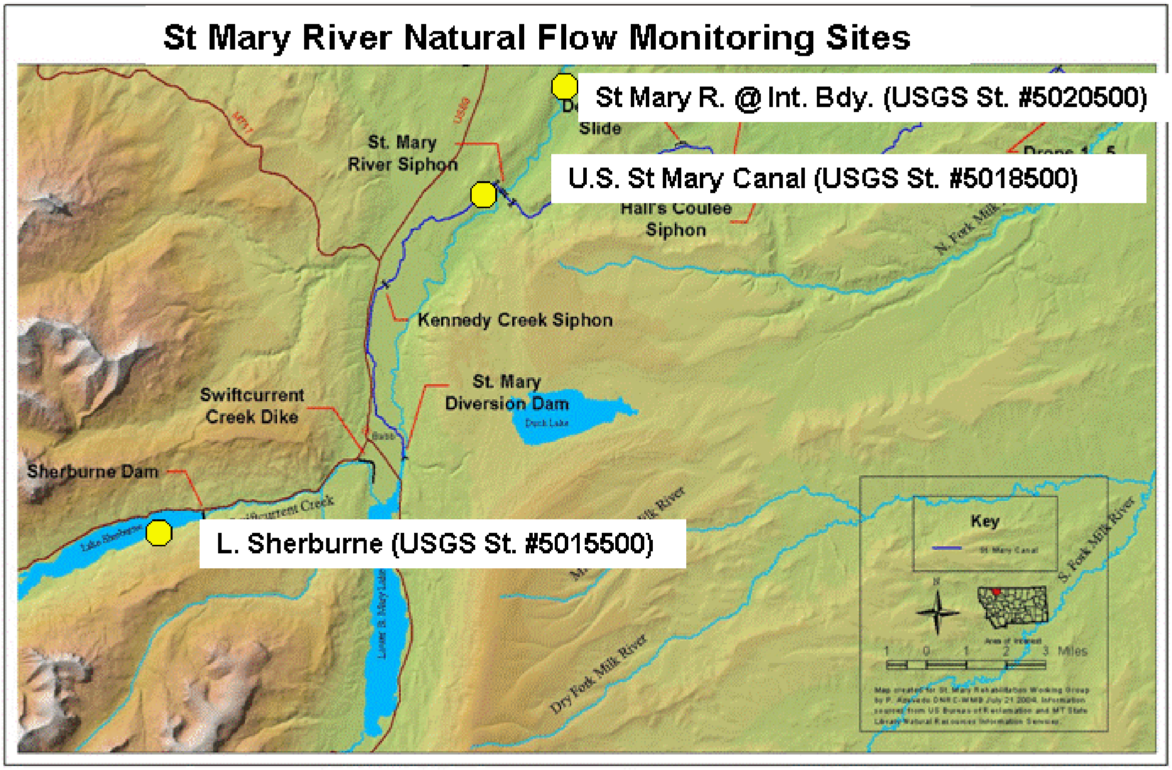

Figure 5.6 – Location of monitoring sites in St. Mary River natural flow computation.

Quick Facts

- **Bimonthly balancing provides flexibility by allowing deficits to be carried over and made up during the next balancing period.**
- **Surpluses can be applied against deficits in the previous period but cannot be carried forward to offset future deficits.**

Today's technology would permit more frequent balancing. However, it would require significantly more manpower. Hence, the practice of computing balances twice monthly continues.

The last column in Table 5.1 shows the daily surplus/deficit deliveries as well as the balance (896 cfs-days) for the period. This surplus can be applied against deficit deliveries in the previous balancing period [June16-30, 2008]. It cannot be carried forward to offset future deficits. Table 5.2 shows the apportionment summary for the March 1-June 15 2008 period.

Table 5.1 – June 1-15, 2008 Natural flow and entitlement computation for St. Mary River at the International Boundary.

INT-1C NATURAL FLOW AND WATER DIVISION OF ST. MARY RIVER AT INTERNATIONAL BOUNDARY ***PROVISIONAL***
JUNE 2008
QUANTITIES IN CFS-DAYS

DAY	CHANGE IN CONTENTS OF LAKE SHERBURNE (WITH 1 DAY LAG)	DIVERTED BY ST. MARY CANAL	TOTAL USED BY UNITED STATES	ST.MARY RIVER AT INTERNATIONAL BOUNDARY	NATURAL FLOW AT INTERNATIONAL BOUNDARY	SHARES OF NATURAL FLOW UNITED STATES	SHARES OF NATURAL FLOW CANADA	FLOW IN EXCESS OR DEFICIT (-) OF CANADIAN SHARE
1	966	640	1606	2290	3896	1781	2115	175
2	1030	652	1682	2330	4012	1839	2173	157
3	906	648	1554	2270	3824	1745	2079	191
4	820	646	1466	2080	3546	1606	1940	140
5	754	642	1396	1840	3236	1451	1785	55
6	662	638	1300	1660	2960	1313	1647	13
7	750	631	1381	1500	2881	1274	1607	-107
8	550	627	1177	1350	2527	1097	1430	-80
9	561	621	1182	1160	2342	1004	1338	-178
10	424	618	1042	1050	2092	879	1213	-163
11	494	652	1146	1880	3026	1346	1680	200
12	635	588	1223	2390	3613	1640	1973	417
13	704	563	1267	1870	3137	1402	1735	135
14	631	624	1255	1650	2905	1286	1619	31
15	793	623	1416	1570	2986	1326	1660	-90
S.TOTAL	10680	9413	20093	26890	46983	20989	25994	896
MEAN	712	628	1340	1793	3132	1399	1733	59.7
AC/FT	21184	18671	39854	53336	93191	41632	51559	1777
16	845	0	845	0	845	256	589	-589
17	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0
S.TOTAL	845	0	845	0	845	256	589	-589
MEAN	56.3	0.0	56.3	0.0	56.3	17.1	39.3	-39.3
AC/FT	1676	0.0	1676	0.0	1676	508	1168	-1168
TOTAL	11525	9413	20938	26890	47828	21245	26583	307
MEAN	384	314	698	896	1594	708	886	10.2
AC/FT	22860	18671	41531	53336	94867	42139	52727	609

Computed by: nam Date: 16-Jun-08

Table 5.2 – St. Mary River apportionment summary.

SUMMARY OF ST. MARY RIVER DIVISION FOR 2008* QUANTITIES IN CFS-DAYS

DIVISION PERIOD AT INTERNATIONAL BOUNDARY	NATURAL FLOW	CANADA'S SHARE	RECEIVED BY CANADA	RECEIVED BY CANADA		*DEFICIT TO DATE
				ABOVE SHARE	BELOW SHARE	
MAR 1 - MAR 15	1,848	924	1,573	649		0
MAR 16 - MAR 31	1,560	780	1,420	640		1
APR 1 - APR 15	1,321	991	1,615	624		0
APR 16 - APR 30	4,724	3,544	1,836		1,708	1,708
MAY 1 - MAY 15	12,673	8,683	5,693		2,990	4,698
MAY 16 - MAY 31	60,300	32,818	38,708	5,890		4,000
JUNE 1 - JUNE 15	46,983	25,944	26,890	946		3,054
JUNE 16 - JUNE 30	45,451	25,227	29,710	4,483		2,000
JULY 1 - JULY 15				0		2,000
JULY 16 - JULY 31				0		2,000
AUG 1 - AUG 15				0		2,000
AUG 16 - AUG 31				0		2,000
SEP 1 - SEP 15				0		2,000
SEP 16 - SEP 30				0		2,000
OCT 1 - OCT 15				0		2,000
OCT 16 - OCT 31				0		2,000
TOTAL	174,860	98,911	107,445			

* Letter of Intent allows for a deficit up to 4,000 cfs-days between March 1 and May 31 which may be reduced to no less then 2,000 cfs-days between June 1 and July 15. No refunds will count against deficit until September 16.

Figure 5.7 shows the location of the monitoring sites used in the computation of natural flows for the Milk River. Table 5.3 shows the natural flow and apportionment computation for the Milk River for the June 1-15, and June 16-30, 2008 periods. As indicated in columns 9 and 10, the U.S. and Canadian consumptive use is constant throughout each balancing period. This is because until recently, it was not being measured. Rather it was estimated based on a water use survey conducted in the early 1990s. Table 5.3 also indicates that in September 2008, as in most years during the late summer and early fall, the U.S. diversions account for nearly all of the flow in the Milk River.

Milk River Natural Flow Computation

As the recorded flow for the Milk River at the Eastern Crossing of the International Boundary is significantly modified from a natural state due to U.S. St. Mary Canal diversions into the river and upstream irrigation in the U.S. and Canada, procedures have been developed over time to estimate the natural, or apportionable flow, for the Milk River at the Eastern Crossing. The formula used today is as follows:

$$QN_{ec\,(t)} = QN_{wc(t-4)} + N\Delta Q_{wec} + Et_e + CU_{us} + CU_{can}$$

Where QN_{ec} = the natural daily mean discharge of the Milk River at the Eastern Crossing for day "t",

QN_{wc} = the natural daily mean discharge of the Milk River at the Western Crossing (computed as the sum of the recorded daily mean discharge of 11AA032 and 11AA025) at time "t-4" days (t-4 days is used to adjust for water travel time),

$N\Delta Q_{wec}$ = the net change in flow between the Eastern and Western Crossings (computed as the recorded daily mean discharge at the Eastern Crossing [11AA031] minus the total recorded daily mean discharge at the Western Crossing [11AA001+11AA025] at time "t-4" days,

Et_e = Evaporation losses above natural due to the St. Mary Canal water in the river, and

$CU_{us\text{-}can}$ = net consumptive uses in the basin (uses-additions).

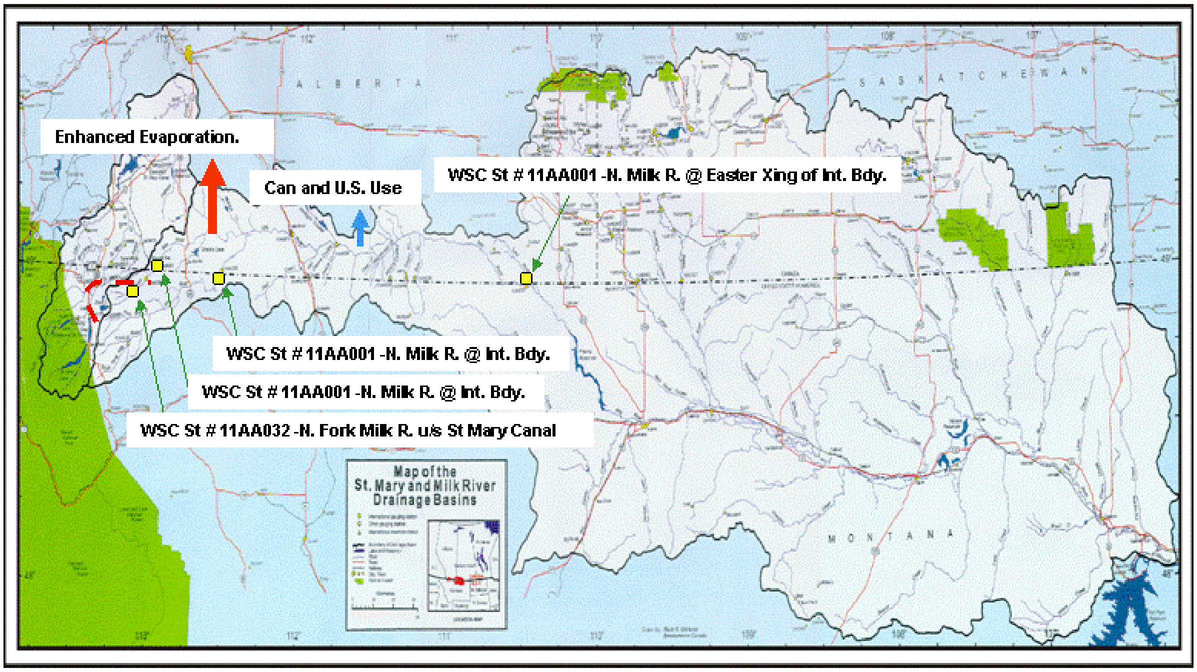

Figure 5.7 – Location of monitoring sites for the Milk River natural flow computation.

Table 5.3 – June 1-15 & 16-30 Natural flow and entitlement computation for Milk River at International Boundary.

PROVISIONAL

NATURAL FLOW OF MILK RIVER AT EASTERN CROSSING
SEPTEMBER 2008
QUANTITIES IN CFS-DAYS

DAY	ACTUAL FLOW: N.FK. ABOVE CANAL (1)	ACTUAL FLOW: NORTH MILK (1)	ACTUAL FLOW: MILK WEST XING (1)	ACTUAL FLOW: VERD-IGRIS COUL. (2)	ACTUAL FLOW: MILK EAST XING	*EVAPORATION: AVEG EVAP (IN.) (3)	*EVAPORATION: EVAP LOSS (CFS) (4)	CONSUMPTIVE USE *NORMAL YEAR*: U.S.	CONSUMPTIVE USE *NORMAL YEAR*: CAN.	NATURAL FLOW: EAST XING	SHARES OF NATURAL FLOW: U.S.	SHARES OF NATURAL FLOW: CAN.	SHARES OF NATURAL FLOW: FLOW IN EXCESS OR DEFICIT (-) OF U.S. SHARE (5)
1	12	597	2	0	1210	0.15	18	6	10	659	494	165	155
2	12	597	2	0	1130	0.12	15	6	10	576	432	144	134
3	12	604	1	0	820	0.09	11	6	10	255	191	64	54
4	12	600	1	0	748	0.08	10	6	10	186	140	46	36
5	12	607	1	0	759	0.06	7	6	10	187	140	47	37
6	14	608	2	0	832	0.07	9	6	10	263	197	66	56
7	14	605	2	0	902	0.09	11	6	10	338	253	85	75
8	13	596	2	0	904	0.09	11	6	10	348	261	87	77
9	13	593	3	0	925	0.07	9	6	10	370	278	92	82
10	13	592	10	0	928	0.08	10	6	10	375	281	94	84
11	13	599	9	0	917	0.08	10	6	10	357	268	89	79
12	14	592	7	0	915	0.09	11	6	10	364	273	91	81
13	13	592	7	0	821	0.10	12	6	10	270	202	68	58
14	13	528	8	0	611	0.10	11	6	10	123	92	31	21
15	15	371	12	0	397	0.09	9	6	10	66	50	16	6
S.TOTAL	195	8681	69	0	12819	1.36	163	90	150	4736	3552	1185	1035
16	14	248	11	0	293	0.12	10	0	0	69	52	17	17
17	13	136	10	0	220	0.12	6	0	0	103	77	26	26
18	14	57	11	0	160	0.11	2	0	0	119	89	30	30
19	13	30	13	0	123	0.12	1	0	0	107	80	27	27
20	13	23	10	0	104	0.14	1	0	0	95	71	24	24
21	12	22	9	0	89	0.13	1	0	0	80	60	20	20
22	12	20	9	0	103	0.13	0	0	0	95	71	24	24
23	12	14	7	0	112	0.13	0	0	0	110	82	28	28
24	12	13	5	0	134	0.11	0	0	0	133	100	33	33
25	12	13	4	0	107	0.09	0	0	0	106	79	27	27
26	13	14	4	0	82	0.08	0	0	0	81	61	20	20
27	13	14	3	0	74	0.07	0	0	0	73	55	18	18
28	13	13	3	0	67	0.07	0	0	0	67	50	17	17
29	13	13	3	0	63	0.08	0	0	0	63	47	16	16
30	13	14	3	0	60	0.08	0	0	0	59	44	15	15
S.TOTAL	192	644	105	0	1791	1.58	20	0	0	1359	1018	342	342
TOTAL	387	9325	174	0	14610	2.94	183	90	150	6095	4570	1527	1377
AC/FT	768	18496	345	0	28979		364	179	298	12090	9065	3029	2731

5.1.4 Annual Records Meeting

Every winter, usually in February, agency representatives from the United States and Canada meet to discuss data collection, the computation of natural flow and apportionment of the Milk and St. Mary River flows during the previous season. This meeting is referred to as the annual "Records Meeting". The measurement and apportionment of the flows of the eastern tributaries of the Milk River (Lodge Creek, Battle Creek and the Frenchman River) are also discussed. Mutual concerns, future plans, changes in computational procedures and a schedule of field operations for the upcoming season are additional topics at the meeting. The location of the Annual Records Meeting alternates between the U.S. and Canada. The meeting is usually attended by representatives of the U.S. Geological Survey, Environment Canada, Alberta Environment, U.S. Bureau of Reclamation, Saskatchewan Water Authority and often an IJC staff member.

Quick Facts

- **At the Annual Records Meeting, data and computation methods for determining apportionment are reviewed and approved for the previous year.**
- **The Annual Meeting is also a time to discuss mutual concerns, suggested changes to procedures or work plans for the upcoming year.**

A major purpose of these discussions is to finalize "provisional" data and interim computations that have been collected and made by Environment Canada and the U.S. Geological Survey. Natural flow computations, bi-monthly accountings, deficit deliveries and any outstanding deficits at the end of the season are approved and finalized, as is the accounting of water associated with the "Letter of Intent" (discussed below). Any proposed changes to the computational procedures and the procedures manual are reviewed and approved at the meetings.

The funding and condition of data collection stations in both countries, operated to provide the necessary data to compute natural flows and to apportion the water, is often a topic of discussion. Most of these stations are for measuring stream flows, but ditch and canal measurements, evaporation and climate data are also collected. Data quality and the need for any additional data collection and analyses may be discussed, with a focus on how to improve the accuracy of collected data and apportionment computations. Problems are identified and solutions proposed. For instance, how to make more accurate stage-discharge ratings and better accounting for "shifts" at gauging stations are topics just about every year.

Another purpose of these meetings is to produce an annual report to the IJC on the division of the waters of the St. Mary and Milk Rivers. An appendix to the annual report is produced which summarizes all of the hydrologic data collected for the natural flow and apportionment computations.

The status of non-apportioned streams, such as the southern tributaries of the Milk River that flow out of the Sweet Grass Hills, may be provided. Border crossing procedures are reviewed and joint discharge measurements (to check the cross-border consistency of measurement procedures) are scheduled. Updates on ongoing studies and investigations in each country and water supply conditions may also be presented.

Since 2000, stakeholders such as Alberta Environment, Montana Department of Natural Resources and Conservation and Saskatchewan Water Authority, have been invited to attend the meetings. This has led to better communications and formation of technical working groups in 2000. These groups were formed for the purposes of developing better procedures for the computation of natural flows for the upper Milk River and the eastern tributaries.

5.1.5 2001 Letter of Intent

Quick Facts

- **Under the revised 2001 Letter of Intent, Montana is allowed to accumulate a deficit of up to 4,000 cfs-days on the St. Mary River during the March 1 to May 31 period, then reduce this deficit by half during the June 1 to July 15 runoff period.**
- **In return, Canada is allowed to accumulate a deficit of up to 2,000 cfs-days on the Milk River between June 1 and September 15.**

During the dry 1980s, the U.S had the canal capacity to divert much more than its share of the early spring flow of the St. Mary River. Through informal arrangements with Canada, they often accumulated deficits during the March to early May over multiple division periods, relying on high elevation snowmelt runoff in the June-July period to offset their accumulated deficit.

During this period, the Milk River often went dry by late June. Alberta irrigators often went into deficit by diverting more than Canada's share of the Milk River during the summer months. Alberta had no means of directly repaying these deficits. Thus Alberta often requested (through the IJC Field Officers) that the U.S. Bureau of Reclamation (USBR) divert and convey via the U.S. St. Mary Canal, a portion of Canadian St. Mary River entitlements with which to offset its accumulated deficit.

On several of these occasions, the USBR had no surplus canal capacity to divert Canadian St. Mary entitlements to the Milk River. Thus, Alberta began looking at potential structural alternatives which it could use to meet irrigation requirements and thus avoid apportionment deficits. Two structural alternatives examined at the time included a dam on the Milk River and a diversion via Verdigris Coulee. A Letter of Intent was also examined as an administrative way for the U.S. and Canada to cover these practices, without having to construct new infrastructure.

In 1991, the Accredited Officers and their Field Officers, in cooperation with Alberta and Montana, signed a Letter of Intent (LOI). The LOI allowed the U.S. to accumulate a deficit on the St. Mary River during the March to May period and Canada to accumulate a deficit on the Milk River during the July to September period. The original intent was to permit the two countries to accumulate offsetting deficits. However, as the 1991 LOI did not specify how deficits were to be repaid, Canada was often left in a position in which the U.S. had repaid its entire deficit with surplus St. Mary River deliveries from high flows it normally could not capture in the June-July period. This left no residual deficit with which to offset Canada's deficit on the Milk River later in the irrigation season.

In 2001, the Accredited Officers with input from Alberta and Montana, developed and signed a revised Letter of Intent (Appendix E) which clarified the timing of allowable deficit deliveries and how they are to be repaid. Under the revised 2001 LOI, Montana is allowed to accumulate a deficit of up to 4,000 cfs-days (8,000 ac-ft) on the St. Mary River during the March 1 to May 31 period. The U.S.

is allowed to reduce this deficit by half to 2,000 cfs-days (4,000 ac-ft) through surplus deliveries on the St. Mary River during the June 1 to July 15 runoff period. In return, Canada is allowed to accumulate a deficit of up to 2,000 cfs-days (4,000 ac-ft or 4,900 dam^3) on the Milk River between June 1 and September 15 to help meet its irrigation needs in the Milk River Basin.

Residual deficits on the two streams after June 15 are offsetting with only the difference having to be balanced. In 2008, a procedure was developed for tracking deficits under the LOI, which has more flexibility. This is separate from other deficits which have a much more stringent bi-monthly repayment requirement. Table 5.4 shows the apportionment tracking revision carried out in 2008 to permit separate tracking of deficits under the LOI to those outside the LOI.

Table 5.4 – The 2008 apportionment tracking for the St. Mary River.

SUMMARY OF ST. MARY RIVER DIVISION FOR 2008*
QUANTITIES IN CFS-DAYS

DIVISION PERIOD AT INTERNATIONAL BOUNDARY	NATURAL FLOW	CANADA'S SHARE	RECEIVED BY CANADA	RECEIVED BY CANADA		*LOI DEFICIT TO DATE	DEFICIT OUTSIDE LOI TO DATE
				ABOVE SHARE	BELOW SHARE		
MAR 1 - MAR 15	1,848	924	1,573	649		0	0
MAR 16 - MAR 31	1,560	780	1,420	640		0	0
APR 1 - APR 15	1,200	900	1,483	583		0	0
APR 16 - APR 30	4,622	3,467	1,734		1,733	1,733	0
MAY 1 - MAY 15	12,652	8,664	5,672		2,992	4,000	725
MAY 16 - MAY 31	69,640	37,488	48,048	10,560		4,000	0
JUNE 1 - JUNE 15	56,786	30,895	36,670	5,775		2,000	0
JUNE 16 - JUNE 30	56,140	30,572	40,370	9,798		2,000	0
JULY 1 - JULY 15	44,899	24,950	35,920	10,970		1,200	0
JULY 16 - JULY 31	21,669	13,503	13,821	318		1,200	0
AUG 1 - AUG 15	11,747	8,315	7,819		496	552	496
AUG 16 - AUG 31	10,179	7,595	7,394		201	552	697
SEP 1 - SEP 15	7,362	5,522	5,067		455	308	1,192
SEP 16 - SEP 30	5,902	4,426	4,584	158		0	1,034
OCT 1 - OCT 15				0		0	1,034
OCT 16 - OCT 31				0		0	1,034
TOTAL	306,206	178,001	211,575				

* Letter of Intent allows for a deficit up to 4,000 cfs-days between March 1 and May 31 which may be reduced to no less then 2,000 cfs-days between June 1 and July 15. No refunds will count against deficit till September 16.

5.2 Alberta Agreements

5.2.1 Master Agreement on Apportionment (1969)

Quick Facts

- **The St. Mary River is a tributary of the South Saskatchewan River.**
- **The sharing of the waters of the South Saskatchewan River between Alberta, Saskatchewan and Manitoba is governed by the *Master Agreement on Apportionment.***
- **The Agreement requires each province to permit one-half of the natural flow of each watercourse to flow into the downstream province.**

In 1969, the Governments of Canada, Alberta, Saskatchewan and Manitoba signed the *Master Agreement on Apportionment* which outlined how the waters of eastward flowing interprovincial streams were to be shared between the three Prairie Provinces. The Agreement was comprised of four Schedules:

- Schedule A – outlines how waters of interprovincial streams flowing eastward from Alberta into Saskatchewan are to be shared "equitably",
- Schedule B – outlines how waters of interprovincial streams flowing eastward from Saskatchewan into Manitoba are to be shared "equitably",
- Schedule C – created the Prairie Provinces Water Board (comprised of two members appointed by the Government of Canada and one member appointed by each of the Provinces) to administer the Agreement, and
- Schedule D – recognized the priority of certain "*Previous Allocations of Interprovincial Waters Approved By Orders-in-Council by the Government of Canada, Alberta, Manitoba, and Saskatchewan.*"

In 1992, the *Master Agreement* was amended by adding an Agreement on Water Quality (Schedule E) and a commitment to begin working towards the development of an agreement on shared ground water resources.

5.2.2 Master Agreement on Water Quantity (1969)

Under the general terms and conditions of the Master Agreement, each province is allowed *"… to make a net depletion of [up to] one half of the natural flow of water arising in or flowing through the Province …"* and is required *"…to permit the remaining one-half of the natural flow of each watercourse to flow into…"* the downstream Province.

Figure 5.8 outlines the watercourses for which compliance with apportionment is currently being monitored and reported on. As indicated, apportionment monitoring under the Master Agreement includes the South Saskatchewan River (1) - which includes the St. Mary River as one of its tributaries - and Battle, Lodge and Middle Creek (2) which are part of what is generally referred to as the eastern tributaries of the Milk River.

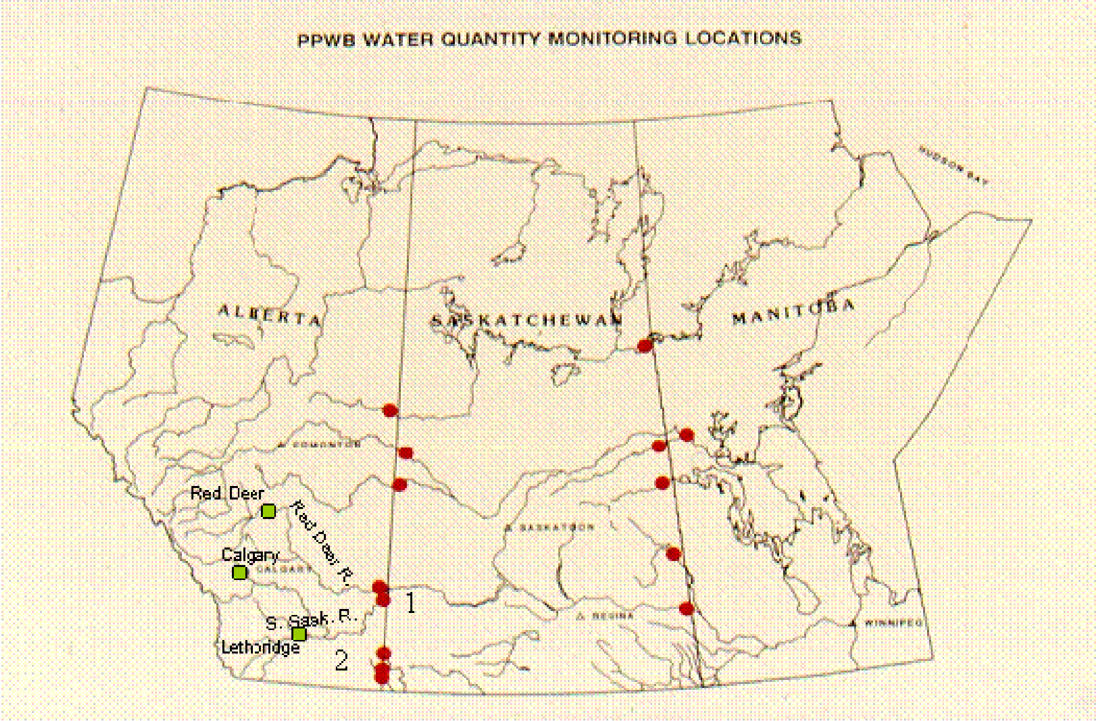

Figure 5.8 – Watercourses monitored for apportionment compliance.

5.2.2.1 South Saskatchewan River Water Quantity Apportionment

While the general principle of the Master Agreement is that "*Alberta shall permit a quantity of water equal to one-half of the natural flow [less U.S. diversions] of each watercourse to flow into the Province of Saskatchewan …*" the South Saskatchewan River is subject to several additional conditions which recognize allocation prior to the signing of the agreement. These provisions are:

- Article 2C, which states; "… *the point at which the natural flow of the watercourses known as the South Saskatchewan and Red Deer Rivers is to be determined may be, at the option of Alberta, a point at or as near as reasonably may be below the confluence of the said two rivers*."
- Article 4A, which states; "*Alberta shall be entitled in each year to consume, or to divert or store for its consumptive use a minimum of 2,100,000 acre-feet net depletion out of the flow of the watercourse known as the South Saskatchewan River even though its share for the said year … would be less than 2,100,000 acre-feet net depletion, provided however Alberta shall not be entitled to so consume or divert or store for its consumptive use, more than one-half the natural flow … if the effect thereof at any time would be to reduce the actual flow … at the common boundary … to less than 1500 cubic feet per second.*"
- Article 4B, which states; "*The consumption or diversion by Alberta provided for under the preceding subparagraph shall be made equitably during each year, depending on the actual flow of water in the said watercourse and the requirements of each Province, from time to time*".

In the Administering the Master Agreement to the South Saskatchewan River, these special provisions have been applied as follows:

- Article 2C, directs that the waters of the South Saskatchewan and Red Deer Rivers, for apportionment purposes, may be treated as a single entity. That is, Alberta's delivery of Saskatchewan's entitlements during a particular year may be made entirely from the Red Deer River or entirely from the South Saskatchewan River, or any combination thereof, at the discretion of Alberta.
- Article 4A contains two conditions, one on the minimum flow rate and another on the annual volume. These conditions have been applied as follows:

  Under the minimum flow condition, Alberta is required to pass to Saskatchewan, on a continuous basis, the lesser of:

  a) 1,500 cubic feet per second (42.5 cubic meters per second), or

  b) 50% of the natural flow [less U.S. diversions] of the South Saskatchewan River at the boundary.

Figure 5.9 illustrates the minimum flow requirement of this provision.

Under the annual volume provision,

a) in consideration of Alberta's prior allocations, Alberta is allowed to store or consume a minimum of 2,100,000 acre-feet (2,590,000 dam^3) of water, even though this may be more than 50% of the apportionable annual volume, provided that it maintains a minimum flow of 1,500 cfs at the border throughout the year, or

b) 50% of the apportionable annual volume is at any time throughout the year the flow rate at the provincial crossing falls below 1,500 cfs (42.5 cms).

Figure 5.10 illustrates the minimum annual volume provided for by this condition, if a continuous minimum flow of 1,500 cfs (42.5 cms) is maintained throughout the year at the Provincial Boundary.

The Master Agreement permits Alberta to take and store or consume up to 50% of the annual natural flow of the South Saskatchewan River. While Alberta has fully allocated its share within the South Saskatchewan River upstream of its confluence with the Red Deer River, on average Alberta has passed 75% of the apportionable flow [natural flow less U.S. diversions] of the South Saskatchewan River to Saskatchewan. Figure 5.11 provides a comparison of Alberta's annual delivery to Saskatchewan versus Saskatchewan's entitlements.

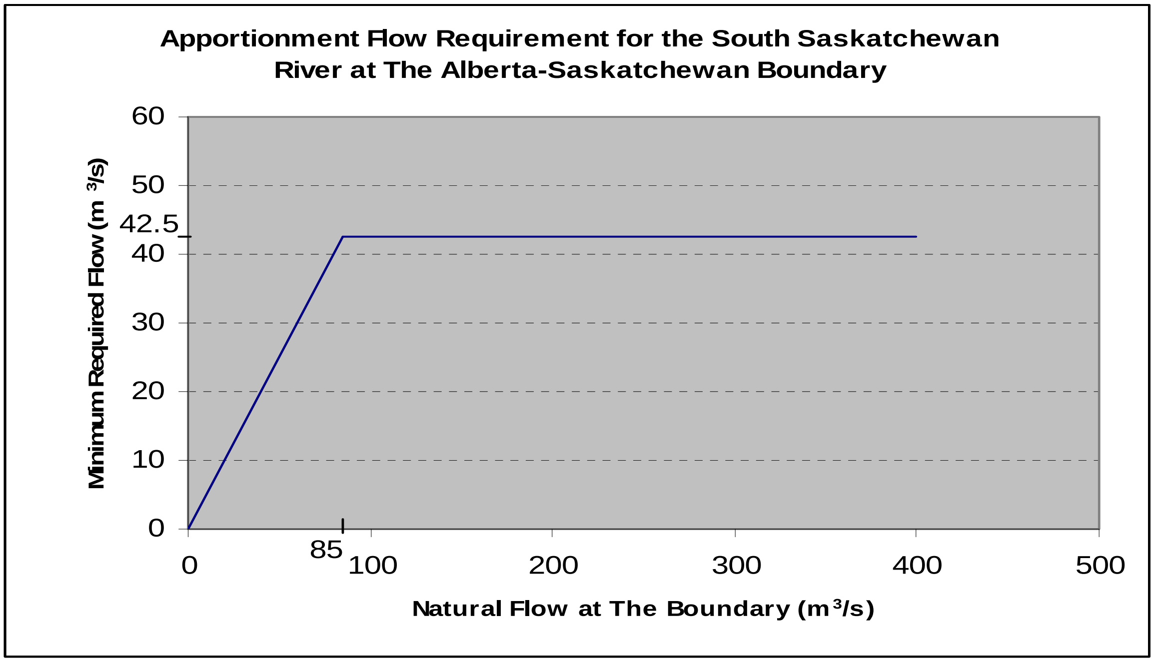

Figure 5.9 – Minimum flow requirement at the Alberta-Saskatchewan Boundary.

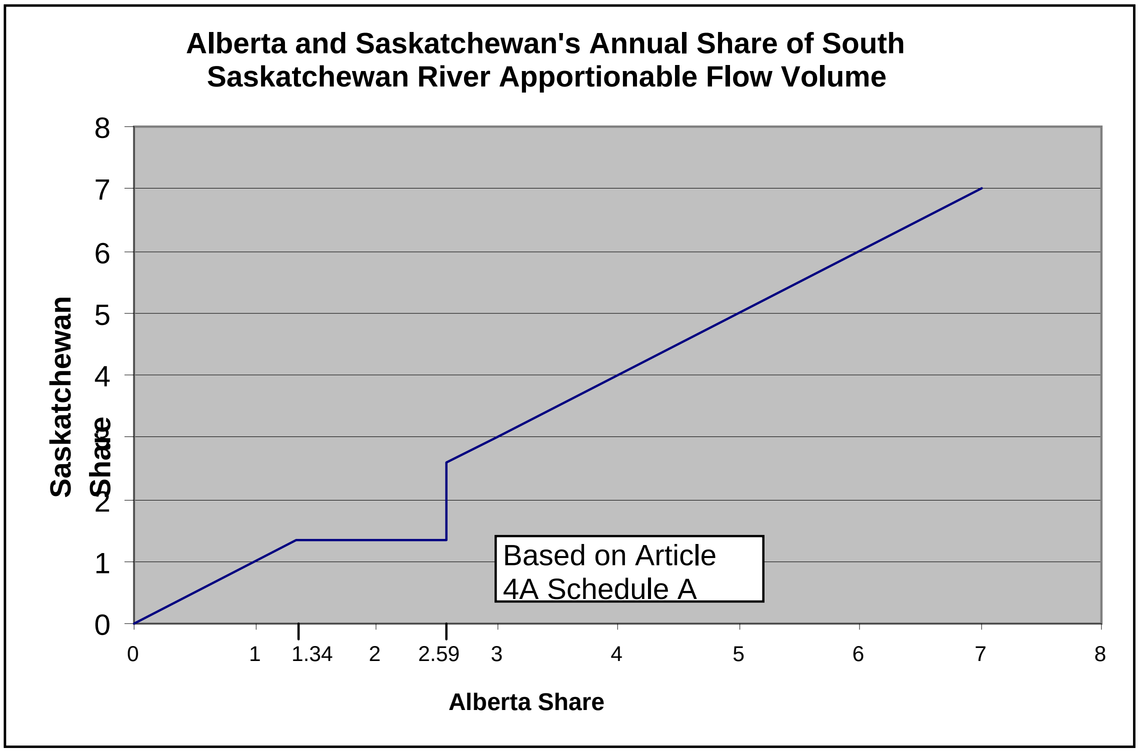

Figure 5.10 – Annual volume entitlements (dam³ x 10^6) provided under Article 4A if Alberta maintains a continuous minimum flow of 1,500 cfs.

Figure 5.11 may be read as follows: in 1995, the South Saskatchewan experienced an annual natural flow volume of 12,000,000 dam^3 (diamond marked 1995), while Alberta was only required to pass 6,000,000 dam^3 to Saskatchewan (solid line); Saskatchewan actually received 10,000,000 dam^3 due Alberta being unable to capture and utilize its share. As indicated, while Alberta has taken nearly all of its South Saskatchewan River entitlements during dry years, on average it passes nearly 75% with the percentage increasing during wet years when it is unable to fully capture and utilize its entitlements.

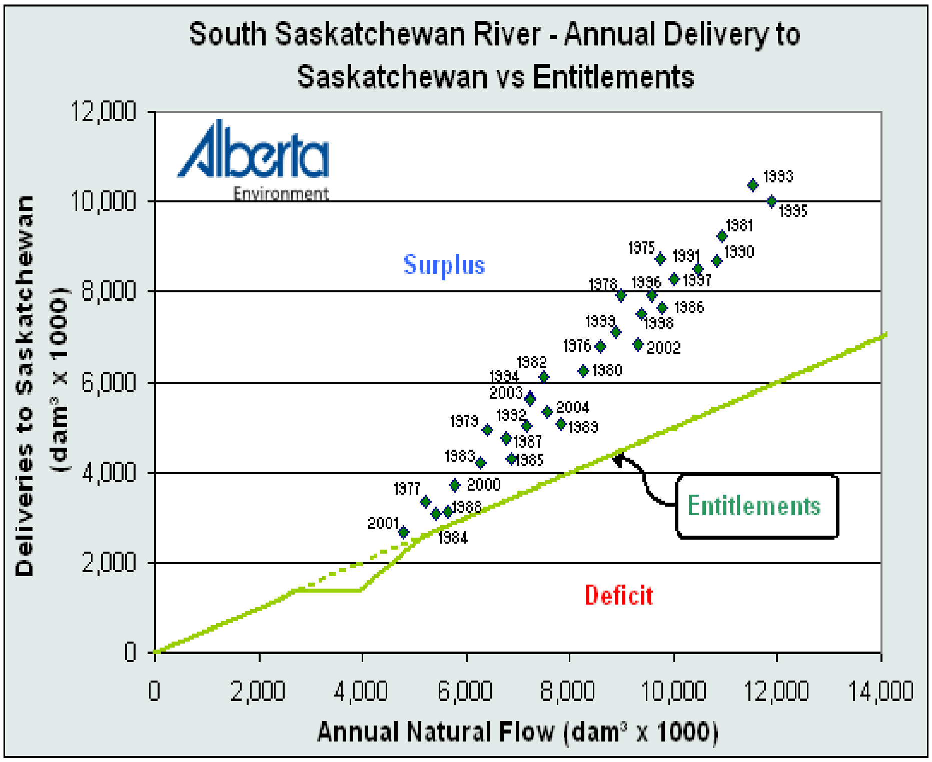

Figure 5.11 – Comparison of Alberta's annual delivery to Saskatchewan versus Saskatchewan's entitlements.

5.2.2.2 Battle, Lodge and Middle Creek Water Quantity Apportionment

> ***Quick Fact***
>
> - **Alberta must permit 75% of the annual natural flow of Battle Creek, Lodge Creek and Middle Creek to pass to Saskatchewan to meet both the *Boundary Waters Treaty* and the *Master Agreement*.**

The sharing of the waters of Battle, Lodge and Middle Creek (generally referred to as the Eastern Tributaries of the Milk River) is governed by Article 6, Schedule A. This schedule states: "…*with respect to each of the three watercourses known as Battle Creek, Lodge Creek and Middle Creek, the annual flow shall be apportioned such that in each of the said watercourses, Alberta permits a quantity of water equal to 75 percent of the natural flow to pass … to Saskatchewan".* This ensures that 50% is available to meet International requirements under the Boundary Waters Treaty and a further 25% is available to meet the Master Agreements equal sharing requirements.

5.2.3 Master Agreement on Water Quality (1992)

In 1992, the Master Agreement on Apportionment was amended to include Schedule E, an "Agreement on Water Quality" which established site-specific water quality objectives at 11 interprovincial watercourses crossings. It also mandated the Board "... *to foster and facilitate interprovincial water quality management among the parties that encourages the protection and restoration of the aquatic environment*". The water quality objectives set for the crossing of the South Saskatchewan River from Alberta into Saskatchewan are listed in Table 5.5.

Table 5.5 – Water quality objectives, South Saskatchewan River at Alberta-Saskatchewan Crossing.

WATER QUALITY OBJECTIVES (South Saskatchewan River Reach: Highway #41 to Confluence with Red Deer River)	
Chemical, Physical, or Biological Parameter	**Acceptable Limit or Limits**
ARSENIC (diss.)	0.05
BARIUM (total)	1.0
BORON (diss.)	5.0
CADMIUM (total)	0.001
CHROMIUM (total)	0.011
COPPER (total)	0.01
FECAL COLFORM	100/100ml
FLUORIDE (diss.)	1.5
IRON (diss.)	1.0
LEAD (total)	0.02
MANGANESE (diss.)	0.05
NICKEL (total)	0.025
NO_2+NO_3 (as N)	10.0
SELENIUM (diss.)	0.002
SULPHATE (diss.)	500
ZINC (total)	0.05
COBALT	1.0
SAR	3.0
TOTAL DISS. SOLIDS	500
VANADIUM (total)	0.1
AMMONIA (total)	Dependent on Temperature
LINDANE	0.0001
2,4-D	0.004
2,4,5-TP	0.01
CHLOROPHENALS (total)	0.001
CYANIDE (free)	0.005
MERCURY IN FISH (ug/g)	0.5
PCB IN FISH (ug/g)	2.0

5.3 Montana Agreements and Compacts

> ***Quick Fact***
>
> - **Montana utilizes "compacts" to establish water entitlements with federal agencies and Indian Tribes claiming federal reserved water rights within the State of Montana.**

Montana's Reserved Water Rights Compact Commission (RWRCC) was established by the Montana Legislature in 1979 as part of the state-wide general stream adjudication process (§85-2-701, MCA). The RWRCC is authorized to negotiate compacts with federal agencies and Indian tribes claiming federal reserved water rights within the State of Montana.

Federal reserved water rights are implied rights recognized by the U. S. Supreme Court in its decision *Winters vs. United States* (1908) (207 U.S. 564). This historic case of national significance sprang from clashes over Milk River water among the Fort Belknap Indian Reservation and upstream and downstream irrigators. The resultant U.S. Supreme Court Decision, in what has come to be known as the *Winters Doctrine,* ruled that lands set aside from the public domain for a specific purpose (e.g. an Indian reservation or a national park) by an act of Congress, a treaty, or an executive order, have a reserved water right with a priority date of the date of the reservation sufficient to fulfill the reservation's designated purpose.

Furthermore, unlike in traditional western water law, these implied rights cannot be lost or diminished in quantity or priority date by virtue of non-use. However, while the *Winters Doctrine* recognizes that a federal reserved water right exists, it did not quantify any specific federal reserved water right. There are two ways to achieve the quantification of a given federal reserved water right – litigation and negotiation. The RWRCC is tasked with negotiating such quantification agreements (called "compacts") on behalf of the State of Montana.

In Montana, reserved water rights have been claimed for Indian reservations and tribal allotments, national parks, wildlife refuges, Wild and Scenic Rivers and other federal lands. Though each compact is unique in process and content, finalization typically follows a multi-step process. A compact is:

1) Reached and signed by all parties;
2) Submitted to the Montana Legislature for ratification;
3) Submitted to the United States Congress for ratification if necessary (generally if federal funding is contemplated to make the settlement work);
4) Sent to the United States Department of Justice for approval (if congressional approval is not required);
5) If it is a water right for an Indian reservation, it must go back to the Tribes for approval under tribal law; and
6) Decreed by the Montana Water Court and integrated into the final decrees (adjudication) of the affected basins.

The compacts discussed in the following subsections involve waters of the Milk and/or St. Mary Rivers in Montana. Additional information on the RWRCC, the compacting process and complete language of existing compacts can be found at www.dnrc.mt.gov/rwrcc/.

5.3.1 The Gros Ventre and Assiniboine Tribes of the Fort Belknap Indian Reservation Compact

The Fort Belknap Indian Reservation is located in north-central Montana south of the Milk River, with the Milk River delineating its northern boundary. This Compact was ratified by the Montana Legislature on April 16, 2001, after 15 years of negotiations. Major components of this compact pertaining to the Milk River include:

- The Tribes' water rights settlement with a priority date of October 17, 1855, based on the date of the Ft. Laramie Treaty signing.
- The Tribes' right to 645 cfs (18.27 cms) from the Milk River, limited by the U.S. share of the natural flow of the Milk River and the Tribal capacity to develop the water.
- Rules governing Tribal groundwater development.
- Quantification of Tribal water rights on Milk River tributaries within or adjacent to the Fort Belknap Indian Reservation.
- Tribal access to federal Milk River Project water when uses upstream of the reservation interfere with Tribal water rights.
- Protection for Milk River Project irrigators from adverse impacts associated with implementation of the compact. The Compact calls for up to 35,000 acre-feet of mitigation based on full development of the Tribal water right.
- The formation of the Milk River Coordinating Committee (MRCC), tasked with basin-wide coordination of releasing stored water, diversions, grant and loan management and improving water supply conditions in Montana.
- The creation of several funds including a Mitigation Account and a Watershed Improvement Trust managed by the MRCC.
- The formation of the Fort Belknap-Montana Compact Board tasked with dispute resolution of controversies arising from the compact.
- Acknowledgment that permanent successful implementation of the compact hinges on reliable water from the St. Mary River to the Milk River; that there is a need to rehabilitate the St. Mary Diversion Facilities; and that the parties agree to work with the Blackfeet Tribe, Milk River Project Irrigators and the U.S. Government in any future efforts to rehabilitate the St. Mary Facilities.

This compact must be ratified by the United States Congress. Once it is approved by Congress, the compact must then be approved by a Tribal referendum before it is sent to the Montana Water Court for final decree.

5.3.2 The Chippewa Cree Tribe of the Rocky Boy's Indian Reservation Compact

The Rocky Boy's Indian Reservation is located in north-central Montana approximately 10.5 miles south of the Milk River near Havre, Montana. The vast majority of the reservation is situated in the Milk River Basin, but the Tribe has no claims directly from the Milk River. This Compact was ratified by the Montana Legislature on April 15, 1997, by Congress on December 9, 1999, and decreed by the Montana Water Court on June 13, 2002. Major components of this compact pertaining to the Milk River include:

- The Tribe's priority date of September 7, 1916, the year the Rocky Boy's Indian Reservation was established.

- An allocation of 10,000 ac-ft per year (AFY) to the Tribe from water arising on the reservation: 9,260 AFY from Big Sandy Creek, and 740 AFY from Beaver Creek.
- 800 ac-ft of storage from Lower Beaver Creek Reservoir is contracted by the State of Montana to mitigate impacts to irrigation on Lower Beaver Creek and the Milk River.
- Establishment of a Compact Board to address disputes arising from the compact.

5.3.3 The Blackfeet Tribe of the Blackfeet Indian Reservation Compact

The Blackfeet Indian Reservation is located in northern Montana on the east slopes of the Rocky Mountain front and adjacent to Glacier National Park. The St. Mary and upper Milk Rivers are situated in and make up the northern tier of the Blackfeet Indian Reservation. The Blackfeet Tribe and the RWRCC agreed on a Compact in December 2007. This Compact was ratified by the 2009 Montana Legislature. Major components of this compact pertaining to the Milk and St. Mary Rivers include:

- A priority date of October 17, 1855.
- A 50,000 AFY right from the St. Mary River, which may only be developed in a manner that does not harm the Milk River Project.
- Remaining portion of St. Mary River after 50,000 AFY and satisfaction of Water Rights arising under Montana law.
- Tribal rights to all groundwater not subject to the 1909 *Boundary Waters Treaty*.
- Tribal rights to remaining water in Lee and Willow Creek after satisfaction of all water rights arising under state law.
- Tribal rights to remaining water in the Milk River drainage (within the Reservation) after satisfaction of all water rights arising under state law.
- A 2 cfs Tribal instream flow right in the Milk River drainage within the Reservation.
- A 10-year deferral period until the Tribe may develop new irrigation uses in the Milk River drainage.
- Basin closures to new appropriations under the state permitting process on the Reservation.
- Establishment of a three-member Compact Board to address disputes that arise under the compact.

5.3.4 Bowdoin National Wildlife Refuge Compact

The U.S. Fish & Wildlife Service (USFWS) Bowdoin National Wildlife Refuge (BNWR) is located in northeastern Montana near Malta. The U.S. Department of the Interior and the State of Montana entered into a compact for BNWR. BNWR is in the Beaver Creek drainage, but receives most of its water from the Milk River via the Dodson South Canal, which is operated by Malta Irrigation District and federally-owned by USBR. BNWR has an existing contract with USBR for 3,500 AFY from the Milk River Project. Major components of this compact include:

- A priority date of November 12, 1940.
- Development of 5,300 AFY of deep groundwater wells within the BNWR boundaries.
- 223 AFY of groundwater within the BNWR.

- USFWS subordination of their water rights to all other water users on Beaver Creek and Black Coulee. In turn, USFWS will be entitled to take whatever water is left after everyone else's rights are satisfied, and make use of Black Coulee that drains naturally into BNWR.
- A Memorandum of Understanding (MOU) is to be negotiated between USFWS and the State of Montana to ensure that USFWS does not exercise its reserved water right for the BNWR until the State of Montana is satisfied that the USFWS has adequately addressed salinity concerns.

The BNWR compact was ratified by the 2007 Montana Legislature. This compact does not require Congressional approval. The MOU must be completed by 2012.

5.3.5 Other Compacts in Milk and St. Mary River Basins

The following compacts have minimal effects on water supplies, but are included for completeness:

a) United States National Park Service (Glacier National Park)

The headwaters of the Milk and St. Mary Rivers are in Glacier National Park. Consumptive use in Glacier National Park is outlined in Table 5.6. The National Parks Reserved Water Rights Compact was finalized in 1993, and ratified by the 1995 Montana Legislature. This compact does not require Congressional approval.

Table 5.6 – Summary of consumptive use rights in Glacier National Park.

Place of Use	Total Volume (ac-ft)	Maximum Flow Rate (gpm)
St. Mary River Basin		
Northern Border Areas	2.2	20
Many Glaciers Areas	166.4	600
St. Mary Areas	128.4	915
Backcountry Use	2.02	*NA*
Backcountry Patrol Cabins	1.5	40
Milk River Basin		
Backcountry Use	0.02	*NA*

b) Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation Compact

The Fort Peck Indian Reservation is located in northeastern Montana with the western portion of the Reservation lying within the Milk River Basin. A small portion of the Milk River defines the southwest boundary of the Reservation below the confluence of Porcupine Creek. Although the Fort Peck Indian Reservation is partially within the Milk River, water from the Milk River mainstem is excluded from Tribal claims under the terms of the compact. The compact specifies a priority date of May 1, 1888. This compact was ratified by the Montana Legislature on May 15, 1985. It is still waiting for Congressional approval.

c) The Turtle Mountain Band of Chippewa

The Turtle Mountain Band of Chippewa owns numerous small allotments scattered throughout Montana. The RWRCC has met with the Tribe to discuss how to resolve potential water rights associated with the parcels. As of 2008, the United States has not assigned a federal team which is required for potential negotiations with the Tribe. There are Turtle Mountain Band allotments in the north eastern portion of the Milk River Basin; however, standard negotiations are unlikely to occur due to the scattered nature of these individual tribal member allotments. Effects on the Milk River water supply resulting from a future agreement or Water Court litigation concerning these allotments will likely be inconsequential. A summary of all compacts in the St. Mary and Milk River Basins is shown in Table 5.7.

Table 5.7 – St. Mary and Milk River Basins compact summary.

Compact	Status	St. Mary River Basin Allocations	Milk River Basin Allocations
Fort Belknap	Settled, ratified by Montana, federal legislation being drafted.	None.	Up to 645 cfs of the U.S. share of the natural flow at the Tribes' point of diversion.
Rocky Boy's	Completed.	None.	None, though depletions on southern tributaries arising on the Reservation may have impacts on downstream water users. Up to 800 AFY of mitigation impacted water users.
Blackfeet	Settled, ratified by Montana Legislature, and Federal legislation being drafted.	50,000 AFY of U.S. share; groundwater not subject to the *1909 Boundary Waters Treaty*. Remaining portion of the St. Mary River after the 50,000 AFY and Water Rights arising under Montana law.	All U.S. flows after satisfaction of water rights arising under state law on the Reservation; 2 cfs instream flow right on the Reservation.
Bowdoin NWR	Ratified by Montana Legislature, does not require federal legislation. Data collection to complete MOU.	None.	Right to all flows after satisfaction of all water users on Beaver Creek. Note: BNWR has a contract for Milk River Project water for 3,500 AFY, which is not a part of this compact.
National Park Service	Completed.	300.52 AFY with a 1,575gpm maximum	0.02 AFY (0.026 dam^3)
Fort Peck	Complete.	None.	None.
Turtle Mountain	Not Started.	None.	Unknown.

6.0 Water Rights, Allocation and Use

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This chapter provides a general understanding of the water rights acquisition, management and enforcement processes in both Montana and Alberta. It also provides information on the quantity of allocations, diversions and consumptive use. This includes the key purposes (irrigation, power, municipal, instream flow, etc.) for which water rights can be obtained. Finally, the amount that has been allocated under each purpose is shown.

6.1 Water Rights System

In allocating their share of the water, the jurisdictions responsible for management of the Milk and St. Mary Rivers are each guided by their respective water legislation and processes.

6.1.1 The Montana Water Rights System

Quick Facts

- **Prior to 1972, a right could be obtained in Montana by posting and/or putting water to beneficial use. In 1973, the *Montana Water Use Act* established an adjudication of existing water rights and a system for new water rights.**
- **The Montana Department of Natural Resources and Conservation is responsible for the management of the permitting and Water Right Change system and some aspects of the adjudication process.**

Montana's water rights laws are principled on the prior appropriation doctrine, also known as "first-in-time, first-in-right". These laws are detailed in *Montana Code Annotated (MCA), Title 85 Water Use*. The prior appropriations doctrine evolved during the early mining days of the western U.S. in response to the region's scarcity of water. The prior appropriation doctrine works on a simple priority rule relating to a priority date when the water was first diverted and put to beneficial use.

In the late 1800s and early 1900s, the United States Congress validated the unique dynamics of western water use and the newly developed prior appropriation doctrine with legislation like the 1877 *Desert Land Act*, the 1886 *Mining Act*, the 1870 *Placer Act* and the 1902 *Reclamation Act*. The 1902 *Reclamation Act* dedicated federal funds to large-scale water storage projects such as the Milk River Project to enhance appropriation opportunities.

In Montana, there are four primary elements of the prior appropriation doctrine:

Intent: Prior to July 1, 1973, intent was recognized by a posting on the land, filing at the county court house and/or simply putting water to beneficial use. After ratification of the *Montana Water Use Act* in 1973, intent became recognized by submitting a permit application to the Montana Department of Natural Resources and Conservation (DNRC) and proof of the requisite criteria to divert, impound or withdraw water for a beneficial use.

Beneficial Use: To perfect an appropriation, beneficial use must occur. Usage is so critical, that an unused water right may be deemed abandoned. Common beneficial uses include but are not limited to domestic/municipal, agricultural, industrial, recreation and fish/wildlife.

Priority Access: Once put to beneficial use, the water right receives a priority date. The priority date is generally the date of established intent. Priority dates determine seniority of users on a water source: the earlier the priority date, the more senior the user. Subsequent priority date users are junior appropriators. Water users exercise their rights in descending order of priority.

Definite Flow and Quantity: The quantity of a right depends on water availability, quantity of water needed for the beneficial use and diversion capacity. Diversions cannot exceed that amount necessary for a beneficial use and must occur in priority order.

6.1.1.1 Montana Water Rights and the 1973 *Montana Water Use Act*

The *Montana Constitution* was adopted by the Constitutional Convention, March 22, 1972 and ratified by the people on June 6, 1972. Article IX, Section 3 of the newly adopted Montana Constitution led to passage of the *Montana Water Use Act* (WUA) by the 1973 Montana Legislature (effective July 1, 1973). The WUA significantly changed Montana water rights administration by requiring a statewide adjudication process in state courts of all water rights existing prior to July 1, 1973; establishing a permit system for obtaining water rights for new or additional water developments after June 30, 1973; establishing an authorization system for changing water rights; establishing a centralized water rights records system; and providing a system for reserved water for future consumptive uses and to maintain minimum instream flows for water quality and fish and wildlife.

The WUA was amended in 1979 to streamline the adjudication process which included establishing the Montana Water Court. Since 1979, the adjudication process has been administered by the Montana Water Court. Today, the WUA is administered by the DNRC and the Montana Water Court and overseen legislatively by the Environmental Quality Council. The DNRC is tasked with administering the permit and change system for water; maintaining the central records system; and assisting the Water Court. The Water Court has jurisdiction over adjudication of all water rights existing prior to July 1, 1973. The Environmental Quality Council provides policy oversight to the administration of state water rights.

6.1.1.2 The Adjudication Process

The WUA of 1973 required all claim holders to file their Water Right Claims with the DNRC, which was necessary to begin the adjudication process. State waters were divided into eighty-five adjudication basins as a means to manage this massive undertaking. There are essentially five steps to the adjudication process:

Examination: DNRC staff must factually examine each claim, determine if it is factually complete, accurate and reasonable and attempt to resolve any discrepancies with the claimant. If a discrepancy cannot be resolved, an issue remark is placed on the claim. After all claims have been examined in a given adjudication basin, DNRC issues a Summary Report to the Water Court.

Temporary/Preliminary Decree: The Water Court issues a temporary or preliminary decree which is based on the statements of claim, the DNRC Summary Report and reserved water right compacts, if applicable. Issuance of a temporary or preliminary decree depends on whether any unquantified reserved water rights exist in the basin. If reserved water rights are involved, the Water Court issues a temporary preliminary decree. If not, a preliminary decree is issued.

Public Notice: A public notice of the decree is issued for every preliminary decree to all parties who may be affected. The notice provides information about deadlines for objections.

Hearings: Persons disagreeing with a decree have 180 days to file an objection. Hearings are held to reevaluate all disputes.

Final Decree: A final decree is issued by a Water Judge after resolution of all objections and issue remarks. Each water right in a decree states a flow rate, priority date, beneficial use, time and place of use, source of water and place and means of diversion. Irrigation rights also include an acreage. Water rights may or may not contain a volume depending on the type of right. Irrigation Water Right Claims typically do not have a volume.

6.1.1.3 Obtaining a New Water Right in Montana

Quick Facts

- **Montana water rights are based on the principle of Prior Appropriation.**
- **In Montana, a person must apply and receive a permit before beginning to construct a diversion for surface water.**
- **For ground water, a permit is only necessary if use is expected to exceed 10 AFY.**

Any person planning new or expanded development for a beneficial use of water from surface or ground water must obtain a permit to appropriate water in accordance with the WUA. The permit system is administered by the DNRC. To appropriate surface water, a person must apply and receive a permit before beginning to construct a diversion or divert water. DNRC follows a five-step process for all applications as outlined below:

1. *Application Review* for completeness.
2. *Environmental Review* to evaluate potential impacts to the environment.
3. DNRC issues a *Preliminary Determination* to Grant or Deny Application.
4. If a Preliminary Determination to Grant, the Application is *Public Noticed* for potential objections.
5. If no objection received, Application is granted.
6. If objection(s) received and not settled, an *Administrative Hearing* is held on the Application to determine whether the Application is granted, modified or denied and a Final Order issues.
7. If the Department issues a Preliminary Determination to Deny, an Administrative hearing is held with the Applicant to show cause why the Application should not be denied. The Department then issues a Preliminary Determination to Grant or a Final Order denying the application.

Once the project has been completed, the applicant must file a Project Completion Notice with the DNRC. Failure to do so results in a terminated water right. For ground water, a permit is only necessary if the anticipated use is expected to exceed 35 gpm, or 10 AFY. Ground water developments less than said amounts require that the driller file a Well Log Report and the owner file a "Notice of Completion of Ground Water Development" form. Legislative approval is required to appropriate more than 3,000 AFY of ground water.

6.1.1.4 Water Right Ownership

Anyone who transfers ownership of land with a water right is required under the law to file a "Water Rights Ownership Update" form with the DNRC. Water rights may also be severed from the land and sold or retained independently from the land. Any changes in the place of use, point of diversion, purpose of use or place of storage of a water right requires the water-right holder to submit a change application to the DNRC providing other water right holders an opportunity to object to the change if they believe it will cause adverse effect to their water use.

6.1.1.5 Water Reservations

Water reservations may be granted for future beneficial uses; to maintain minimum streamflows; or for quality of water. Water reservations are only granted to political subdivisions, the State of Montana or its agencies, or to the United States or any of its agencies. Water reservations maintain the priority date even though the water may not be put to beneficial use for decades.

6.1.1.6 Water Rights Dispute Resolution, Management and Enforcement

In Montana, it is illegal to waste water, use water without authorization, prevent water from reaching a prior appropriator or otherwise violate water use laws. Anyone breaking water use laws is guilty of a misdemeanor and subject to civil penalties of up to $1,000 per violation. Each day of a violation is a separate violation. A senior water right holder also may bring a civil action and seek damages from a junior water right holder who interferes with the senior's use of water.

6.1.1.7 Water Rights Dispute Resolution

In the event that a water user feels their water right is being adversely affected by the actions of another user, it is the senior's obligation by law to make "call" on the water to junior water users. Disputes typically arise when a senior water rights holder is not receiving water. The DNRC urges the parties to attempt to settle the matter privately. If the parties cannot settle, numerous District Court actions exist depending on individual circumstances and the basin's adjudication status.

6.1.1.8 Water Rights Management

Montana has several statutory water management tools including: Controlled Ground Water Areas, legislative, compact and administrative rule basin closures, a water measurement program to alleviate pressure on "chronically dewatered streams" and an instream use and leasing system.

6.1.1.9 Controlled Ground Water Areas

A Controlled Ground Water Area designation is used to address groundwater quantity and water quality issues. A Controlled Ground Water Area may be proposed by state agencies, a local public health agency, municipalities, counties, conservation districts or by petition of ground water users.

6.1.1.10 Basin Closures

Montana has legislatively closed several basins to new water appropriations because of water availability problems, over-appropriation and concerns for protecting existing water rights. The law also provides for administrative rule closures to occur via a water user petition to the DNRC. Compact closures occur as a result of the terms of a given compact.

6.1.1.11 Water Measurement Program

The DNRC administers a statutory Water Measurement Program to alleviate "chronically dewatered" streams and accompanying conflicts among water rights holders. Streams designated as "chronically dewatered" typically require measuring devices to regulate diversions.

6.1.1.12 Instream Use and Leasing

Instream use and leasing was developed to address reduced streamflows during drought to benefit fisheries. Instream use and leasing laws allow water, typically diverted for consumptive use, to be transferred to an instream use for up to 30 years.

6.1.1.13 Water Rights Enforcement

The DNRC has the authority to ensure compliance with permits and laws. Among its powers, the DNRC may require appropriators to install and maintain water measurement/control devices to meter water use, require appropriators to record and report measurements and inspect diversions and water use locations. Enforcement issues of water rights fall under the jurisdiction of the District Courts. Additional Information may be obtained on the following websites:

- http://dnrc.mt.gov/wrd/
- http://www.montanacourts.org/
- http://data.opi.mt.gov/bills/mca_toc/85.htm

6.1.2 The Alberta Water Allocation System

The water allocation system in Alberta is based on "prior allocation". The system began in 1894 when the Government of Canada passed the *North West Irrigation Act*. The Act claimed all water for the Crown and initiated a licensing system for all persons wanting to use water, except for domestic use by riparian landowners. With the *Natural Resources Transfer Act* of 1931, the Government of Canada transferred the responsibility for the management of natural resources including water to the western Provinces. The *Water Resources Act* was passed by Alberta and carried much of the same principles as its predecessor. This Act was replaced in 1999 with the *Water Act* that now enables the management of water use in the Province of Alberta. The *Water Act* carried forward to present day the system of prior allocation and, most notably, added the provision for transfers and licensing instream flows.

The prior allocation system is based on the "first in time, first in right" principle where those first acquiring an allocation have priority over those coming later. The priority of the allocation is identified on a licence by a number representing the date that the allocation was applied for. It is this priority number that is used during a water shortage to determine who is allowed to take the water first. This system provides the water user with a clear defined knowledge of risk of water supply therefore allowing them to make economic decisions for development.

Quick Facts

- **Alberta water rights are based on the principle of Prior Allocation.**
- **In times of shortages, both Montana and Alberta rely on the "first-in-time, first-in-right" principle, where those first acquiring a right have priority over those coming later.**

The water allocation system applies to groundwater as well as to surface water. For surface water, the *Water Act* designates seven major basins within Alberta as water management units. The *Water Act* prohibits movement of water between major basins unless approved by a Special Act of the Legislature. The seven major basins are:

- Milk River Basin
- South Saskatchewan River Basin, which contains the St. Mary River Basin
- North Saskatchewan River Basin
- Beaver River Basin
- Athabasca River Basin,
- Peace/Slave River Basin, and
- Hay River Basin

Under the *Water Act,* there are three ways of recording the consumptive use of water within the Province of Alberta: 1) a Household Statutory Right, 2) a Water Allocation Licence and 3) a Traditional Agricultural Registration.

6.1.2.1 <u>Household Statutory Right</u>

This authority is a "right" under the *Water Act* where up to one acre-foot of water per year can be used for human consumption, sanitation and the watering of lawns, gardens, trees and some animals. This water use must be associated with a household or dwelling place and the water must be sourced on or under the land where it is used. There is no document issued for this type of use and household use has priority over all other users in the basin.

6.1.2.2 <u>Water Allocation Licences</u>

Water allocations are defined by the location, volume, rate and timing of the use. The allocations are recorded by issuance of a licence. The licence includes five critical items:

- the maximum annual volume of water that may be diverted,
- the maximum diversion rate,
- the source and location of the diversion,
- the purpose of the use, and
- priority number based on the date of application for the licence.

Other conditions are also included in a licence to define further the diversion. For example, restrictions may be placed on the timing of the water diversion as well as any applicable minimum flow requirements.

The Milk River Basin has been under moratoria regarding the issuance of new irrigation licences since 1986. In 1991, the *South Saskatchewan Basin Water Allocation Regulation* capped the use of water for irrigation purposes in the St. Mary River Basin. In 2002, the St. Mary River Basin was closed to the new allocation of water for any purpose and remains closed as per the recommendations of the *South Saskatchewan River Basin Water Management Plan (2006).* In August 2007, a *Ministerial Order* was established reserving all unallocated water in the basin, including the St. Mary River Basin, for specific purposes only. Essentially, licences can now only be issued for First Nations and for the protection of the aquatic environment.

In addition to regulation of the prior allocation system, the *Water Act* also provides additional tools for water management. Water Assignments and Water Allocation Transfers allow users to manage risk of water shortage. Water Assignments are available to licensees where a licensee with a senior priority may assign their allocation to a licensee with a junior right. Assignments are intended as a short term tool for management of a shortage situation where the junior licensees may be without water for the season.

Water Allocation Transfers allow new water users in a basin to seek out and acquire an existing allocation. The tool is intended to encourage the best use of the available water supply and to allow users to reduce the risk of shortage by acquiring an allocation with a more senior priority. An application for a transfer of water allocation may only be considered if the ability to transfer an allocation has been authorized in an applicable approved water management plan or, if there is no approved water management plan, by an order of the Lieutenant Governor in Council. At the present time, the approved South Saskatchewan River Basin Plan authorizes the transfer process for the St. Mary River Basin. The transfer process is not yet available in the Milk River Basin due to the lack of a water management plan or approval by the Lieutenant Governor in Council.

6.1.2.3 Traditional Agricultural Registration

When the *Water Act* was proclaimed in January of 1999, there was an opportunity for traditional agricultural users who previously used a “domestic” exemption, to register their livestock use and establish a priority within the prior allocation system. The opportunity to register the use and “grandfather” the priority to their first date of use was open only for a three-year period following proclamation of the Act. The opportunity to establish new registrations is now closed.

The Traditional Agricultural Registration is for water use within a farm unit of up to 5 acre-ft where the water is used for the purpose of raising animals or applying pesticides to crops. The water must be sourced on or under the land where it is used. A registration is recorded by the issuance of a document identifying the location of the water source and a priority number which identifies the first date of use.

Registrations differ from water allocation licences in that they are appurtenant to the land and must remain with that land. They cannot be transferred to another location. The priority number stated on the registration is established under the prior allocation system and is treated the same as a licence. That is, it is used to determine who is entitled to receive the water first in a water shortage.

6.1.2.4 Administration of Priority

The principal of Prior Allocation is that a user with an established senior priority is entitled to receive its entire allocation before those with a junior priority. The only exception is for household use accessed under a Household Statutory Right. A Household Statutory Right has priority over all other users in the basin. For Licences and Registrations, it is the priority number stated on the document which reflects the priority of the licence.

A water shortage is determined by stream flows not being adequate to satisfy demand and other commitments, as well as maintain minimum instream flows. In the event of water shortage where a minimum instream flow is not being achieved or a call on priority is made by a water user with a senior priority, administration of the priority system is initiated. All licences and registrations are inventoried in respective basins including the rates of diversion and volumes. Diversion sites are listed according to location within the basins. Licences and registrations are placed in blocks representing a reach of stream between monitoring installations. Before administration of priorities under the *Water Act*, there is extensive investigation into options for managing the shortage with measures such as releases from government-owned storage.

If no storage is available, the Alberta Department of Environment will initiate restrictions on licensed and registered diversions. First considered are licences with specific conditions that need to be respected such as minimum instream flows and calendar date restrictions. These conditions on diversions will be enforced. If a shortage still exists, in a specific reach of influence on a stream, licensees and registrants with junior priorities will be the first to be ordered to cease diversion. Junior licensees will be cut off in order of priority number until the reduction of diversions is sufficient to mitigate the claims of senior licensees.

> *Allocation* means the volume, rate and timing of a diversion of water.
>
> *Diversion of water* means the impoundment storage, consumption taking, or removal of water for any purpose, except the taking or removing for the sole purpose of removing an ice jam, drainage, flood control, erosion control, or channel realignment and any other thing defined as a diversion in the regulations for the purpose of the Act.

6.2 MONTANA WATER RIGHTS AND USE

6.2.1 Montana St. Mary River Basin Water Rights

Water Right Claims and permits for water use in the U.S. portion of the St. Mary River watershed, not including reserved rights for the Blackfeet Indian Reservation, are summarized in Tables 6.1 and 6.2. The largest existing water use in the U.S.'s portion of the St. Mary River Basin is that associated with Claims by the USBR, for the operations of the St. Mary Canal and Sherburne Reservoir. The claims to operate the canal are for 850 cfs of water for the irrigation of 128,285 acres of land. There are also Claims by the USBR for the storage of 67,604 ac-ft per year of water in Sherburne Reservoir for a variety of uses.

There are numerous other Water Right Claims and permits for small domestic and commercial water uses in the St. Mary River Basin in the United States, mostly in the vicinity of the towns of Babb and St. Mary. Most of these homes and businesses are supplied with water from wells. There is a relatively small Claim to irrigate 33 acres with water from Kennedy Creek. There are also Claims for stock water and Claims for lawn and garden use. Overall, the net depletions to the St. Mary River associated with these uses probably are relatively small. The St. Mary watershed is in adjudication basin 40T. All of the state-based Water Rights Claims in the basin have been examined by DNRC but a summary report has not yet been issued.

> ***Quick Facts***
>
> - **In the U.S., the largest water user in the St. Mary Basin is the U.S. Bureau of Reclamation operating the St. Mary Canal and Sherburne Reservoir.**
> - **The largest water users in the Milk River Basin on the U.S. side are irrigators.**

Table 6.1 – Summary of Water Right Claims in St. Mary River Basin, Montana.

Purpose	Number	Rate (cfs)	Volume (ac-ft/ year)	Max Acres	Notes
Commercial	3	0.56	228.	3.25	
Domestic	10	0.40	20	3.25	
Fish & Wildlife	1		67,604		Sherburne Reservoir
Irrigation	5	882	67,604	128583	Flow is for St. Mary Canal, volume for Sherburne Reservoir. Acres are for irrigation in the Milk River Basin.
Recreation	2	0.03	67,614		Primarily Sherburne Reservoir.
Stock	95	0	0		Livestock drinking directly from source.
Other	2	850.00	78,345		Duplicate for St. Mary Canal diversions.
Total Claims	**118**	**1,733**	**281,415**	**128,589**	

Table 6.2 – Summary of Water Permits in the St. Mary River Basin, Montana.

Purpose	Number	Rate (cfs)	Volume (ac-ft / year)	Max Acres
Domestic	1	0.09	5.63	0.25
Irrigation	1	0.26	118.80	33.00
Lawn and Garden	3	0.16	0.78	0.31
Total Claims	**5**	**0.51**	**125.21**	**33.56**

6.2.2 Montana Milk River Basin Water Rights

The discussion in Section 6.1.1 gives some insight into the complexities and challenges of water rights in Montana. This section explains how they are relevant to the Milk River Basin in Montana. Though ground water development is an important component to any water budget, it is not included in this discussion due to lack of ground water data, the adjudication status and the fact that ground water uses are relatively small in comparison to surface waters uses. Map 6.1 (at the end of this chapter) shows ground water irrigation points of diversion in the Milk River Basin.

6.2.2.1 Milk River Purposes

Montana water law provides significant latitude for what constitutes a beneficial use. This point is illustrated in Tables 6.3 which summarizes the many purposes for surface water rights that exist in the Montana portion of the Milk River Basin.

6.2.2.2 Milk River Allocations

Montana's permit-based approach to water allocation is a relatively young program that started with the WUA of 1973. Table 6.4 shows that "permits" make up roughly ten percent of the total number of surface water rights in the Milk River Basin, with pre-1973 water rights making up the bulk of the balance. Map 6.2 shows surface water points of diversion for irrigation in the Montana portion of the Milk River Basin. Though Water Right Claims by definition are senior to permits, they remain largely unquantified. The point to stress is that the Claims filed with the DNRC do not at this time necessarily reflect actual water use. The Milk River Basin accounts for ten of the eighty-five adjudication drainages created by the WUA. Table 6.5 provides an overview of the Milk River adjudication drainages and their status.

A small part of basin 40J (Lodge and Battle Creeks) also drains from southeast Alberta, across the southwest corner of Saskatchewan, and into Montana. The water rights in these two basins are still under examination by the DNRC, meaning the DNRC is actively working with the water users to ensure that the claims match the actual historic use. Tables 6.6 and 6.7 give a more detailed summary of the water rights in Basin 40F. The DNRC anticipates that the 40F and 40J Summary Reports will be issued in 2009.

6.2.2.3 Compliance

DNRC exercises its administrative authority over permit holders on the Milk River by sending a water availability status letter informing them of water supply conditions. The water availability letter is particularly important in dry years when there is no available water for permit holders. Permit holders are also directed to contact the USBR regarding Milk River Project operations. Noncompliance may lead to fines and legal action as defined by statute. Though the DNRC has administrative authority of water rights, the District Court has jurisdiction over all matters of enforcement and water distribution controversies arising under Montana water law.

6.2.2.4 DNRC Ordered Milk River Mainstem Closure

The Montana Legislature gave authority to the DNRC to order closures within the Milk River drainage basin (85-2-321, MCA). Effective January 1, 1983, the DNRC closed the mainstem of the Milk River, from Eastern Crossing (at the Canadian border) to the Vandalia Diversion Dam in Valley County. The closure applied to new appropriations that are direct diversions without storage for irrigation or any other consumptive use. The periods of closure for the above type of appropriations are:

1. Year-round from Eastern Crossing to Fresno Dam,
2. June 15 - September 30 from Fresno Dam to Dodson Dam,
3. June 15 - September 30 from Dodson Dam to Vandalia Dam.

6.2.2.5 Southern Tributaries of the Milk River Closures

Effective September 1, 1991, the DNRC ordered closure on Miners Coulee, Halfbreed Coulee, Bear Creek and all their respective tributaries in Toole and Liberty Counties. This DNRC order closes the area to new appropriations of surface water that are direct diversions without an on-source storage facility for irrigation or any other consumptive use during any time of the year. The area is closed because unappropriated water occurs so infrequently that any new appropriation from the source of the type described above will adversely affect the rights of prior appropriators on the source. Applications of up to three AFY for new domestic and stock watering purposes are accepted.

6.2.2.6 Milk River Basin Compact Closures

The Fort Belknap Compact closes the entire Milk River Basin to new development, except for Tribal water rights as stipulated in the compact, and a few non-Tribal exceptions regarding municipal, stock and ground water development. Since the Fort Belknap Compact has been ratified by the Montana Legislature, the closure is in effect. The Rocky Boy's Compact closes the Big Sandy Basin with similar stipulations. The Blackfeet Compact also stipulates closure of the Milk River Basin above the Western Crossing within the Reservation's boundaries. Upon ratification of the Blackfeet Compact, the Milk River Basin will, with a few exceptions, be closed in its entirety.

6.2.2.7 The U.S. Bureau of Reclamation's Milk River Project

The Milk River Project facilities, authorized under the *Reclamation Act* of 1902, provide the capability to store, manage and utilize the U.S.'s share of the Milk and St. Mary Rivers. The Project facilities, constructed, owned and operated by the USBR, are managed to satisfy international apportionment requirements, Project water users, Tribal water rights and incidental beneficiaries. Tribal water rights aside, the USBR is the largest and for all intents and purposes, the senior water rights holder in the Milk and St. Mary River Basins.

The USBR works with their contract holders to set allotments based on the latest water supply forecast. The intensive nature of Milk River Project and Tribal irrigation often utilizes the entire flow of the Milk River, meaning water is frequently unavailable to non-project water users. Water rights filed by the USBR account for large portions of water in basins 40F, 40J, 40O and 40T. The USBR has recently filed an amendment to their claims to change their water rights from individual claims for each use, to a “storage” claim for the purpose of saleable water.

Table 6.3 – Milk River Claim and Permit Surface Water Rights by Purpose.

Purposes	No. of Water Rights by Use	Volume (ac-ft)	Volume (dam³/Year)	Acres	Percent WR	Percent AF	Comments
Agricultural Spraying	11	87	107		0.04	0.00	
Commercial	15	129	158		0.06	0.01	
Domestic	104	518	637	167	0.40	0.03	
Erosion Control	5	76.40	94		0.02	0.00	
Fire Protection	4	4	5		0.02	0.00	
Flood Control	83	92,550	113,837		0.32	4.84	
Fish and Wildlife	114	276,707	340,349	1	0.44	14.47	Includes Storage. Overlapping water rights
Fisheries (instream flows)	8	26,712	32,855		0.03	1.40	
Fish Raceways	1	3	4		0.00	0.00	
Industrial	4	125	154		0.02	0.01	
Institutional	1	0.50	1		0.00	0.00	
Irrigation	2846	1,013,349	1,246,420	839,062	10.98	53.00	Overlapping water rights
Lawn and Garden	48	253	311	115	0.19	0.01	
Mining	1	95	117		0.00	0.00	
Multiple Domestic	7	715	879		0.03	0.04	
Recreation	7	211,215	259,795		0.03	11.05	Overlapping water rights
Stock	16,823	13,981	17,196	202	64.89	0.73	
Storage	1	7,415	9,120		0.00	0.39	
Wildlife	5,650	37,490	46,112		21.79	1.96	
Waterfowl and Wildlife	185	2,814	3,461	6	0.71	0.15	
Other	6	227,695	280,065		0.02	11.91	Overlapping water rights
Totals	**25,924**	**1,911,938**	**2,351,684**	**839,555**	**100**	**100.00**	

Table 6.4 – Milk River Surface Water Rights Summary.

Water Right Type	Count	Volume (Ac-ft)	Volume (dam^3)	Max Acres
Water Right Claims	23,748	1,842,415	2,266,170	823,468
Permits	2,263	50,204	61,750	16,637
Instream Flow Reservations	8	26,712	0.00	0.00

Table 6.5 – Milk River Basin Adjudication Status as of 8/6/09.

Basin Number	Basin Name	Status
40F	Milk River Above Fresno Dam	Examination Complete
40G	Sage Creek	Preliminary Decree
40H	Big Sandy Creek	Preliminary Decree
40I	Peoples Creek	Examination
40J	Milk River between Fresno Dam and Beaver Creek	Examination
40K	Whitewater Creek	Temporary Decree
40L	Frenchman Creek	Temporary Decree
40M	Beaver Creek	Preliminary Decree
40N	Rock Creek	Preliminary Decree
40O	Milk River from Beaver Creek to Missouri River Confluence (Includes Porcupine Creek).	Preliminary Decree

Table 6.6 – Detailed Summary of Surface Water Right Claims Adjudication Basin 40F.

Purpose	Count	Flow Rate (cfs)	Flow Rate (cms)	Volume (ac-ft)	Volume (dam³)	Max Acres
Agricultural Spraying	4	0.09	0.00	48.43	59.57	NA
Commercial	1		0.00	5.00	6.15	NA
Domestic	17	0.18	0.01	93.70	115.25	34.00
Erosion Control	3	12.02	0.34	71.00	87.33	NA
Flood Control	1		0.00	40,430.00	49,728.90	NA
Fish & Wildlife	13		0.00	130,380.30	160,367.77	NA
Industrial	1	1.50	0.04	18.40	22.63	NA
Irrigation	317	800.90	22.67	146,301.85	179,951.28	128,857.90
Lawn & Garden	7	0.09	0.00	18.60	22.88	9.75
Recreation	1		0.00	129,062.00	158,746.26	NA
Stock	1262	45.68	1.29	143.14	176.06	NA
Wildlife	2		0.00	4.31	5.30	NA
Other	5	5.00	0.14	129,180.50	158,892.02	NA
Total Claims	**1,634**	**865.46**	**24.492518**	**575,757.23**	**708,181.3929**	**128,901.65**

*Gray areas denote consumptive uses.

Table 6.7 – Detailed Summary of Surface Water Permits Adjudication Basin 40F.

Purpose	Count	Flow Rate (cfs)	Flow Rate (cms)	Volume (ac-ft)	Volume (dam³)	Max Acres
Agricultural Spraying	1		0.00	2.50	3.08	NA
Domestic	2		0.00	14.00	17.22	NA
Fish & Wildlife	8	2.00	0.06	479.80	590.15	NA
Irrigation	17	16.61	0.47	672.20	826.81	526.70
Lawn & Garden	2	0.22	0.01	5.00	6.15	6.00
Stock	66	16.74	0.47	493.28	606.73	140.50
Waterfowl & Wildlife	1		0.00	340.00	418.20	NA
Total Permits	**97**	**35.57**	**1.01**	**2,006.78**	**2,468.34**	**673.20**

*Gray area denotes consumptive uses.

6.3 ALBERTA WATER ALLOCATION AND USE

Quick Facts

- **In Alberta, the *Water Act* (1999) enables the management of water use under licensed allocations.**
- **Alberta Environment is the provincial government department responsible for the management of water use and allocations.**
- **In Canada, the largest water users in the St. Mary and Milk River Basins are irrigators.**
- **Generally speaking, both basins are largely allocated and face full or partial closures to new licences on the Canadian side.**

As described previously, water allocations in the Province of Alberta are recorded by the issuance of licences and registrations. The allocations are tracked in a database. Information collected includes priority, volume, rate and timing of diversion as well as the point of diversion and the source of supply.

Water obtained under a Household Statutory Right does not require issuance of an approval from the Province of Alberta. Water use under a Household Statutory Right is not tracked. Information is limited on the volume of water used under the Household Right. However, each household is limited to one acre-foot.

6.3.1 St. Mary River Basin

The allocations in the St. Mary River Basin were capped in 2002 based on water availability calculated from the Canadian share. The total volume of water allocations in Alberta from the St. Mary River Basin is listed by purpose in Table 6.8.

There is a total volume of 515,282 ac-ft of allocations from the St. Mary River Basin including all licences and registrations. There is a volume of 509,393 ac-ft of allocations with direct delivery from the St. Mary River mainstem with the balance of 5,889 ac-ft of allocations from tributary sources. The total volume of allocations by purpose from the St. Mary River mainstem is listed in Table 6.9

Water use in the basin is for many purposes. The largest use is for irrigation at 93% of the allocated volume. Of particular note are the allocations for the St. Mary River Irrigation District, the Raymond Irrigation District, the Magrath Irrigation District and the Taber Irrigation District. The allocations for these Districts comprise the oldest (1899 priority) and largest allocation from the St. Mary River Basin at a total allocation of 471,435 ac-ft.

The network of canals in these Districts serves as a delivery system to other users in Southern Alberta for municipal, commercial and industrial use. The Main Canal is over 200 miles long. The St. Mary River Basin was capped for irrigation in 1991 and has been closed to the issuance of new licence allocations for any purpose since 2002.

Table 6.8 – Total Water Allocations for the St. Mary River Basin in Alberta.

	TOTAL BY PURPOSE			
ST. MARY RIVER BASIN	**Quantity (m^3)**	**Quantity (ac-ft)**	**# of Allocations**	**Percentage**
Agricultural	3,910,477	3,169	224	0.62%
Commercial	8,393,724	6,802	31	1.32%
Government Holdback	166,667	135	2	0.03%
Industrial	1,372,840	1,113	6	0.22%
Irrigation	588,509,880	476,932	70	92.56%
Municipal	14,292,058	11,582	52	2.25%
Storage/Stabilization	18,826,777	15,257	10	2.96%
Agric. Registration	359,427	291	1,112	0.06%
Total	**635,831,850**	**515,282**	**1,507**	**100%**

Table 6.9 – Total Water Allocations for the St. Mary River Mainstem in Alberta.

	TOTAL BY PURPOSE			
ST. MARY RIVER	**Quantity (m^3)**	**Quantity (ac-ft)**	**# of Allocations**	**Percentage**
Agricultural	2,916,188	2,363	69	0.46%
Commercial	8,016,270	6,496	25	1.28%
Government Holdback	0	0	0	0.00%
Industrial	1,372,840	1,113	6	0.22%
Irrigation	584,621,799	473,781	33	93.01%
Municipal	12,773,263	10,352	42	2.03%
Storage/Stabilization	18,826,777	15,257	10	3.00%
Registration	38,885	32	93	0.01%
Total	**628,566,022**	**509,393**	**278**	**100%**

6.3.2 Milk River Basin

The allocations in the Milk River Basin were capped for irrigation in 1986 based on 70% of the median Canadian share. The total volume of water allocations in Alberta from the Milk River Basin is listed by purpose in Table 6.10. There are a total volume of 25,724 ac-ft of allocations in the Milk River Basin including all licences and registrations. There is a volume of 12,131 ac-ft of allocations from the Milk River mainstem with the balance of 13,593 ac-ft of allocations from tributary sources.

The Milk River Basin has many small areas known as closed basins that do not contribute to the Milk River mainstem. It also has many small projects listed as back-flood irrigation that are actually controlled wetland drainage and net contributors to the river. The total volume of allocations by purpose from the Milk River mainstem is listed in Table 6.11. Map 6.3 shows the location of the licensed allocations in the Milk River Basin. Map 6.4 shows the location of the traditional agricultural registrations in the Milk River Basin.

Water use in the basin is for many purposes. The largest use is for agriculture and irrigation with a combined total of 92.5 % of the allocated volume. There are no Irrigation Districts that source their water from this basin. The irrigation use is by private irrigators only. Most of the agricultural allocations come from tributary sources. Municipal use by the Town of Milk River and the Village of Coutts is the third largest use in the basin with direct diversion from the mainstem of the Milk River. The Milk River Basin has been under moratoria regarding the issuance of new irrigation licences as well as stock water over 20 ac-ft since 1986. Administrative closure for all other purposes is currently in place.

Over the past two years, Alberta Environment has continued a program to inspect and review all agricultural and irrigation licences and registrations within the St. Mary and Milk River Basins. The program was intended to confirm the accuracy of the file information when compared to actual on-site conditions. Inspections of the Milk River Basin projects are complete. Inspections of the St. Mary River Basin projects are continuing.

6.3.3 Water Use Information - Milk River Basin

In general, depending on licence conditions, most water use must be reported on an annual basis. In the Milk River Basin, actual water use has been gathered by a program of direct contact with the users on a monthly basis. The information is used for apportionment purposes. Actual water use in any one year is highly variable and dependent on prevailing weather conditions.

Since 2005, Alberta Environment has been investigating via a pilot project, the viability of monitoring actual water use for all private irrigation projects. By installing meters, the project provides the means to monitor an irrigator's actual water use. This will facilitate better resource management and ensure compliance with water allocations and delivery of Montana entitlements.

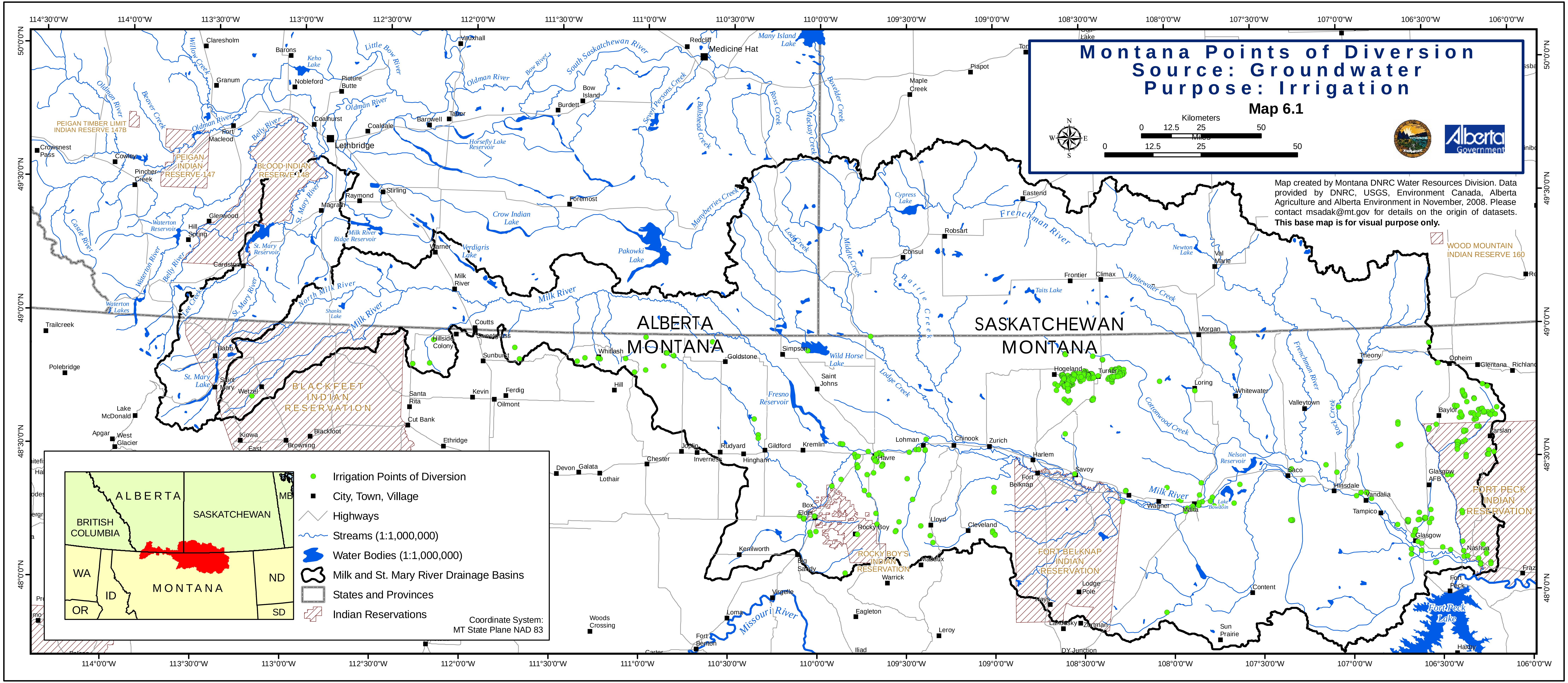
During August 2007, the real-time water use information transmitted from the pilot project was used in combination with a temporary website application to allow for better water management decisions along the Milk River. The pilot project is continuing and the new website is being tested.

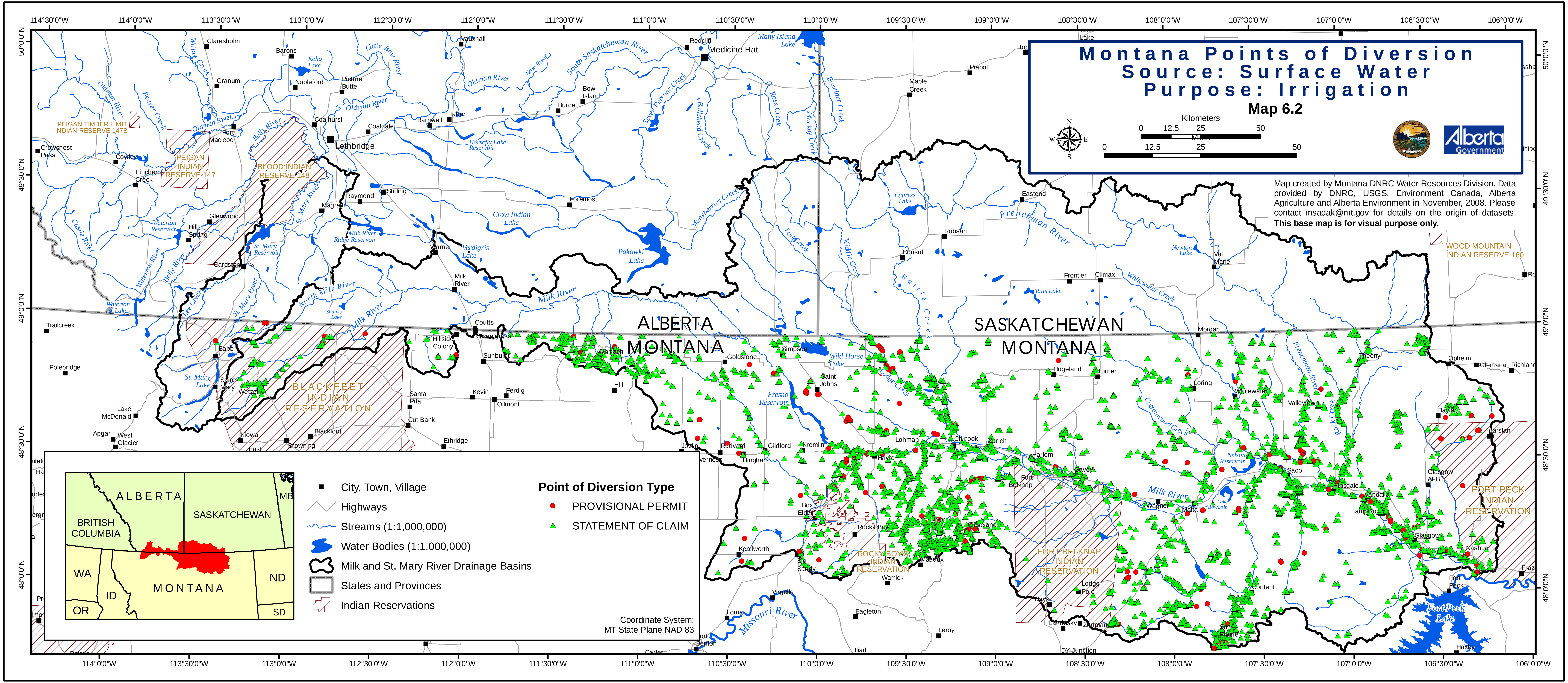
Table 6.10 – Total Water Allocations Milk River Basin – Alberta.

	TOTAL BY PURPOSE			
MILK RIVER BASIN	**Quantity (m³)**	**Quantity (ac-ft)**	**# of Allocations**	**Percentage**
Agricultural	4,578,636	3,711	434	14.42%
Commercial	114,700	93	2	0.36%
Irrigation	24,785,536	20,086	128	78.08%
Municipal	962,376	780	8	3.03%
Storage/Stabilization	1,021,330	828	8	3.22%
Registration	280,129	227	652	0.88%
Total	**31,742,707**	**25,724**	**1,232**	**100%**

Table 6.11 – Total Water Allocations Milk River Mainstem – Alberta.

	TOTAL BY PURPOSE			
MILK RIVER	**Quantity (m³)**	**Quantity (ac-ft)**	**# of Allocations**	**Percentage**
Agricultural	84,744	69	3	0.57%
Commercial	114,700	93	2	0.77%
Irrigation	13,748,336	11,142	66	91.84%
Municipal	957,446	776	6	6.40%
Storage/Stabilization	0	0	0	0.00%
Registration	63,895	52	121	0.43%
Total	14,969,121	12,131	198	100%


Montana Points of Diversion
Source: Groundwater
Purpose: Irrigation
Map 6.1
Kilometers
0 12.5 25 50
Miles
0 12.5 25 50
Map created by Montana DNRC Water Resources Division. Data provided by DNRC, USGS, Environment Canada, Alberta Agriculture and Alberta Environment in November, 2008. Please contact msadak@mt.gov for details on the origin of datasets.
This base map is for visual purpose only.
Irrigation Points of Diversion
City, Town, Village
Highways
Streams (1:1,000,000)
Water Bodies (1:1,000,000)
Milk and St. Mary River Drainage Basins
States and Provinces
Indian Reservations
Coordinate System:
MT State Plane NAD 83
ALBERTA
SASKATCHEWAN
MONTANA
BRITISH COLUMBIA
MB
WA
ID
OR
ND
SD
BLACKFEET INDIAN RESERVATION
ROCKY BOY'S INDIAN RESERVATION
FORT BELKNAP INDIAN RESERVATION
FORT PECK INDIAN RESERVATION
WOOD MOUNTAIN INDIAN RESERVE 160
BLOOD INDIAN RESERVE 148
PEIGAN INDIAN RESERVE 147
PEIGAN TIMBER LIMIT INDIAN RESERVE 147B
Milk River
Missouri River
Frenchman River
Fort Peck Lake
Medicine Hat
Lethbridge


Montana Points of Diversion
Source: Surface Water
Purpose: Irrigation
Map 6.2
Kilometers
Miles
Map created by Montana DNRC Water Resources Division. Data provided by DNRC, USGS, Environment Canada, Alberta Agriculture and Alberta Environment in November, 2008. Please contact msadak@mt.gov for details on the origin of datasets.
This base map is for visual purpose only.
ALBERTA
MONTANA
SASKATCHEWAN
MONTANA
BLACKFEET INDIAN RESERVATION
FORT BELKNAP INDIAN RESERVATION
ROCKY BOY'S INDIAN RESERVATION
FORT PECK INDIAN RESERVATION
BLOOD INDIAN RESERVE 148
PEIGAN INDIAN RESERVE 147
PEIGAN TIMBER LIMIT INDIAN RESERVE 147B
WOOD MOUNTAIN INDIAN RESERVE 160
Milk River
Missouri River
Fort Peck Lake
City, Town, Village
Highways
Streams (1:1,000,000)
Water Bodies (1:1,000,000)
Milk and St. Mary River Drainage Basins
States and Provinces
Indian Reservations
Point of Diversion Type
PROVISIONAL PERMIT
STATEMENT OF CLAIM
ALBERTA
BRITISH COLUMBIA
SASKATCHEWAN
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MONTANA
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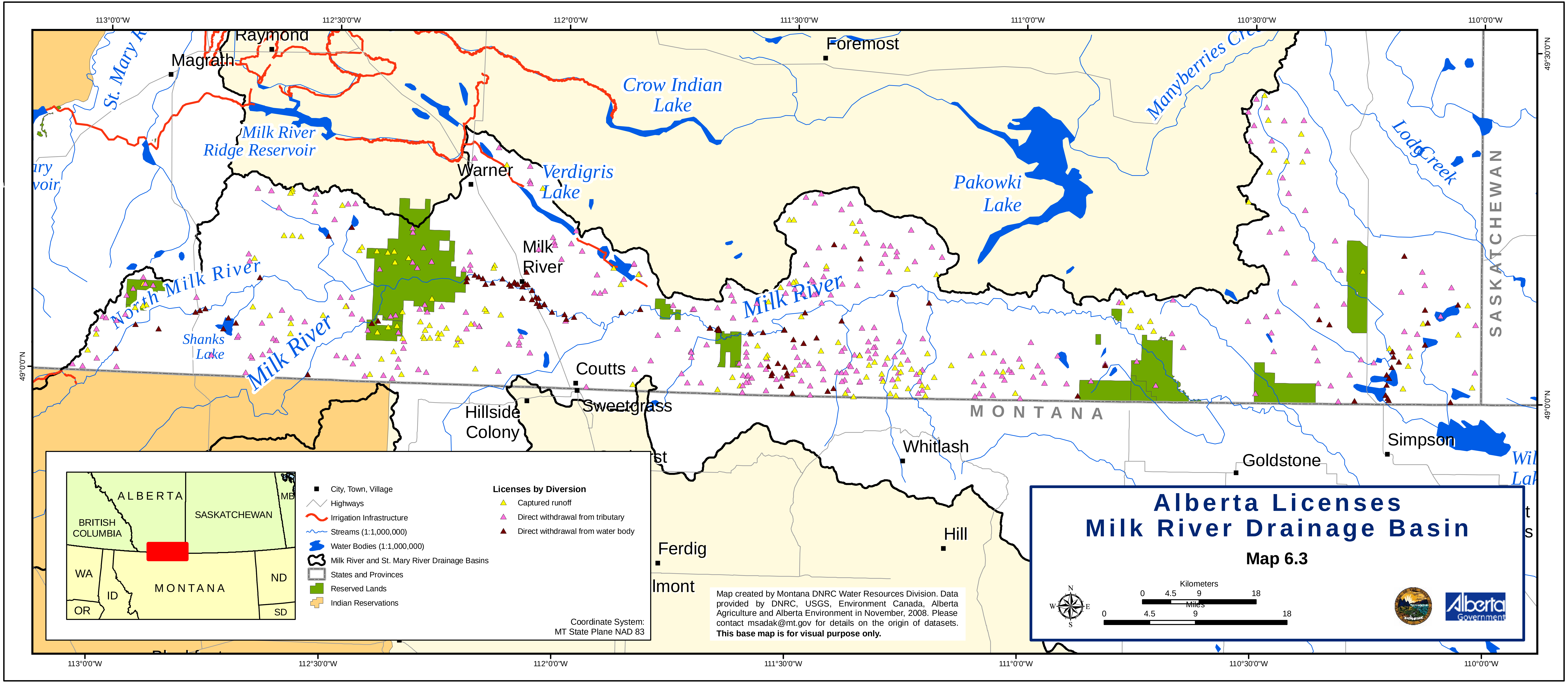
OR
SD
Coordinate System:
MT State Plane NAD 83



Alberta Licenses
Milk River Drainage Basin
Map 6.3
Raymond
Magrath
Foremost
Crow Indian Lake
Milk River Ridge Reservoir
Warner
Verdigris Lake
Pakowki Lake
Manyberries Creek
Lodge Creek
Milk River
North Milk River
Milk River
Shanks Lake
Milk River
Coutts
Sweetgrass
Hillside Colony
Whitlash
Simpson
Goldstone
Hill
Ferdig
SASKATCHEWAN
MONTANA
ALBERTA
BRITISH COLUMBIA
WA
ID
OR
MB
ND
SD
City, Town, Village
Highways
Irrigation Infrastructure
Streams (1:1,000,000)
Water Bodies (1:1,000,000)
Milk River and St. Mary River Drainage Basins
States and Provinces
Reserved Lands
Indian Reservations
Licenses by Diversion
Captured runoff
Direct withdrawal from tributary
Direct withdrawal from water body
Coordinate System:
MT State Plane NAD 83
Map created by Montana DNRC Water Resources Division. Data provided by DNRC, USGS, Environment Canada, Alberta Agriculture and Alberta Environment in November, 2008. Please contact msadak@mt.gov for details on the origin of datasets.
This base map is for visual purpose only.
Kilometers
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Miles
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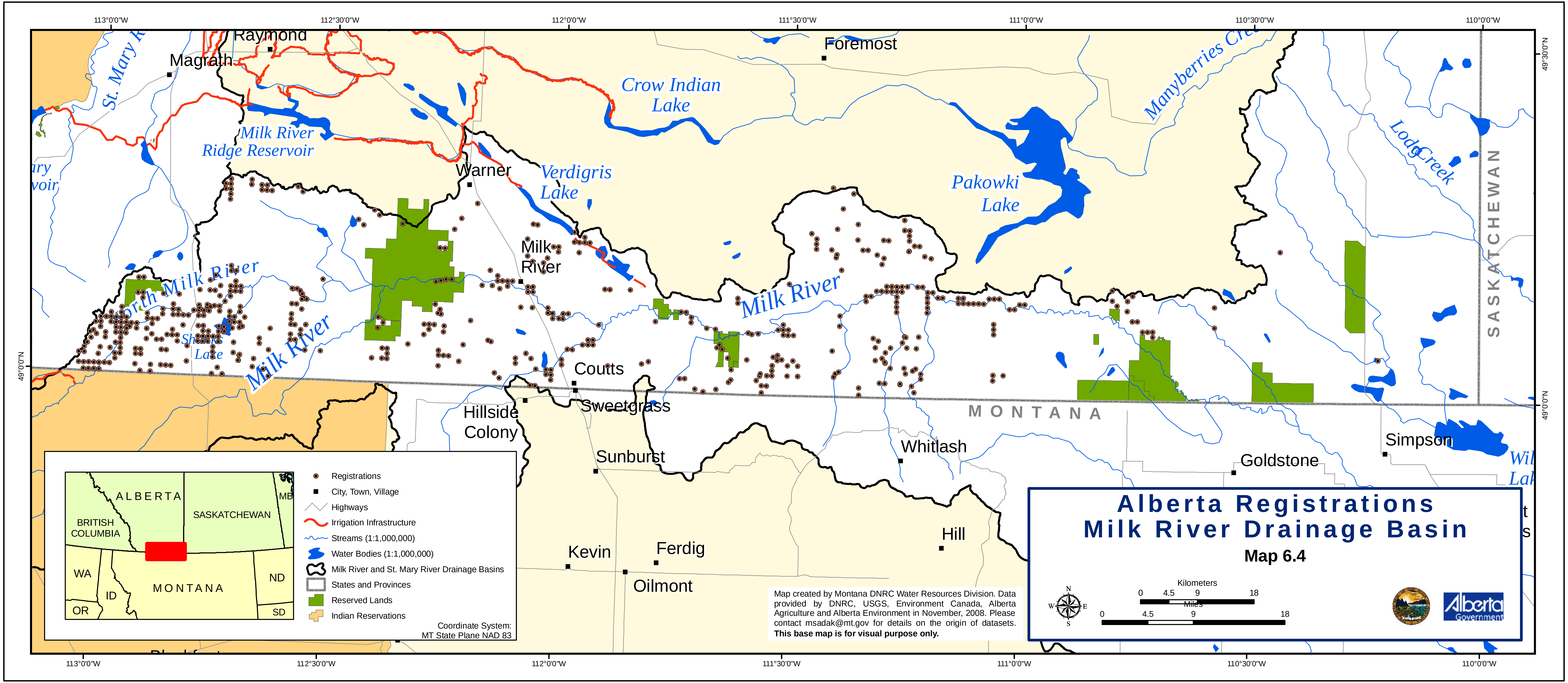
49°0'0"N



Alberta Registrations
Milk River Drainage Basin
Map 6.4
Raymond
Magrath
St. Mary River
Milk River Ridge Reservoir
Foremost
Crow Indian Lake
Manyberries Creek
Lodge Creek
Pakowki Lake
Verdigris Lake
Warner
Milk River
North Milk River
Milk River
Milk River
Coutts
Sweetgrass
Hillside Colony
Sunburst
Whitlash
Goldstone
Simpson
Kevin
Ferdig
Oilmont
Hill
SASKATCHEWAN
MONTANA
113°0'0"W
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112°0'0"W
111°30'0"W
111°0'0"W
110°30'0"W
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ALBERTA
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Registrations
City, Town, Village
Highways
Irrigation Infrastructure
Streams (1:1,000,000)
Water Bodies (1:1,000,000)
Milk River and St. Mary River Drainage Basins
States and Provinces
Reserved Lands
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Coordinate System:
MT State Plane NAD 83
Map created by Montana DNRC Water Resources Division. Data provided by DNRC, USGS, Environment Canada, Alberta Agriculture and Alberta Environment in November, 2008. Please contact msadak@mt.gov for details on the origin of datasets.
This base map is for visual purpose only.
Kilometers
0 4.5 9 18
Miles
0 4.5 9 18
N
S
E
W
Alberta Government

7.0 Instream and Ecosystem Flows

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This section provides a general understanding of the planning processes used in each jurisdiction to establish the quantity and quality of water that must be left in the stream to meet aquatic ecosystem requirements. These minimum "instream" or "ecosystem" objectives may be set for a river reach or a tributary stream.

7.1 Instream and Ecosystem Flows in Montana

7.1.1 Process for Establishing Instream Flows in Montana

Quick Facts

- **Instream or ecosystem rights for water quality and quantity may be set to meet aquatic ecosystem requirements.**
- **In Montana, there are no state-based instream flow water rights on the mainstem of the St. Mary or Milk Rivers.**

In Montana, instream flow rights to protect water quality, fish, wildlife and recreation can be established through a water reservation. Only the State, Federal agencies or political subdivisions of the state can apply for a water reservation. The priority date for a water reservation is generally the date that the reservation application has been received or the date that a basin-wide water reservation proceeding was established by the Montana Legislature.

Most instream flow reservations in Montana are held by the Department of Fish, Wildlife and Parks (DFWP). DFWP uses several methods to determine instream flow needs for fish, wildlife and recreation. The most common is the wetted perimeter inflection point method. This method is based on the assumption that riffle areas produce the most food for gamefish. Hence, flows are requested that maintain the "wetted perimeter" of these riffle areas.

In some cases in the Milk River Basin, water was reserved for the "base flow" of the stream, which was defined by DFWP as the lowest mean monthly flow for a particular period. DFWP may, under certain circumstances, change existing water rights to instream flow. Montana statute also allows existing water rights to be temporarily leased for instream flows. To date, there have been no instream flow leases in the Milk or St. Mary River Basins.

7.1.2 Montana's St. Mary River Watershed

There are no state-based instream flow water rights in the upper St. Mary River Basin. Operations of Sherburne Dam might be changed in the future to provide minimum instream flows in Swift Current Creek for bull trout. Currently, there is no established minimum flow below Sherburne Dam and winter outflows are often set to zero.

7.1.3 Montana's Milk River Watershed

In the Milk River Basin, the DFWP have water reservations to protect minimum flows for fish, wildlife and recreation on many of the larger Milk River tributaries. These reservations are summarized in Table 7.1. Due to their late priority date (1991), these instream flow reservations are junior to almost all irrigation water rights on these tributaries. DFWP applied for, but was not granted, channel maintenance instream flows for some Milk River tributaries.

There are no protected instream flows on the main stem of the Milk River. Although the Milk River can be dewatered below some of the major irrigation diversion dams, the conveyance of irrigation water, minimum releases from Fresno Reservoir, and irrigation return flows maintain instream flows in many segments of the river.

The water rights compact with the Blackfeet Tribe contains a minimum flow for both the North Fork and the South Fork of Milk River of 2 cfs year-round. This minimum flow would be effective within the external boundaries of the Blackfeet Indian Reservation and be higher in priority to existing state-based irrigation water rights on those streams.

Quick Facts

- **Montana has several instream objectives for fish, wildlife and recreation on several of the Milk's larger tributaries.**
- **The conveyance of irrigation water, minimum releases from Fresno Reservoir, and irrigation return flows maintain instream flows in many segments of the Milk River.**

Table 7.1 – Instream flow water reservations in the Milk River watershed of Montana.

Stream	Segment	Dates	Flow (cfs)
Battle Creek	International Boundary to mouth	Dec. - Mar.	2
		Apr. - Nov.	5
Beaver Creek (Hill County)	Rocky Boy's Reservation Boundary to Beaver Creek Reservoir	Year-round	7
Upper Beaver Creek (Phillips County)	Headwaters to Fort Belknap Reservation Boundary	Year-round	0.2
Lower Beaver Creek (Phillips County)	Highway 191 to mouth	Dec. - Mar	7
		Apr. - Nov.	11
Clear Creek	Headwaters to Clear Creek Road	Year-round	5
Frenchman River	International Boundary to mouth	Dec. – Mar.	2
		Apr. - Nov.	5
Little Box Elder Creek	Headwaters to Clear Creek Road	Year-round	1
Peoples Creek	Headwaters to Barney Olson Road	Year-round	1
Rock Creek	International Boundary to mouth	Dec. – Mar.	2
		Apr. - Nov.	8

7.2 Instream and Ecosystem Flows within Alberta

7.2.1 Process for Establishing Instream Flows in Alberta

Quick Facts

- **In Alberta, the St. Mary River is a tributary of the Oldman River and is subject to water conservation objectives established in 2005.**
- **The St. Mary River Basin is closed to new water allocations. Should an allocation be permitted, it would be subject to the instream flow need of 45% of natural flow, established in 2005.**

The process for establishing instream flow requirements in Alberta has evolved over time and continues to evolve. In early years of licence allocations, there were no instream flow requirements placed on licences as conditions. There are still existing licences that do not have conditions reflecting an instream flow requirement. Later, instream flow requirements were established and placed as conditions on licences and represented as minimum instream flow requirements or as an Instream Objective.

Instream objectives were previously established in various ways including the use of Fish Rule Curves, Tennant/Tessman and other science based evaluations. Some Instream Flow Objectives were not based on scientific methods but rather were related to operational considerations of the infrastructure, assimilation requirements, etc. These instream flow objectives, while not based on ecosystem requirements, are also reflected as conditions on existing licences.

The *Water Act* now defines instream flow requirements as Water Conservation Objectives. The *Water Act* states:

> "*Water Conservation Objective means the amount and quality of water established by the Director … based on information available to the Director, to be necessary for the*
> *(i) protection of a natural water body or its aquatic environment, or any part of them,*
> *(ii) protection of tourism, recreation, transportation or waste assimilation uses of water, or*
> *(iii) management of fish or wildlife.*

The *Water Act* also specifies the Director must engage in public consultation to the level that the Director considers appropriate during the establishment of a water conservation objective. This is generally accomplished during the Water Management Planning process.

7.2.1.1 Process in the South Saskatchewan River Basin

The St. Mary River Basin is the most southerly tributary in the South Saskatchewan River Basin (SSRB). In the SSRB, a Water Conservation Objective was established during the Water Management Planning process. The objective included not only scientific considerations but also social and economic considerations determined from public input to the process.

Basin Advisory Committees (BAC) with membership from the public were established as part of the South Saskatchewan River Basin Water Management Plan. BACs made recommendations to the Director on Water Conservation Objectives for each of four sub-basins in the South Saskatchewan. The Advisory Committees were provided with information reports to support their decisions. One of the reports was an instream flow needs assessment titled *Instream Flows Needs Determinations for the South Saskatchewan River Basin.*

Instream Flow Needs are defined as the scientifically determined amount of water, flow rate, water level or water quality that is required in a river or other body of water to sustain a healthy aquatic environment or to meet human needs such as recreation, navigation, waste assimilation or aesthetics.

The Alberta Method for establishing Instream Flow Needs generates one Instream Flow Need for each period (week, month) based on the highest flow requirements from four riverine components: water quality, fish habitat, riparian vegetation and channel maintenance. This method was developed by an expert technical team within Alberta Environment and Alberta Sustainable Resource Development who accessed expert knowledge from within and outside of the Government of Alberta. It was reviewed by independent technical experts and was accepted as the method for establishing Instream Flow Needs in the Province of Alberta. A report on this method can be found at http://ssrb.environment.alberta.ca/instream_flows_needs_determinations.html.

After consideration of the Instream Flow Needs Assessment as well as other information reports, the BACs made a recommendation to the Steering Committee overseeing the SSRB Basin Planning process. The Water Management Plan, which includes the recommendation on the Water Conservation Objective, was approved by Cabinet in August 2006. The recommended Water Conservation Objective is a factor the Director under the *Water Act* must consider when making a decision on water allocations.

7.2.1.2 Process in the Milk River Basin

In the Milk River Basin, the water management planning process is currently being conducted by the Milk River Watershed Council Canada in a manner similar to that completed for the South Saskatchewan River Basin (See www.milkriverwatershedcouncil.ca/index.html). It is anticipated that this process will ultimately result in a Water Conservation Objective being established for the Milk River Basin.

7.2.2 Regulatory Instream Flow Requirements and Conservation Objectives

7.2.2.1 St. Mary River Basin

The St. Mary River Basin is a tributary to the Oldman River sub-basin of the South Saskatchewan River Basin. The Water Conservation Objective for the Oldman River sub-basin as recommended in the South Saskatchewan River Basin Water Management Plan is as follows:

- *Water Conservation Objective (WCO) for the Oldman River mainstem (below the Oldman River Dam to the confluence with the Bow River) to be either 45% of the natural rate of flow, or the existing instream objective increased by 10%, whichever is greater at any point in time.*
- *WCO for the headwater reaches (above Oldman Dam) of the Oldman River and tributaries of the Oldman River to be not less than the existing instream objective or the WCO downstream on the mainstem, whichever is greater at any point in time.*
- *Implementation date for the WCOs to be May 1, 2005.*

Quick Facts

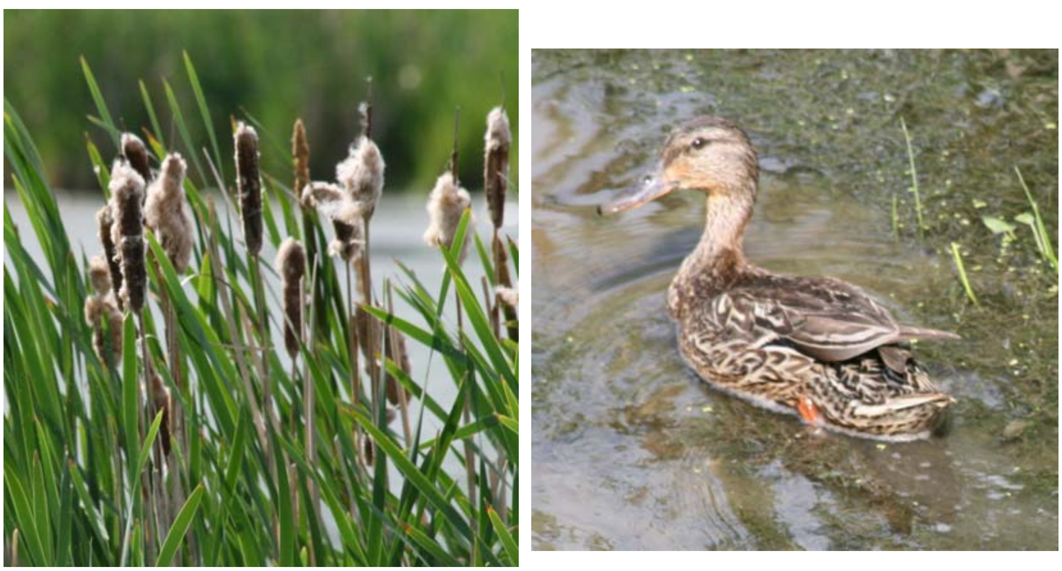
- **In Alberta, no Instream Objective was identified for the Milk River in the past because this river, during the demand season, flows at a rate considerably higher than natural due to the diversion from the St. Mary River.**
- **The Milk River Watershed Council Canada is currently undertaking a planning exercise to develop a water conservation objective.**

The above applies only to licences issued after May 2005. Implementation of the Water Conservation Objectives is described in the SSRB Water Management Plan. A copy of the complete plan can be found at http://environment.alberta.ca/documents/SSRB_Plan_Phase2.pdf.

The Instream Objective for the St. Mary River has been 97 cfs for the reach of the river between the St. Mary Dam and the confluence with the Oldman River. There has not been an Instream Objective identified for the St. Mary River upstream of the St. Mary Dam as there have been no conflicts regarding minimum flows due to the minimal demand for water use in Alberta in this reach of the river. The 97 cfs instream flow requirement below the St. Mary Dam applies to licences issued prior to May 2005. The basin is now closed to any new allocations. However, should an allocation be permitted, it would be subject to an instream flow requirement of 45% of natural flow.

7.2.2.2 Milk River Basin

There is no water management plan for the Milk River Basin. Therefore, a Water Conservation Objective has not yet been established for this river. No Instream Objective was identified for the Milk River when licences were issued because the Milk River, during the demand season, flows at a rate considerably higher than natural due to the U.S. St. Mary River diversion conveyance system. This diversion has been in place since the early part of the 20th century.



Determining instream flow requirements can include calculating the amount of water required to maintain water quality, riparian areas and other aspects of aquatic health. Photos: P. Rowell

8.0 Water Management Infrastructure and Irrigation

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John Sanders, P.Eng. Civil Engineer, Montana Department of Natural Resources and Conservation

This chapter provides a description of water management infrastructure not previously discussed. This includes the operation of dams and reservoirs and other irrigation infrastructure for water delivery and water application. Where possible, it provides information on the amount of water being diverted, the area being irrigated, the actual quantity being applied to the land, return flows, live storage, evaporative losses and conveyance capacity. Finally, it discusses the condition of existing infrastructure and its potential role in future management scenarios.

8.1 Montana Water Delivery System and Irrigation Infrastructure

Quick Facts

- **The U.S. government recognized the need for supplemental irrigation water in the Milk River Basin as early as the 1890s.**
- **Construction of the 29-mile U.S. St. Mary Canal, diverting water from the St. Mary River to the Milk River, was authorized in 1903.**
- **Construction of the gravity-fed system started in 1906.**

In the 1890s, the United States (U.S) Government recognized that there was insufficient water supply in the Milk River Basin. This prompted an investigation of alternatives for supplying supplemental water to the Milk River. The most feasible plan was the trans-basin diversion of water from the St. Mary River to the North Fork of the Milk River via a 29-mile canal system. From there the water would flow through the Milk River in Canada and back to the United States at the Eastern Crossing of the International Boundary.

The initial plan, referred to as the Milk River Project, was prepared by the United States Reclamation Service, precursor to the United States Bureau of Reclamation's (USBR). It was submitted to the Secretary of Interior July 8, 1902 and conditionally authorized on March 25, 1903 as one of the USBR's first five projects. Funding was allocated in 1905 and construction of the St. Mary Facilities started in 1906.

The gravity-fed, trans-basin St. Mary system was built between 1906 and 1924. Downstream on the Milk River, the Dodson Diversion Dam was completed in January 1910, and the first water delivered for irrigation in 1911. In 1915, the Nelson Reservoir Dikes in the Milk River basin and the Swift Current Dike and St. Mary Diversion Dam in the St. Mary River Basin were completed. In 1916, the Vandalia Diversion Dam was completed on the Lower Milk River, Lake Sherburne Dam was completed in 1921 in the St. Mary River Basin and the Fresno Dam on the Milk River near Havre was completed in 1939. The Dodson Pumping Plant on the Milk River was completed in 1946.

There are approximately 145,000 acres irrigated from the Milk River in Montana. The St. Mary Canal and Milk River Project in north-central Montana furnish water for the irrigation of about 121,000 of those acres. Water is conveyed from the St. Mary River to the Milk River system, where it is used to supply project lands extending about 165 miles along the river starting near Havre to a point six miles below Nashua, Montana.

The Milk River Project lands are divided into the Chinook, Malta and Glasgow Divisions. The Chinook Division includes Fort Belknap, Zurich, Harlem, Paradise Valley and Alfalfa Valley Irrigation Districts, providing irrigation water for 37,200 acres. The Malta Division includes Malta and Dodson Irrigation Districts, which provides irrigation water to 43,600 acres. The Glasgow Division provides irrigation water to 18,000 acres in the Glasgow Irrigation District.

The distribution systems are a mix of privately and federally-owned, but all are operated by the Irrigation Districts. There are about 630 miles of canals and ditches in the distribution system. Overall conveyance efficiencies range from 65 percent early in the season to 80 percent when the canal banks are saturated. In addition, numerous private contract water users use small pumps to divert water from the Milk River.

Quick Facts

- **Designed for a capacity of 850 cfs, the U.S. St. Mary Canal had an initial capacity of 440 cfs and first delivered water in 1916. The canal currently conveys up to 675 cfs.**
- **In Montana, a system of dams, dikes and pumping stations delivers water to a number of irrigation districts, contract pumpers and private licence-holders to irrigate about 145,000 acres.**

8.1.1 U.S. St. Mary River Water Delivery System

8.1.1.1 Description of St. Mary Water Storage and Delivery System

The following section discusses the Montana water storage and delivery system and irrigation infrastructure. It begins with the facilities in the St. Mary River Basin and ends with the irrigation districts and diversion dams along the lower Milk River in Montana (Map 8.1).

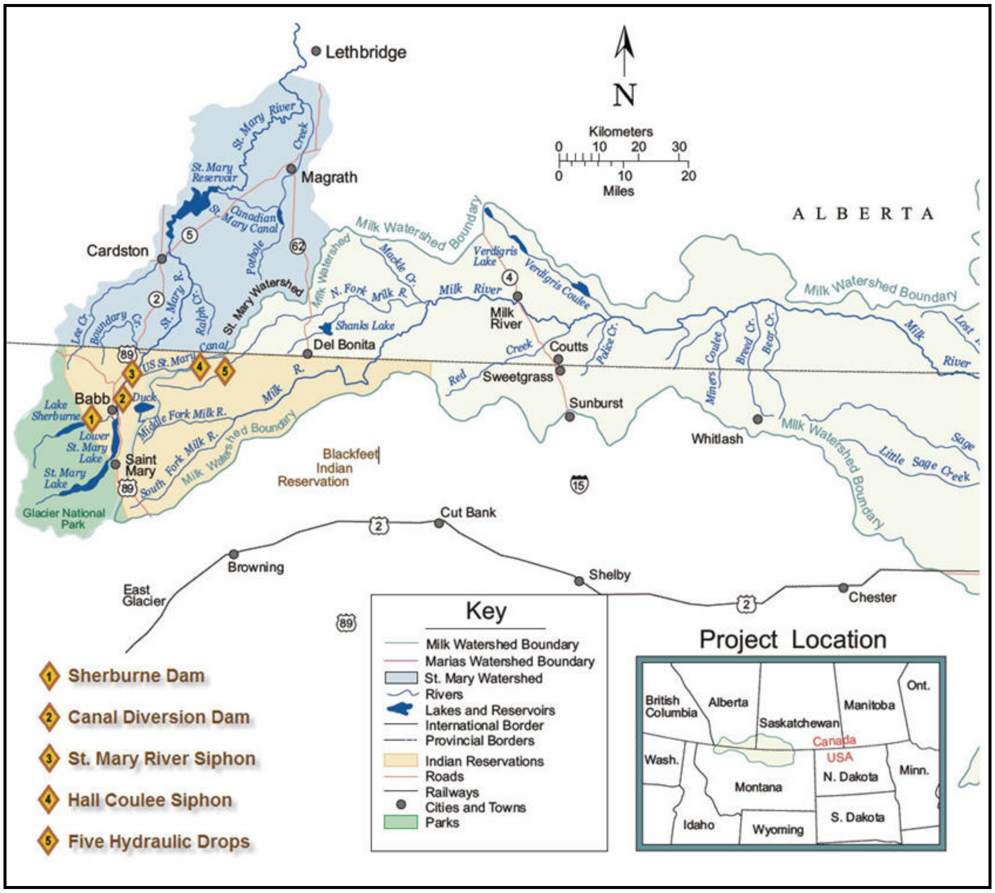
a) Lake Sherburne Dam

Lake Sherburne Dam (Photo 8.1) is a compacted earth-fill structure 107 feet high above its foundation with a crest length of 1,086 feet. The total volume of material in the dam is 242,000 cubic yards. In 1960, the intake tower was modified by adding a circumferential overflow spillway crest. As well, the weir-type overflow spillway at the left abutment of the dam was filled with compacted earth material, extending the crest of the dam to the left abutment.

Reservoir water surfaces are controlled by operation of two 4-by-5 feet high-pressure gates which permit a discharge of up to 2,100 cubic feet per second (cfs) at an elevation of 4,788 feet. At water surface elevations above 4,788 feet, water flows over the crest of the overflow spillway. The discharge through the outlet works is then comprised of the water flowing over the spillway crest and through the 4-by-5 feet gates. Maximum discharge through the outlet works conduit, at an elevation of 4,809.2 feet, is 4,200 cfs. A total storage capacity of 67,850 ac-ft is provided in Lake Sherburne, the only U.S. storage in the St. Mary Basin. The Montana Department of Natural Resources and Conservation (DNRC) estimates that average annual evaporation from Sherburne Reservoir is about 550 ac-ft.

Quick Fact

- **Lake Sherburne, on Swiftcurrent Creek, provides up to 67,850 ac-ft of storage and is the only U.S. storage in the St. Mary Basin.**



Map 8.1 – United States St. Mary River Diversion System Major Features.

Photo 8.1 – Lake Sherburne Dam and Reservoir. Photo: U.S. Bureau of Reclamation

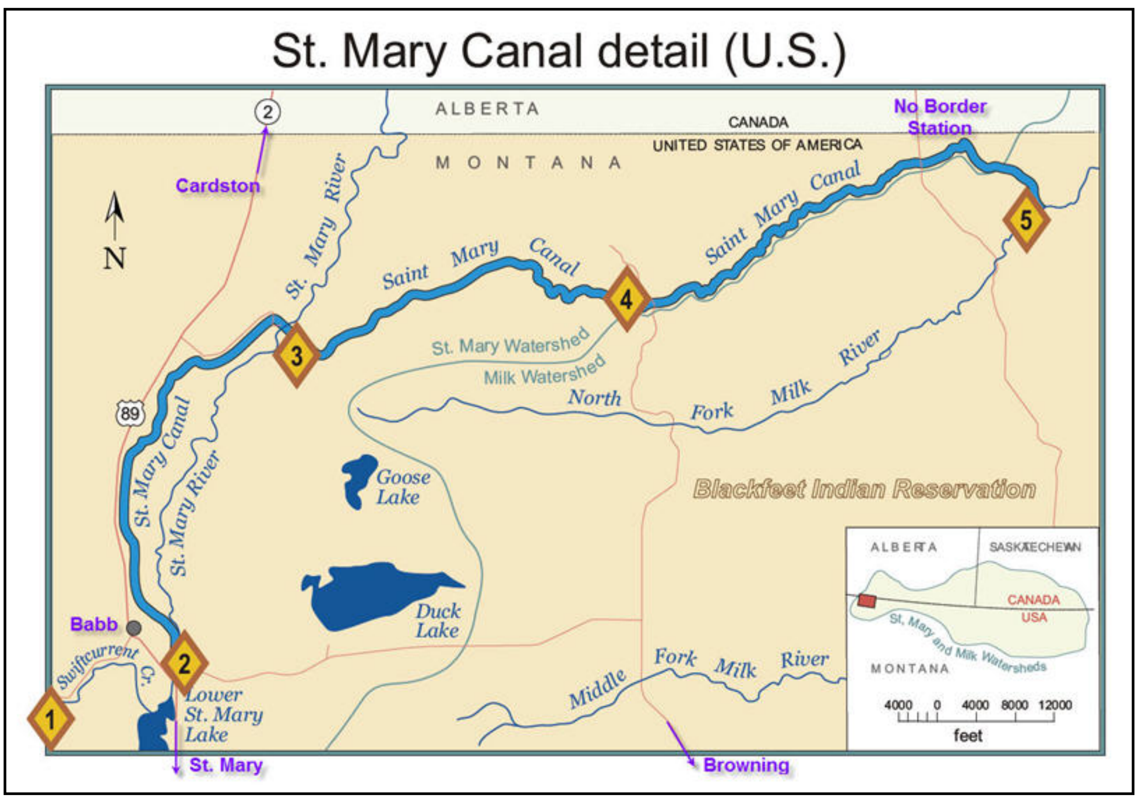
In 1982, the dam embankment was raised to a crest elevation of 4,814.5 feet using the reinforced earth concept. This provided additional surcharge to pass safely the inflow design flood. The probable maximum flood at Sherburne Lake Dam is 32,777 cfs, generating a volume of 69,000 ac-ft. The facilities that comprise Sherburne Dam are in reasonably good repair. The USBR recently contracted repair work to the twin outlet tunnels. They are also pursuing design of a new low level gate system that would allow for minimum winter time releases for the endangered Bull Trout.

b) Swift Current Dike

The Swift Current Dike directs the flow of Swiftcurrent Creek into Lower St. Mary Lake. If not for the dike, the creek could flow across the old alluvial fan and directly into the St. Mary River, perhaps downstream of the St. Mary Canal Diversion Dam. The Swift Current Dike is an earth and rock structure with a timber crib core. It is 13 feet high, 4,800 feet long at the crest and contains 98,000 cubic yards of material.

c) Montana U.S. St. Mary Canal

The U.S. St. Mary Diversion Works is located on the St. Mary River three-quarters of a mile downstream from Lower St. Mary Lake. It consists of a six-foot-high concrete weir and sluiceway with a length of 198 feet and a total volume of 1,200 cubic yards. The St. Mary Canal begins at St. Mary Diversion Dam on the west side of St. Mary River and crosses the river 9.5 miles below the diversion through a two-barrel steel-plate siphon 90 inches in diameter and 3,600 feet in length. Map 8.2 and Photo 8.2 depict the major features of the St. Mary Canal.



Map 8.2 – United States St. Mary Canal.

Photo 8.2 – U.S. St. Mary Canal and Diversion Dam on the St. Mary River.
Photo: U.S. Geological Survey

Eight miles below the St. Mary Crossing, a second two-barrel steel-plate siphon (78 inch diameter and 1,405 feet long) conveys water across Hall Coulee. A series of five large concrete drops at the lower end of the 29-mile canal provide a total fall of 214 feet to the point where water is discharged into the North Fork Milk River. Design capacity of the canal is 850 cfs. Due to degradation and slope failure issues, measured canal capacity at the inlet to the St. Mary River siphon is approximately 675 cfs: roughly equivalent to a diversion of 725 cfs at the canal headworks.

8.1.1.2 <u>Condition of the U.S. St. Mary Canal and Associated Infrastructure</u>

a) Diversion Dam

The Diversion Dam on St. Mary River downstream of Lower St. Mary Lake (Photo 8.3) is beyond its serviceable life. Deteriorating concrete and old gates, as well as the lack of a fish ladder, fish screens and a bypass structure, make replacement of the structure mandatory.

b) St. Mary Canal

The U.S. St. Mary Canal is a 29-mile, single-bank, contour canal (Photo 8.4). The dirt necessary for its construction was moved with horse or mule teams and fresnos (a type of scraper for moving earth). As the native grass and soil were not stripped before the embankment was built, the canal seeps more than it should. In addition, since there is no right-hand bank, water fills numerous draws and coulees contributing to the inefficiency of the canal. As the canal follows the contour of the land, it is perhaps as much as two miles longer than it could be. The canal is not fenced and suffers from livestock damage. In addition, the USBR has logged and continues to monitor as many as 19 slope failures along the downstream 19 or 20 miles of canal. This canal needs to be replaced with a straightened, two-bank canal, at a higher elevation.

Photo 8.3 – U.S. St. Mary Diversion Dam and Headworks.
Photo: John Sanders

c) St. Mary Siphon

The St. Mary Siphon is well beyond its design life and is exhibiting the results of deep-seated failure of the south slope. Over the past several years, siphon failures have caused the canal to be shut down during the irrigation season. USBR's Camp 9 crew continues to patch leaks in the pipes and install new slip-joint couplers.

A total failure of this siphon would affect Milk River irrigators. It would also cause environmental damage on the Blackfeet Indian Reservation and downstream (in Alberta) on the St. Mary River. This siphon needs to be replaced with a new, more efficient, structure. The need may also be shown for a higher capacity system. Steps should be taken immediately to remediate the south slope movement. Photo 8.5 shows the St. Mary Siphon.

d) Hall Coulee Siphon

Although the Hall Coulee Siphon (Photo 8.6) has not had a "shut-down" failure, it is nonetheless well beyond its design life. Slope monitoring instrumentation has not shown the same degree of movement at the Hall Coulee site that has been recorded at the St. Mary Siphon over the past three seasons. In the fall of 2008, a construction company under contract to the USBR installed three new slip-joint couplers. As part of a general rehabilitation of the St. Mary Project, the Hall Coulee Siphon needs to be replaced with a new, more efficient and perhaps higher capacity structure.

Photo 8.4 – U.S. St. Mary Canal. Photo: John Sanders

Photo 8.5 – St. Mary River Crossing Siphon. Photo: John Sanders

Photo 8.6 – Hall Coulee Siphon. Photo: John Sanders

e) Hydraulic Drop Structures

All five structures that drop the U.S. St. Mary Canal water from the Hudson Bay Divide to the North Fork of the Milk River (214 feet below) are in a deteriorated condition. Concrete walls are spalling (peeling apart). Rebar is exposed. Chute floors are unraveling. Holes in stilling basin walls below the drops allow water to migrate behind them and erode support material from around the structures.

Some form of repair occurs nearly every fall. In the fall of 2008, a USBR crew and a contractor made additional stop-gap repairs on drops two and three, respectively. In one case, a steel plate was used to cover a hole in a concrete wall.

The failure of a lower drop could lead to the successive failure of all drops above it. All five drops should be replaced soon. Given their location at the end of the project, they could be replaced even before a general rehabilitation is undertaken. Photos 8.7 through 8.9 show the drop structures, including their location and condition.

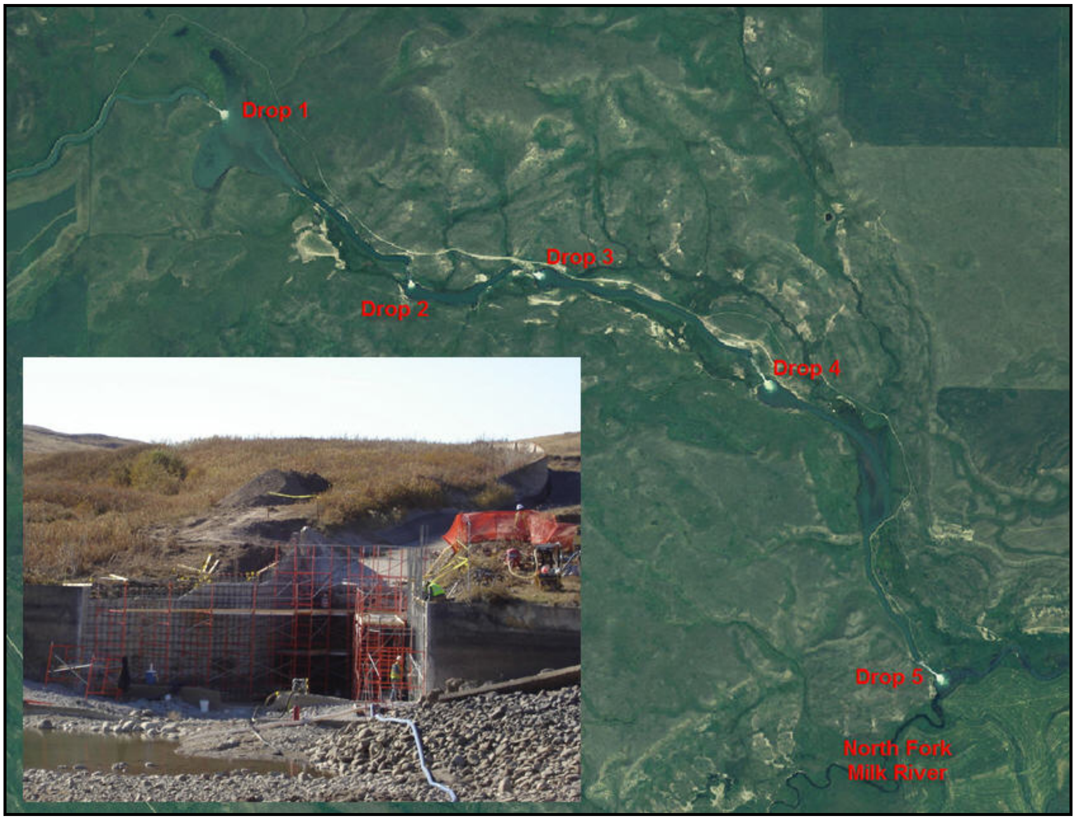


Photo 8.7 – U.S. St. Mary Canal Drop Structures. Photo: John Sanders

Photo 8.8 – Damage and Wear to the U.S. St. Mary Canal Drop Structures.
Photo: John Sanders

Photo 8.9 – Damage and Wear to the U.S. St. Mary Canal Drop Structures.
Photo: John Sanders

8.1.2 Montana Milk River Storage Dams and Reservoirs

8.1.2.1 Description of Milk River Infrastructure

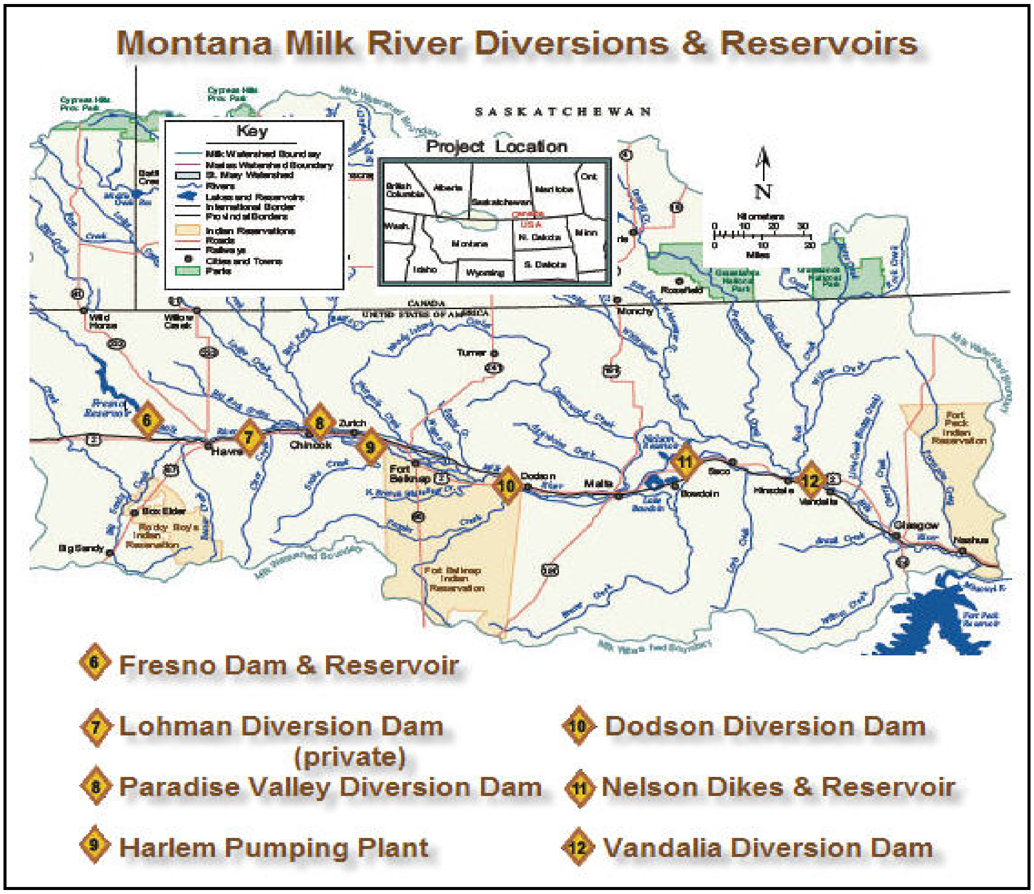
Major infrastructure in the lower Milk River is depicted on Map 8.3. Maps 8.4 through 8.9 at the end of this chapter provide more detail of the Milk River infrastructure, irrigation districts and other irrigated lands.

a) Fresno Dam and Reservoir

The Fresno Dam (Photo 8.10), located on the Milk River 14 miles west of Havre, Montana, is a compacted earth-fill dam with a structural height of 110 feet and a crest length of 2,070 feet. It contains 2,105,000 cubic yards of material. An overflow-type spillway at the north end of the dam provides for a flow of 51,360 cfs through the concrete-lined channel.

The outlet works discharge a maximum of 2,180 cfs through two 72-inch steel pipe outlet tubes. A normal full-pool active conservation storage of 92,880 ac-ft is impounded in Fresno Reservoir. Fresno Reservoir also provides flood control benefits.

A 1999 survey by the USBR showed that the original (1937) reservoir storage capacity of 130,000 ac-ft had been reduced by approximately 40,000 ac-ft to 92,880 ac-ft due to siltation. The DNRC estimates that average annual evaporation from Fresno Reservoir is about 5,800 ac-ft.



Map 8.3 - Major Infrastructure Features in the Lower Milk River Basin in Montana.

Photo 8.10 – Fresno Dam. Photo: Montana DNRC

b) Nelson Dikes and Reservoir

The Nelson Reservoir (Photo 8.11) located 19 miles northeast of Malta, Montana, provides off-stream storage for irrigation of Malta Division lands of the Milk River Project in the Saco and Hinsdale areas. A series of dikes, with a maximum structural height of 28 feet, crest length of 9,900 feet and total volume of 233,000 cubic yards, provides for storage of 79,224 ac-ft of water.

The DNRC estimates that average annual evaporation from Nelson Reservoir is about 6,700 ac-ft. The off-stream reservoir does not have a spillway. Slide gates installed in the Nelson North Canal outlet works permit releases of water to Milk River for use in the Glasgow Division of the Milk River Project. Slide gates installed in the Nelson South Canal outlet works permit releases of water for irrigation of Project lands in the Malta Division.

Photo 8.11 – Nelson Dam and Reservoir. Photo: Montana DNRC

8.1.2.2 Milk River Project Irrigation Districts Infrastructure

a) The Chinook Division

Water is diverted from the Milk River near Chinook and Harlem into private canals on each side of the river irrigating approximately 37,200 acres in the Chinook Division. All water supply and distribution works in the Chinook Division are owned, operated and maintained by the respective irrigation districts. The two diversion dams and pumping stations that provide water to irrigation districts in this Division are described below.

b) Lohman Diversion Dam

Lohman Diversion Dam (Photo 8.12) is located approximately ten miles west of Chinook, Montana. This privately owned dam diverts water from the Milk River into a main canal that conveys irrigation water to approximately 17,200 acres on the north side of the river in Fort Belknap, Alfalfa Valley and Zurich Irrigation Districts. The dam has a permanent concrete base that spans 128 feet across the Milk River.

The dam falseworks are assembled in the spring and dismantled in the fall. These consist of 31 vertical posts and braces that lock into stainless steel brackets along the concrete base. Thirty-two 16-foot 2x6s are nailed to the posts to complete the structure. Lohman Diversion Dam is functional and in good condition. It meets the needs of the irrigation districts it serves but has limited flexibility to respond to river dynamics as it lacks a sluiceway or means to adjust the dam crest.

The head works, located on the north side of the river, are 34 feet across and 15 feet high. They consist of three gates that are operated manually by threaded shaft and cable assemblies. The headworks are in good condition with a recently replaced gate. Water can be diverted from the Milk River up to 375 cfs into the main canal.

Photo 8.12 – Lohman Diversion Dam. Photo: Larry Dolan

c) Paradise Diversion Dam

Paradise Diversion Dam (Photo 8.13) was constructed by the USBR to replace a rock, log and brush dam destroyed by floodwaters in June 1965. Located on the Milk River near Chinook, Montana, the dam diverts water for irrigation in the Paradise Valley Irrigation District. The 200-foot-long concrete diversion structure includes a 100-foot ogee crest spillway with five-foot-high removable flashboard supports at 5-foot centers along the crest. It also includes abutment walls, wingwalls and cutoff walls. In addition, a sluiceway is equipped with a manually operated 5-by-6 foot cast-iron slide gate.

Crest elevation of the spillway is 2,390.5 feet. Extending from the right abutment of this concrete structure is a compacted earth-fill dike. The dike is 20 feet wide at the crest, constructed to an elevation of 2,401.5 feet. A cableway with a winch-operated cable car (used for maintenance and placement of flashboards when required) spans the spillway section of the dam. Paradise Valley Diversion Dam is in good condition.

The headworks are a six-bay concrete gate structure. It is deteriorated and in need of renovation. One of the gates is automated to make remote canal flow adjustments. Up to 175 cfs of water can be diverted from the Milk River into the Paradise Valley Main Canal to irrigate lands on the south side of the Milk River.

Photo 8.13 – Paradise Diversion Dam. Photo: Larry Dolan

d) Harlem Pumping Stations

Main Harlem Pumping Plant: A rock weir across the river, approximately three miles southeast of Zurich, Montana, provides the necessary hydraulic head to serve three electric pumps with 20 cfs, 40 cfs, and 80 cfs capacities to divert water from the Milk River. These pumps are housed at the head of the upper canal. They account for over 78% of the district's water supply by pumping up to 140 cfs into the Harlem Main Canal. This serves irrigated lands on the north side of the Milk River. The pump plant is in good condition (Photo 8.14).

Lower Harlem Pumping Plant: Two electric 20 cfs pumps supply water to the Lower Canal. The Lower Pumping Plant is located above the Bureau of Indian Affairs diversion dam, providing the necessary hydraulic head. These two pumps account for nearly 22% of the Harlem Irrigation District's pumped water supply. The combined capacity of the Lower Harlem Pumping Plant is 40 cfs and serves irrigated acres on the north side of the Milk River. The pumping plant is in good condition.

Photo 8.14 –Harlem Pumping Plant. Photo: Larry Dolan

e) The Malta Division

The Malta Division provides water to approximately 42,000 acres in Malta Irrigation District and 1,000 acres in the Dodson Irrigation District. In the Malta Division, two canals (the Dodson North and Dodson South) divert water at the Dodson Diversion Dam for irrigation of land near Dodson, Wagner, Malta, Bowdoin and Hinsdale. Dodson Pumping Plant lifts water from Dodson North Canal to irrigate lands above the gravity system near Dodson, Montana. The South Canal conveys water for irrigation between Dodson and Bowdoin, and for Nelson Reservoir. From this storage, land is irrigated on the south side of Milk River and on Beaver Creek near Saco and Hinsdale. Storage is released from Nelson Reservoir to the Milk River for Glasgow Irrigation District.

f) Dodson Diversion Dam and Canals

The Dodson Diversion Dam (Photo 8.15) on the Milk River, five miles west of Dodson, Montana, was a timber crib, weir-type structure with movable crest gates and an earth-fill dike section. In 2003 and 2004, the crest gates were replaced with inflatable bladders and a new apron was constructed downstream. The structural height is 26 feet. The total length of the dam with the associated headgates and dike is about 8,154 feet.

The Dodson North Canal, diverting on the north side of the river just above Dodson Dam, has a capacity of 200 cfs. It serves approximately 9,000 acres. The Dodson North Canal head works is a four-bay concrete slide gate structure.

The Dodson South Canal has a capacity of 500 cfs and conveys water for irrigation to Malta Division lands south of the Milk River. It also conveys water for Nelson Reservoir and the Bowdoin National Wildlife Refuge. The headgate structure is an eleven bay concrete slide gate structure. The 2003 renovation project on the Dodson Dam and headworks have left the facilities in excellent condition.

g) Dodson Pumping Plant

The Dodson Pumping Plant, located 2.5 miles northwest of Dodson, Montana, lifts water from the Dodson North Canal 20.5 feet to the Dodson Pump Canal which serves 1,147 acres of land in the vicinity of Dodson. Two impeller pumps of 15 cfs capacity each, driven by 50-horsepower electric motors, provide up to 30 cfs of water. The Dodson Pumping Plant is housed in a concrete building and is in good condition.

Photo 8.15 – Dodson Diversion Dam. Photo: Mike Dailey

h) The Glasgow Division

The Glasgow Division provides irrigation water for about 18,000 acres near Vandalia, Tampico, Glasgow and Nashua, Montana. Water is diverted at Vandalia Diversion Dam to the Vandalia Canal on the south side of the Milk River.

i) Vandalia Diversion Dam and Canal

The Vandalia Diversion Dam on the Milk River, three miles west of Vandalia, Montana, is a reinforced concrete slab and buttress weir-type structure with movable crest gates and an auxiliary spillway. The hydraulic height is 27 feet and the total crest length is 2,350 feet. The auxiliary spillway, 1,200 feet in length, is located north of the dam to provide adequate channel for extreme flood flows. The Vandalia Canal diverts on the south side of the river at the dam and conveys water to the land in the Glasgow Division. The canal has a design capacity of 300 cfs. The headworks are a concrete structure with two 4-by-5 foot slide gates. The head works have been renovated, but Vandalia Diversion Dam is in poor condition and in need of major rehabilitation (Photo 8.16).

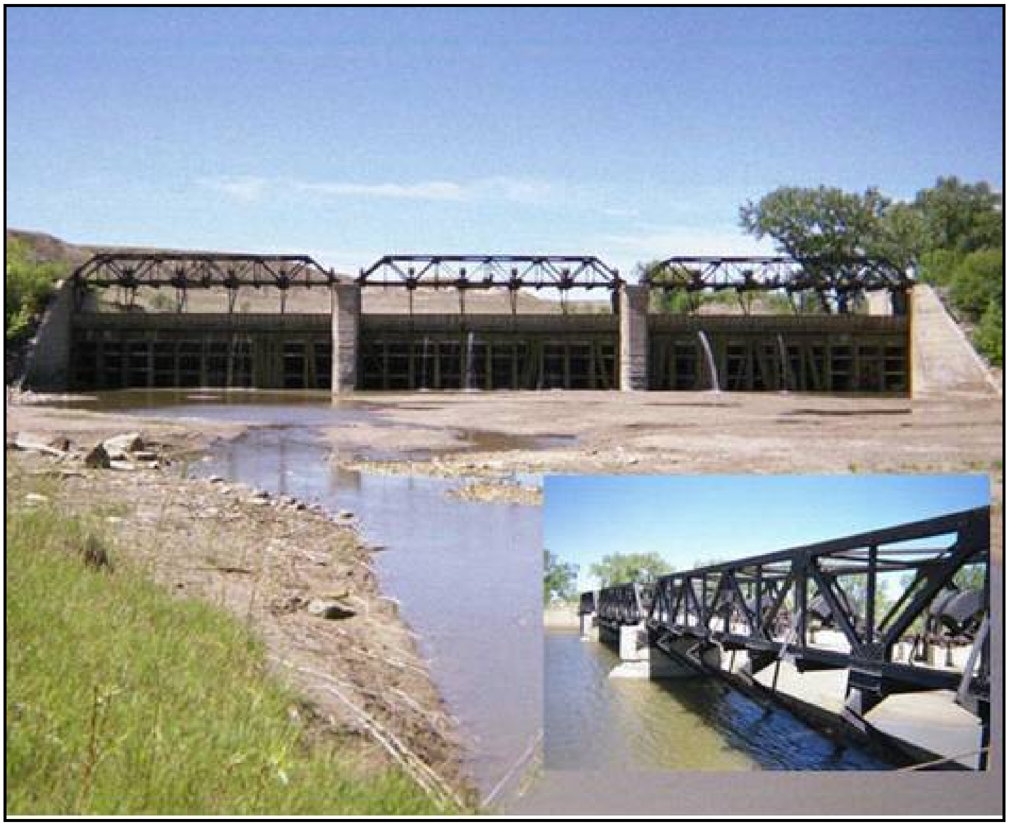


Photo 8.16 – Vandalia Diversion Dam. Photo: Montana DNRC

j) Fort Belknap Indian Reservation Irrigation Project

Water for the Fort Belknap Indian Reservation Irrigation project is diverted from the Milk River at the Fort Belknap Diversion Dam at the town of Fort Belknap (Photo 8.17). The United States Bureau of Indian Affairs (USBIA) has 10,425 acres assessed in the Fort Belknap Irrigation Project. Most of these lands are irrigated with water from the Milk River, although the Ereaux Unit has about 2,550 acres irrigated with water from Peoples Creek. About another 2,500 acres of land on the reservation are irrigated but are not part of the USBIA project.

8.1.2.3 Other Infrastructure

Other infrastructure not discussed in detail include but are not limited to municipal diversion works, rural water systems, Frenchman Dam on the Frenchman River, Beaver Creek Dam near Havre and Lake Bowdoin. These features are important locally but their overall effect on the water balance for the Milk River is relatively small.

Photo 8.17 – Fort Belknap Diversion Dam. Photo: Larry Dolan

8.1.3 Area Irrigated and Water Use

Approximately 145,000 acres are irrigated along the Milk River below Fresno Dam. The irrigated acres fit into four general categories:

1. Milk River Project Irrigation District: These are lands within irrigation districts that receive water from a common diversion and canal for multiple water users. These irrigation districts hold contracts with the USBR to receive water from the Milk River Project.
2. Milk River Project Pump Contractors: These are individual irrigators that have contracts with the USBR to pump Milk River Project water.
3. Tribal Irrigation: Tribal irrigators have rights to Milk River water reserved for use by the respective Tribes.
4. Private Claims and Permits: These are water rights held by individual irrigators and are not for Milk River Project water.

Table 8.1 provides an approximate inventory of the rights described above. In addition to these irrigated acres, there are about 60,000 acres irrigated by Milk River tributaries in the U.S. Most of these tributary acres are partial service irrigation because the tributaries generally do not provide a consistent, reliable water supply.

Table 8.1 – Milk River Irrigation below Fresno Dam.

	Water Right Category	Number of Farms/Irrigators/Water Right	Acres
Irrigation Districts			
	Alfalfa Valley	22	3,664
	Dodson	7	1,006
	Fort Belknap	65	6,482
	Glasgow	106	18,011
	Harlem	49	11,144
	Malta	206	42,487
	Paradise Valley	57	8,315
	Zurich	65	7,666
	Pump Contract	205	11,529
	Indian	Not Available	10,000
	State Based (non USBR)	340 (approx-Not screened for duplicate acres)	25,000
	Totals		**145,304**

8.1.3.1 Crop Mix

Montana's Milk River Valley is predominantly a cow-calf cattle raising area. Most irrigated crops go into winter feed for cattle. The Milk River irrigated crop mix varies from year to year but averages about 20 percent grain and 80 percent hay. The hay crops are made up of alfalfa, grass and a mixture of the two. Some other crops are raised under Milk River irrigation but the figures are not typically significant.

8.1.3.2 Irrigation System Types

Flood irrigation accounts for about 79 percent of Milk River irrigation. About 21 percent is under a sprinkler system. The average on-farm irrigation efficiency is estimated to be 42.9 percent. Table 8.2 provides a summary of irrigation methods in Montana's portion of the Milk River basin.

Table 8.2 – Summary of Milk River Project Irrigation Methods in Montana.
SOURCE: Milk River On-Farm Irrigation Study, January 25, 2005

Irrigation Method	Percent of Total Acres	Field Efficiency (%)
Flood, leveled lands	54	49.9
Flood, unleveled lands	24	26.4
Sprinkler, Pivot	12	49.2
Sprinkler, Wheel Line	10	49.2

8.1.3.3 Irrigation Water Use

Milk River Project irrigators are the primary water users during the irrigation season. Total annual irrigation diversions fluctuate with the amount of available water and weather conditions. Previous canal efficiency studies estimate conveyance efficiencies are about 75 percent. Studies estimate on-farm efficiency to be 42.9 percent. Given this, overall irrigation efficiencies are approximately 32 percent. Attempts to calculate consumptive use by using the efficiency estimates does not agree with the reliable data derived from stream and diversion gauging stations, mapped acreages, crop requirements or actual production.

Quantifying return flow is equally problematic. Very little data is available that quantifies the timing, volume or rates of return flows. Previous modeling efforts adopted a basic rule of thumb that 70 percent of return flows come back within the first month, 20 percent in the second month and 10 percent in the third month.

In lieu of substantive return flow data, the difference between releases at Fresno Dam and the total amount of water diverted supports what is widely known: that return flows are an important component of Milk River Project operations (See Table 8.3). In a typical year, the irrigation diversion allotment is about 1.9 ac-ft per acre irrigated, compared to 1.6 ac-ft per acre released from Fresno Dam. Through analysis of basin-wide water budgets and agricultural statistics, annual crop consumption per acre irrigated in the Milk River basin might average about 12 inches. Tributary contributions to Milk River Project irrigated land are typically inconsequential under normal conditions because when usable tributary flows do occur during the irrigation season, they are diverted by irrigators on those streams.

Table 8.3 – 2005 - 2008 Irrigation Season Totals in Acre-feet for April-Sept.

Diversions	2005	2006	2007	2008	Annual Average 2005-2008
Fresno Dam Releases	195,417	247,350	199,333	201,926	211,007
Lohman Div Dam	49,487	56,394	56,796	45,632	52,077
Paradise Valley Div Dam	15,325	21,741	15,348	19,697	18,028
Harlem Pump Stations	16,146	17,447	19,298	13,059	16,488
BIA Dam	15,036	16,582	16,171	12,795	15,146
Dodson Div Dam N Canal	19,578	28,683	23,537	35,020	26,705
Dodson Div Dam S Canal	45,792	38,526	32,986	52,781	42,521
Nelson S Canal	28,886	26,473	24,093	16,301	23,938
Glasgow Div Dam	35,132	44,680	30,552	31,053	35,354
Estimated Contract Pumps	18,446	18,446	18,446	18,446	18,446
Phreatophytes	15,307	15,307	15,307	15,307	15,307
Total Irrigation Diversion	**243,829**	**268,973**	**237,228**	**244,784**	**248,703**

8.1.4 Montana Water Management and Operations

8.1.4.1 St. Mary Unit

a) Lake Sherburne Reservoir

Sherburne Reservoir, on Swiftcurrent Creek, has an active storage capacity of 66,147 ac-ft when at a full-pool elevation of 4,788 feet. There are 1,899 ac-ft of inactive or "dead" storage below elevation 4,729.3 feet. However, releases are generally discontinued when the storage gets down to approximately 3,000 ac-ft to avoid mobilizing sediment from the reservoir bed. The capacity of the outlet works is about 2,100 cfs. Figure 8.1 depicts how Sherburne Reservoir storage is allocated.

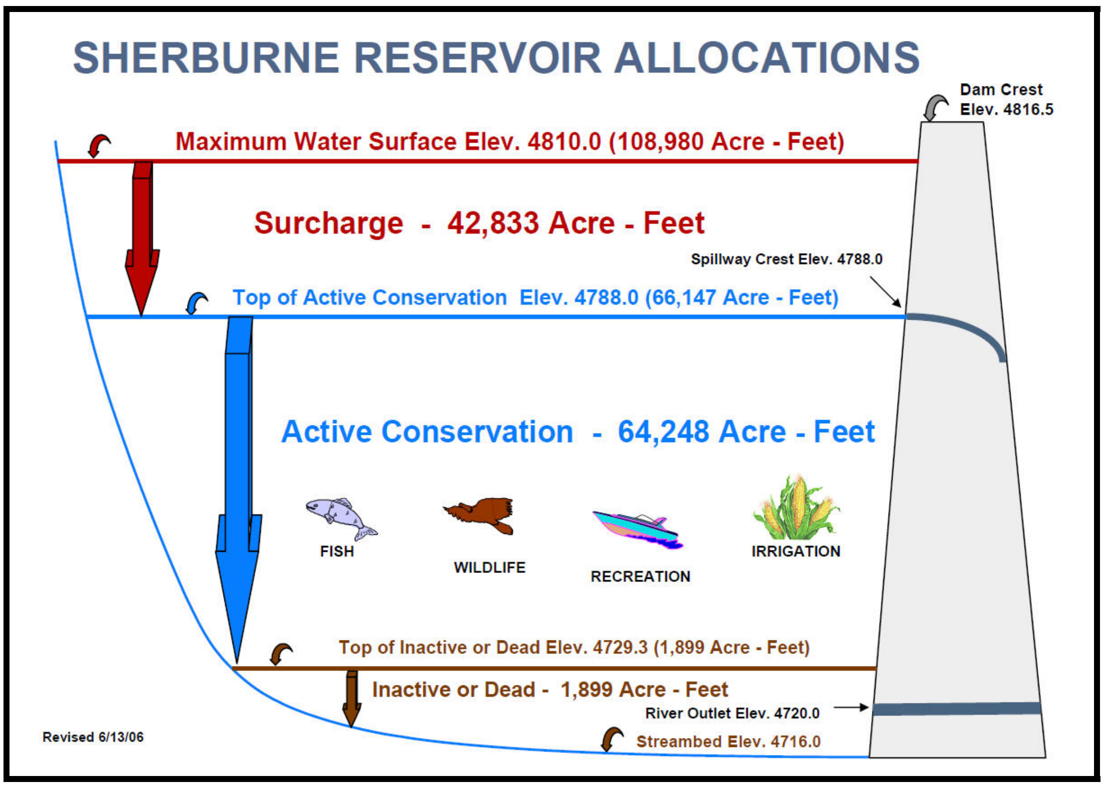


Figure 8.1 – Sherburne Reservoir storage allocation diagram (Source: USBR).

Inflows to Sherburne Reservoir are stored through the winter. Releases from the reservoir outlet at this time are essentially zero. Inflows during November through February normally amount to about 15,000 ac-ft. The March 1st target storage is about 40,000 ac-ft. If the reservoir carry-over storage going into the fall is greater than about 26,000 ac-ft, the excess water is released to avoid undercutting of the grouted riprap on the upstream face of the dam. Once releases are initiated in the spring, the minimum release is about 25 cfs, which corresponds with the minimum gate opening.

Spring water releases from Lake Sherburne are made to supplement U.S. entitlements, which generally are less than the available canal capacity at this time of year. Flood control considerations also are taken into account when controlling reservoir levels during the spring, although there is no official flood-control target level for the reservoir. Runoff forecasts that are prepared by the U.S. Natural Resource Conservation Service (USNRCS) and USBR are used to plan seasonal operations. Starting anywhere from early-March to mid-April, the U.S. begins operations of the St. Mary Canal. Sherburne Reservoir releases are closely tied to canal operations. Because the canal is started before the bulk of the mountain snowmelt begins, water is released from Sherburne Reservoir to provide additional flows needed to operate the canal. One goal of these early spring operations is to move water that was stored in Sherburne Reservoir during the winter to the Milk River system in the U.S., where it can subsequently be stored in Fresno and Nelson Reservoirs. When releases are initiated early in the spring, about 2,500 ac-ft of the stored water is needed to raise Lower St. Mary Lake to a level where the St. Mary Canal can divert 600 cfs.

These early spring operations will draw Sherburne Reservoir down prior to significant snow-melt runoff. This lost storage will be recaptured when the mountain snowmelt runoff starts to peak. The U.S. share of natural flow from the upper St. Mary River alone often is sufficient to fill the St. Mary Canal. The goal is to fill Sherburne Reservoir before the runoff starts to subside in mid-July, with July 4th sometimes being a target fill date.

Following the runoff peak, natural flows will decline to the point where the U.S. will again need to release water from Sherburne Reservoir in order to keep the St. Mary Canal running near full. Based on historic operations, the maximum release to satisfy canal diversion needs is generally not greater than 750 cfs. During drier years, Sherburne Reservoir storage can be exhausted as early as mid-August. In wetter years, there can be substantial storage left in Sherburne Reservoir at the end of the irrigation season. The U.S. will generally operate the canal until about the first part of October, if enough stored water and natural flow is available. At the end of the operating season, the USBR's goal is to have most of the Lake Sherburne storage moved to Fresno Reservoir. When releases are discontinued in the fall, the outlet is completely closed.

The operations of Sherburne Dam are depicted in Figure 8.2 which shows median modeled reservoir inflows and outflows. Peak inflows to the reservoir generally occur in the May-June period while peak releases are in July, August and September. Also, note the early spring releases that can be made in March, April and early May, used to get the St. Mary Canal started for the season.

b) U.S. St. Mary Canal

St. Mary Canal is 29 miles long with an original design capacity of 850 cfs. The current condition of the canal prevents the maximum flow from exceeding about 650 cfs beyond the St. Mary River siphon. About 90% of the amount measured at the St. Mary Canal siphon gauge reaches the Milk River at the Eastern Crossing of the International Boundary. The rest is lost to seepage and evaporation from the canal and from the Milk River between the Eastern and Western Crossings.

St. Mary Canal spring startup is dependent on the need for water in the Milk River basin. If sufficient runoff is expected to occur in the Milk River basin upstream of Fresno Reservoir, startup of the St. Mary Canal is delayed until late April. If natural runoff in the Milk River basin is expected to be low, or Fresno and Nelson storage is much below normal, then startup of the St. Mary Canal can occur in early March if weather conditions permit. Snow removal from the St. Mary Canal by excavator is often necessary for early startup.

Due to unstable soil and the age of the structures, the USBR minimizes the number and quantity of flow changes made to the canal. Canal flows are not incrementally raised or lowered more than 150 cfs during a day, and generally much less. Once the canal has been filled to capacity, the USBR adjusts releases at Lake Sherburne to control the U.S. entitled share of the St. Mary River. The exception to this would be if both downstream reservoirs on the Milk River are at or near capacity and the water is not needed. Table 8.4 summarizes St. Mary Canal monthly operations for the 1987 through 2006 period.

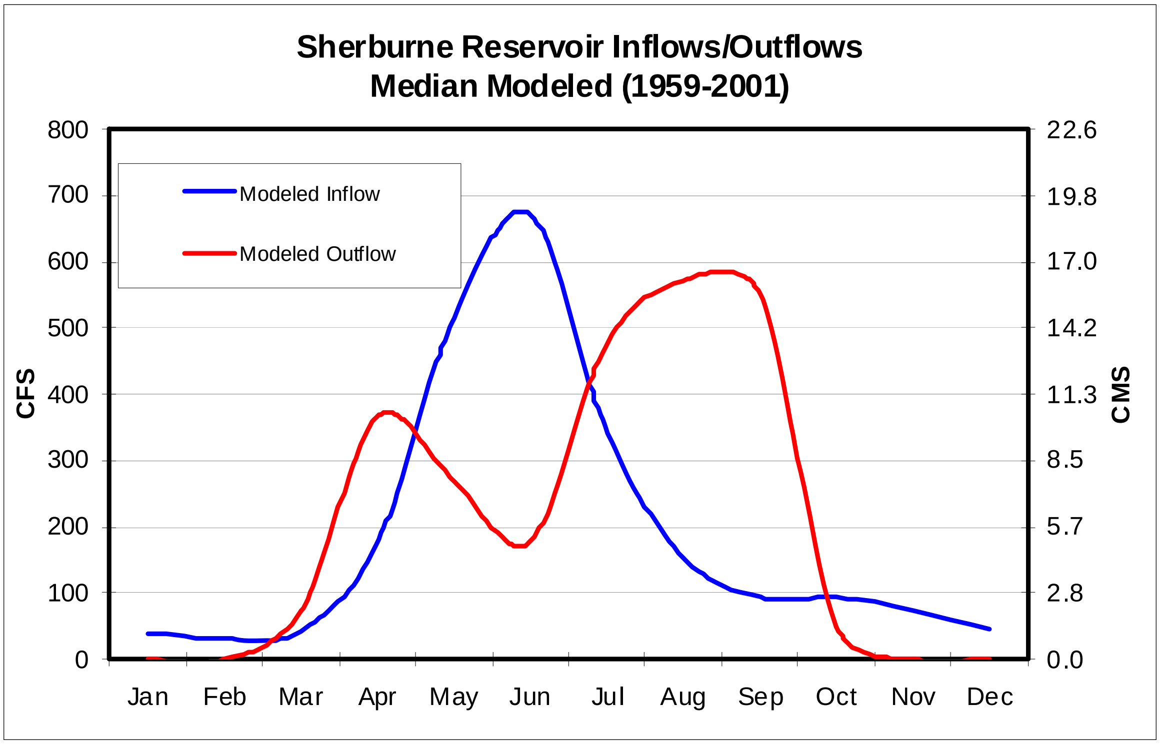


Figure 8.2 – Modeled Median Sherburne Reservoir inflows and outflows.

Table 8.4 – St. Mary Canal Mean and Maximum Discharge at the St. Mary Siphon for the Period 1987 through 2006.

Month	Mean Discharge (cfs)	Maximum Discharge (cfs)
March	88	348
April	323	610
May	553	681
June	553	718
July	534	691
August	511	636
September	327	622
October	45	473

c) Water Supply Data

Water supply forecasts are used in planning the operations of Sherburne Reservoir and the St. Mary Canal. At the beginning of each month from January through June, runoff volume forecasts for April through July runoff are developed. The USNRCS and USBR prepare runoff forecasts for Swiftcurrent Creek flow into Lake Sherburne. The USNRCS also prepares a runoff forecast for the St. Mary River at the International Boundary using mountain snowpack information and fall and winter precipitation. They assume average spring precipitation. These forecasts for the St. Mary and Milk River basins are coordinated with the stream flow forecast staff in Alberta. The USBR uses four SNOTEL (Snowpack Telemetry) sites to track seasonal mountain snowpack. The four sites are Pike Creek at elevation 5,930 feet; Emery Creek at 4,350 feet; Many Glacier at 4,900 feet Mean Sea Level (MSL); and Flattop Mountain at 6,300 feet MSL. Information from these sites is available on the USNRCS website or USBR's Hydromet website.

The USBR also funds the U.S. National Park Service, working in conjunction with Water Survey of Canada, to collect data at five additional snow courses during late April above Lake Sherburne. This data is supplied to the USNRCS and reported on May 1st as mountain snow water equivalent. The snowpack information is used to estimate the date that peak inflow to Lake Sherburne will occur. Mountain snowpack generally peaks during mid- to late-April, and Lake Sherburne inflows generally peak between May 25 and June 15.

The USBR uses data from numerous stream gauges in the basin for making operating decisions (Table 8.5). Data is collected in 15 minute increments and transmitted via satellite every four hours. Many of the gauges have been updated with High Data Rate (HDR) satellite transmitters that send data hourly. All of the gauging stations will be converted to HDR within the next few years.

Table 8.5 – St. Mary River Basin Stream Gauges Used for Operations.

Station Name	Reclamation Station Code	USGS Station Code
Grinnell Creek at Grinnell Glacier	GCRM	05013900
Swiftcurrent Creek at Swiftcurrent Lake	SCLM	05014300
Swiftcurrent Creek at Many Glacier	SMGM	05014500
Lake Sherburne	SHER	05015500
St. Mary Canal at Intake near Babb, MT	SMIM	05018000
St. Mary Canal at St. Mary Crossing, near Babb, MT	STMC	05018500
St. Mary River near Babb, MT	BABB	05017500
St. Mary River at International Boundary	STMB	05020500

The USBR currently utilizes a monthly operations model to make water operation decisions for the Upper St. Mary River system and the rest of the Milk River Project. This model uses estimates of expected streamflows and demands for the next 12 months. It integrates the operation of Lake Sherburne, the St. Mary Canal and Fresno and Nelson Reservoirs. The operations model is discussed further in the Fresno Reservoir operations section.

d) International Treaty

Beginning in April, USBR offices at Babb and Billings receive copies of the interim international water division accounting shortly after the 15th and end of each month from the USGS and Water Survey of Canada. Because the official accounting is finalized after the operating season, it is not used for daily operations.

During the operating season, USBR personnel in Billings and Babb analyze the discharge data every morning to make operational decisions. If operational changes are needed to satisfy Treaty obligations or to capture the maximum amount of water entitled to the U.S., the releases are adjusted at Lake Sherburne, while canal flows are held steady. The conditions of the 2001 Letter of Intent (See Section 5.1.5) are also accounted for in system operations.

e) Endangered Species

The Bull Trout is the only endangered species that affects operations in the St. Mary Unit of the Milk River Project. After releases from Lake Sherburne are discontinued in the fall, the USBR assists the U.S. Fish and Wildlife Service relocate any stranded bull trout in Swiftcurrent Creek, from the Lake Sherburne Dam outlet down to the confluence of Boulder Creek. There are other species of concern in the St. Mary basin but currently they have no effect on operations.

8.1.4.2 Milk River Unit

a) Fresno Reservoir

General Operations: Fresno Reservoir was completed in 1937 with a storage capacity of about 130,000 ac-ft. In a 1999 hydrographic survey, total storage capacity of Fresno Reservoir was 92,880 ac-ft at the full-pool elevation of 2,575 feet. The 448 ac-ft of water that is below elevation 2,530 feet is dead storage. The capacity of the outlet works is about 2,180 cfs. Figure 8.3 depicts how reservoir storage in Fresno Reservoir is allocated.

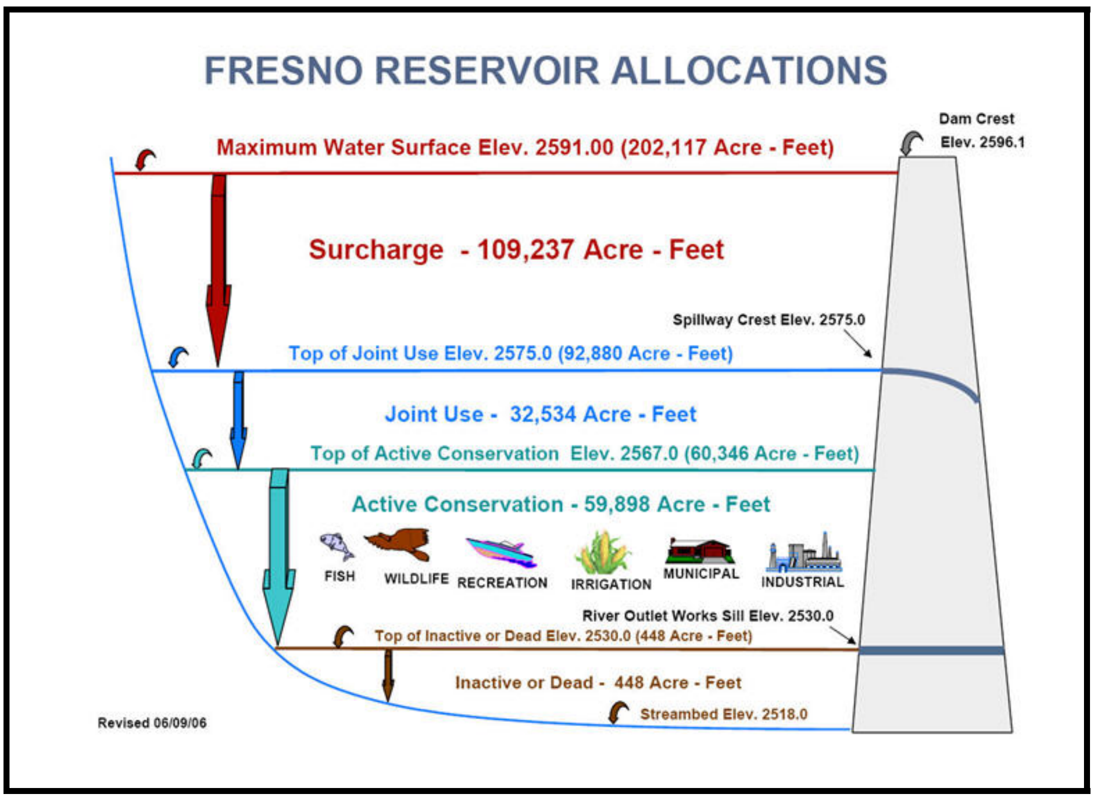


Figure 8.3 – Fresno Reservoir storage allocation diagram (Source: USBR).

Following the irrigation season (normally mid- to late-September), storage content in Fresno Reservoir is evaluated. Water in excess of 50,000 ac-ft is transferred downstream for storage in Nelson Reservoir, if it is needed there. If water cannot be transferred to Nelson Reservoir, then water releases from Fresno Reservoir might be made so storage is not projected to exceed the March 1st target elevation of 2,567 feet or approximately 60,000 ac-ft. This elevation (2,567 feet) is identified as the top of Active Conservation pool. Water stored above this elevation is part of the Joint Use pool for flood control and conservation purposes.

The minimum required winter release from Fresno Reservoir to satisfy contractual obligations is 25 cfs. However, the current minimum gate opening usually results in a minimum release of about 40 cfs. While releases are generally not increased above this rate until irrigation deliveries begin, or when water transfers to Nelson Reservoir are made, the USBR will increase releases as actual or forecasted hydrologic conditions warrant.

Milk River natural peak runoff is typically from plains snowmelt and usually occurs during March or early April. This runoff can add a substantial amount of flow to the Milk River below Fresno Reservoir. Fresno releases during this peak runoff period are set low to minimize flooding when downstream inflows are high. The reservoir is managed to maintain storage at or below the normal full-pool level elevation of 2,575 feet to capture upstream peak flows.

The channel capacity of the Milk River below Fresno Reservoir is approximately 4,500 cfs. When water levels enter the flood control pool at elevation 2,575 feet and inflows are anticipated to increase, USBR operations of Fresno Reservoir are coordinated with the U.S. Army Corps of Engineers and with downstream county disaster management agencies.

During the late spring and summer, Fresno Reservoir is operated to meet downstream irrigation demands. Releases of less than 1,200 cfs are normally sufficient but up to 1,500 cfs may be released for short periods when necessary. Releases of 1,500 cfs are generally limited to less than one week to avoid erosion of river banks. Figure 8.4 depicts average historic gauged flows in the Milk River just downstream of Fresno Reservoir near Havre for wet, typical and median years.

Storage in Fresno Reservoir is maintained at no less than 15,000 ac-ft following the irrigation season in low water years. This amount is necessary to provide the winter release until the following runoff season. Fresno Reservoir storage can be reduced below this amount during the irrigation season, if water is available in the St. Mary River Basin to transfer to Fresno Reservoir prior to the fall shutdown of the St. Mary Canal.

At the beginning of each month from January through June, the USNRCS prepares runoff volume forecasts for the Milk River at the Eastern Crossing of the International Boundary. They also prepare a volume forecast for the irrigation season (March-September) at the Eastern Crossing, which provides an estimate of the total seasonal water supply. During the irrigation season, the Eastern Crossing forecast has to be reduced to account for upstream diversions and channel losses. Table 8.6 shows the reduction factors by month for the irrigation season.

Operation Plans: Beginning in October of each year, the USBR prepares Milk River Project annual operation plans for a range of hydrologic conditions, which are updated each month thereafter. The anticipated operations are reflected in the *Most Probable Runoff* operating scenario in the plan. Operational plans are also included for extremely dry and extremely wet (the minimum and maximum probable runoff probable operating scenarios) conditions. These annual operating plans are developed using historical inflow distributions and conform to the operation guidelines for Lake Sherburne and Fresno Reservoir. Beginning in January or February, these 12-month operating plans are modified to include the stream flow estimates in the April-through-July runoff forecasts.

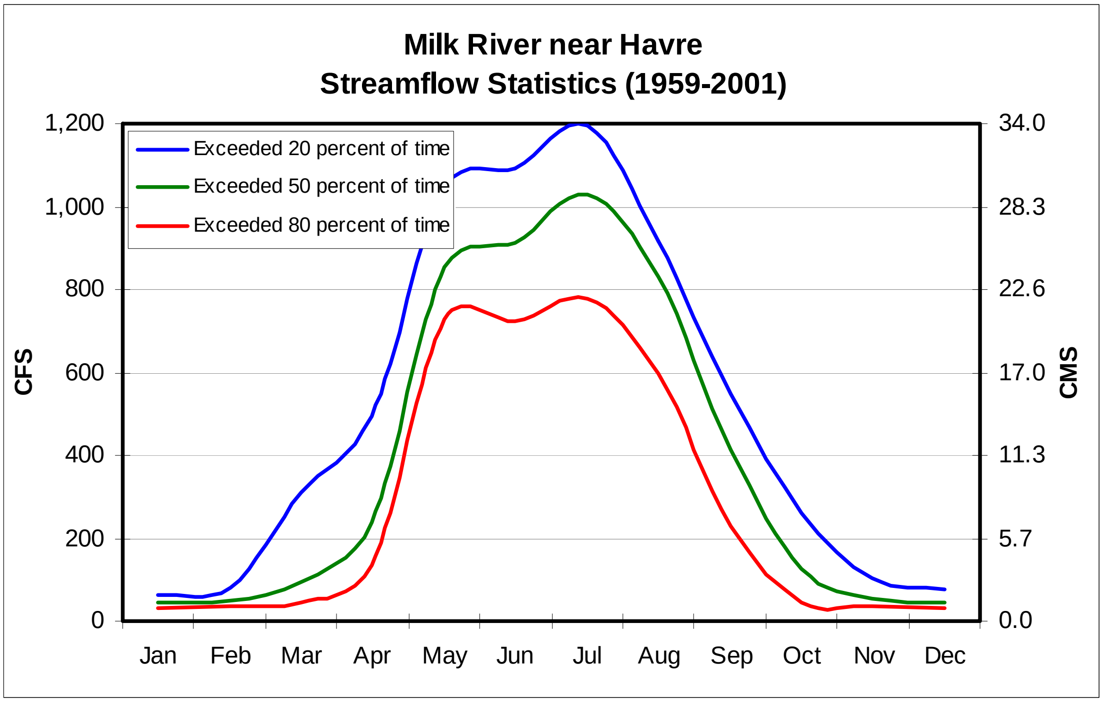


Figure 8.4 – Recorded (gauged) streamflow for the Milk River near Havre. (Source: USGS recorded streamflow data).

Table 8.6 – Reduction Factor for Natural Flow at the Eastern Crossing by Month.

Month	Reduction Factor
March	1
April	1
May	0.5 [0.75]
June	0.33 [0.5]
July	0.1 [0.25] or if <5 KAF then 0
August	0.33 or if <3 KAF then 0
Reduction Factor should be increased for above normal precipitation	

These operation plans are also used to help determine when to begin diversion with the St. Mary Canal, diversion rates, future possible storage levels and when to move water to Nelson Reservoir. The operation plans and stream flow forecasts are provided to the irrigation districts, DNRC, City of Havre and various other entities.

Water Allotments: The USBR meets with all of the Milk River irrigation districts, which form the Milk River Joint Board of Control, in March after water supply forecasts are available and the March operation plan is complete. The purpose of this meeting is to review the water supply conditions with the water users, determine how much water will be moved to Nelson Reservoir and determine the preliminary water allotments that Milk River Project users might receive. The operation plan also includes the estimated portion of water supply that will be allocated to the Ft. Belknap Indian Irrigation Project (FBIIP) and the Bowdoin National Wildlife Refuge.

In April, the USBR again meets with the irrigation districts to decide on when irrigation releases will begin, and to finalize the initial water allotment for the irrigation season. The operation plan is adjusted throughout the summer as conditions warrant. For Milk River Project lands, generally a water supply of 1.9 ac-ft per acre at the headgate is considered a full water supply. If all of the allotments and operating criteria are met and there is still water in the system, then irrigation allotments may be increased to above two ac-ft per acre. The allotment for USBR's water service contracts (river pumpers) is limited by their contracts to two ac-ft per acre, even if the Milk River Joint Board of Control (which actually determines the final allotments for irrigation district irrigators) allows the irrigation district users a higher allotment.

Initiating Irrigation Releases: If irrigation begins when river levels are low, releases from Fresno Dam must be 100-150 cfs above the irrigation demands for 5-to-7 days to make up for river losses. Releases are ramped up with changes of greater than about 100 cfs being made during the course of the day in increments of 50-75 cfs, with total daily release changes limited to 150 cfs. This is done to avoid sudden water level changes that might affect water intake structures, and to decrease the potential for erosion and suspended sediment mobilization. The Havre water plant is notified anytime reservoir releases are changed more than 150 cfs so that they can plan for changes in water levels and turbidity that might occur. Tributary inflows between Fresno Reservoir and the Harlem Gauging Station are monitored and assessed when determining release changes.

Water Orders: During the irrigation season, the irrigation districts are required to place water orders from Fresno, for increases and decreases, in advance of changing diversion rates in their respective canals. This is to account for the time it takes for scheduled water releases to travel down the river. Water order-based releases from Fresno Dam are adjusted to include river loss and increased by 11 percent to account for use by USBR river pump contract holders. Table 8.7 lists the advanced notice that is required for placing water orders for each district, and the percent of river loss added to determine the release from Fresno Reservoir.

Table 8.7 – Water Order Notification and River Loss for Releases from Fresno Dam.

Irrigation District	Advance Notice in Days	River Loss %
Fort Belknap Alfalfa Valley Zurich	2	1.4%
Paradise Valley	3	2.0%
Harlem	3	2.5%
Fort Belknap IIP	4	3.3%
Malta	7	5.1%
Glasgow	14	10.0%

Once the river is charged and flows have stabilized, release changes are made at Fresno Dam. These are to maintain a target flow of 400 to 450 cfs at the Harlem Gauging Station. This is generally sufficient to satisfy the downstream Malta Irrigation District's water order.

Deliveries to Glasgow Irrigation District: Water releases from Fresno Reservoir specifically for the Glasgow Irrigation District (GID) are impractical and inefficient due to the distance the water needs to travel. Water that is diverted by GID is usually a combination of the following: (1) accretions between Dodson Dam and Vandalia Dam; (2) return flows from Malta Irrigation District; and (3) supplemental releases from Nelson Reservoir into the Milk River as needed. Approximately one-half of GID's water allotment is moved from Fresno Reservoir and stored in Nelson Reservoir prior to the beginning of the irrigation season.

Ft. Belknap Agency's Storage in Fresno Reservoir: The Ft. Belknap Indian Irrigation Project (FBIIP) diversion dam is located immediately upstream of the Harlem gauge near the town of Harlem, Montana. The FBIIP has the senior water right for the Milk River natural flow up to 125 cfs plus 1/7 of the natural flow of Milk River water stored in Fresno Reservoir. The Tribes' maximum storage in Fresno Reservoir is currently 13,269 ac-ft and decreasing as sediment reduces Fresno Reservoir's total capacity. The accounting for FBIIP's storage in Fresno Reservoir begins on March 1st each year and is computed every two weeks thereafter.

Bowdoin National Wildlife Refuge: The Bowdoin National Wildlife Refuge receives 3,500 ac-ft per year from Fresno Dam. When the water supply is below average and the Milk River Project irrigators receive less than two ac-ft/acre, the Refuge allotment is reduced proportionally. The Refuge generally diverts water into Lake Bowdoin in March through early May or in September, receiving its water via the Dodson South Canal, operated by Malta Irrigation District.

b) Nelson Reservoir

Basic water data: Nelson Reservoir is an off-stream storage facility with a total capacity of 78,950 ac-ft at elevation 2221.6 feet. The 18,140 ac-ft of storage below elevation 2,200 feet is inactive or "dead" storage. Nelson Reservoir has two outlets. The south outlet releases water to the Nelson South Canal (capacity of about 250 cfs) to serve irrigated lands in the south-eastern portion of the Malta Irrigation District. The north outlet (capacity of up to 500 cfs) releases water back to the Milk River, primarily for the Glasgow Irrigation District. Releases to the south canal are difficult to make when Nelson Reservoir water levels fall below an elevation of 2,203.90 feet. Figure 8.5 is a storage allocation diagram for Nelson Reservoir.

General Filling and Release Procedures: Following the irrigation season, storage content in Fresno Reservoir is evaluated. Stored water in excess of 50,000 ac-ft is transferred from Fresno to Nelson Reservoir. Depending on water supply conditions, water is again transferred to Nelson Reservoir in the spring. During the fall, winter and early spring, Nelson Reservoir loses about 1,800 ac-ft per month due to seepage. For this reason, when extremely dry conditions exist, water users prefer to keep storage in Fresno Reservoir and make releases to fill Nelson Reservoir during the spring. Inflows to Nelson Reservoir are limited by canal capacity to about 450 cfs, so it can take weeks to transfer water to the reservoir. The volume of water moved to Nelson Reservoir in the spring might be adequate to satisfy the irrigation allotment for Malta Irrigation District water users on the Nelson South Canal, and approximately half the allotment for Glasgow Irrigation District downstream.

Endangered Species: Nelson Reservoir filling can be affected by nesting of the piping plover, an endangered species. If plover nesting activity is documented, then the water level in Nelson Reservoir is to remain steady or decrease from the peak content that occurred on or before May 15. An exception to this rule is when the water supply is very low and the additional storage in Nelson Reservoir absolutely needs to be filled to meet irrigation demands. In these instances, U.S. Fish and Wildlife Service personnel will move piping plover nests to higher elevations along the reservoir, allowing more water to be stored in the reservoir. If no plover nesting is identified through field surveys, no such restriction will be placed on the operations of Nelson Reservoir.

c) Milk River Stream Gauging Network

The USBR uses data from numerous stream gauging stations in the basin for making operating decisions. All major canal diversions are measured and monitored by telemetry to assist with water management. Tributary inflows into the Milk River between Fresno Reservoir and the Harlem Gauging Station are monitored to help manage releases from Fresno Dam. Table 8.8 is a list of stream and canal gauging stations that the USBR uses for operation of the Milk River Project.

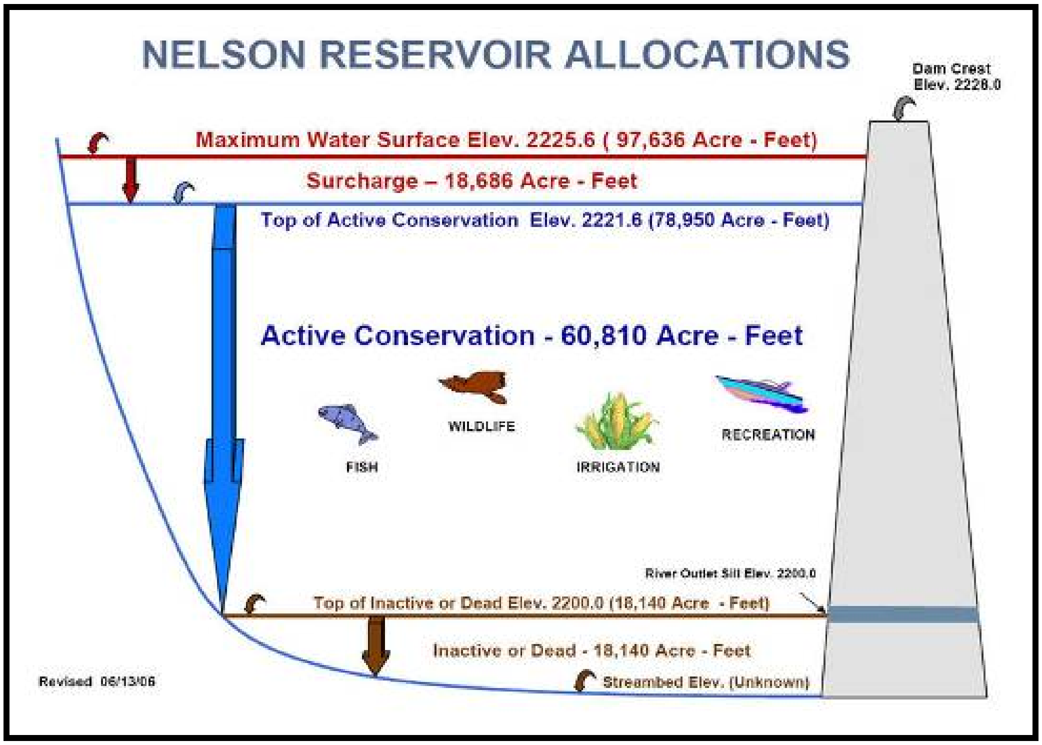


Figure 8.5 – Nelson Reservoir storage allocation diagram (Source: USBR).

Table 8.8 – Milk River Stream and Canal Gauging Stations.

Station Name	Reclamation Station Code	USGS Station Code
North Fork Milk River above St. Mary Canal	NFMA	06133500
North Fork Milk River at International Boundary	NFMB	11AA001
Milk River at the Western Crossing of International Boundary	MRWC	11AA025
Milk River at Milk River, AB	MRMR	11AA005
Milk River at the Eastern Crossing of International Boundary	MREC	06135000
Fresno Reservoir	FRR	NA
Milk River at Havre, Montana	MHVM	06140500
Big Sandy Creek near Havre	BSCK	06139500
Clear Creek near Chinook	CLCK	06142400
Ft. Belknap Canal (Total for Ft. Belknap, Alfalfa Valley, and Zurich Irrigation Districts)	FTBELKMT	NA
Alfalfa Valley Irrigation District Canal (Total Alfalfa Valley and Zurich Irrigation Districts)	ALFVALMT	NA
Zurich Irrigation District Canal	ZURICHMT	NA
Battle Creek near Chinook	BACK	06151500
Paradise Valley Irrigation District Canal	PARDISMT	NA
Harlem Irrigation District Canal Diversion	HARLEMMT	NA
Harlem Secondary Pumps	HSCM	NA
Fort Belknap Indian Irrigation Canal Diversion		
Milk River at Harlem	MRHM	
Dodson North Canal Diversion	DODM	NA
Dodson South Canal Diversion	DSCM	NA
Dodson Pump Diversion	DPCM	NA
Milk River at Dodson	MRDM	06155030
Nelson Reservoir	NELR	NA
Nelson South Canal	NSCM	NA
Nelson North Canal	NNCM	NA
Milk River at Cree Crossing	MCCM	06155900
Milk River near Saco	SACO	06164510
Beaver Creek near Hinsdale	BCHM	06167500
Glasgow Irrigation District Canal	GLASGOMT	NA
Milk River near Tampico	MRTM	06172310
Milk River near Nashua	NAMT	06174500

8.2 Alberta Water Delivery System and Irrigation

8.2.1 Waterton – St. Mary Headwork System

The Waterton - St. Mary Headwork System (WSMHS) was constructed by the Government of Canada to provide a reliable source of water for the primary purpose of irrigation. The Prairie Farm Rehabilitation Administration (PFRA) operated these structures until 1973, when the responsibility was transferred to Alberta Environment (AENV) under a Federal – Provincial agreement.

The WSMHS captures and stores flows from the Waterton, Belly and St. Mary Rivers. It conveys these flows across southern Alberta to supply irrigation water to over 500,000 acres in the Blood Tribe Irrigation Project, Raymond, Taber, Magrath and St. Mary River Irrigation Districts, 21 municipalities, hydro power facilities, households, livestock operations and industry. Several recreational facilities are also supported by the dam site, including two provincial campgrounds, two boat launches and the Cardston Boat Club.

The primary function of the WSMHS is to store water during high runoff and to release stored water to meet downstream and irrigation demands during low flows. The stored water is largely used for irrigation water supply. However, there are additional benefits of flow regulation that include hydropower generation, recreation, domestic and municipal uses and low-flow augmentation for water quality. The major structural components of the St. Mary Headwork System, listed from upstream to downstream (Map 8.10) include:

- Waterton Reservoir,
- Waterton Belly Canal,
- Belly River Weir,
- Belly – St. Mary Canal,
- St. Mary Reservoir,
- St. Mary – Jensen Canal,
- Jensen Reservoir,
- Jensen – Milk Ridge Canal, and
- Milk River Ridge Reservoir.

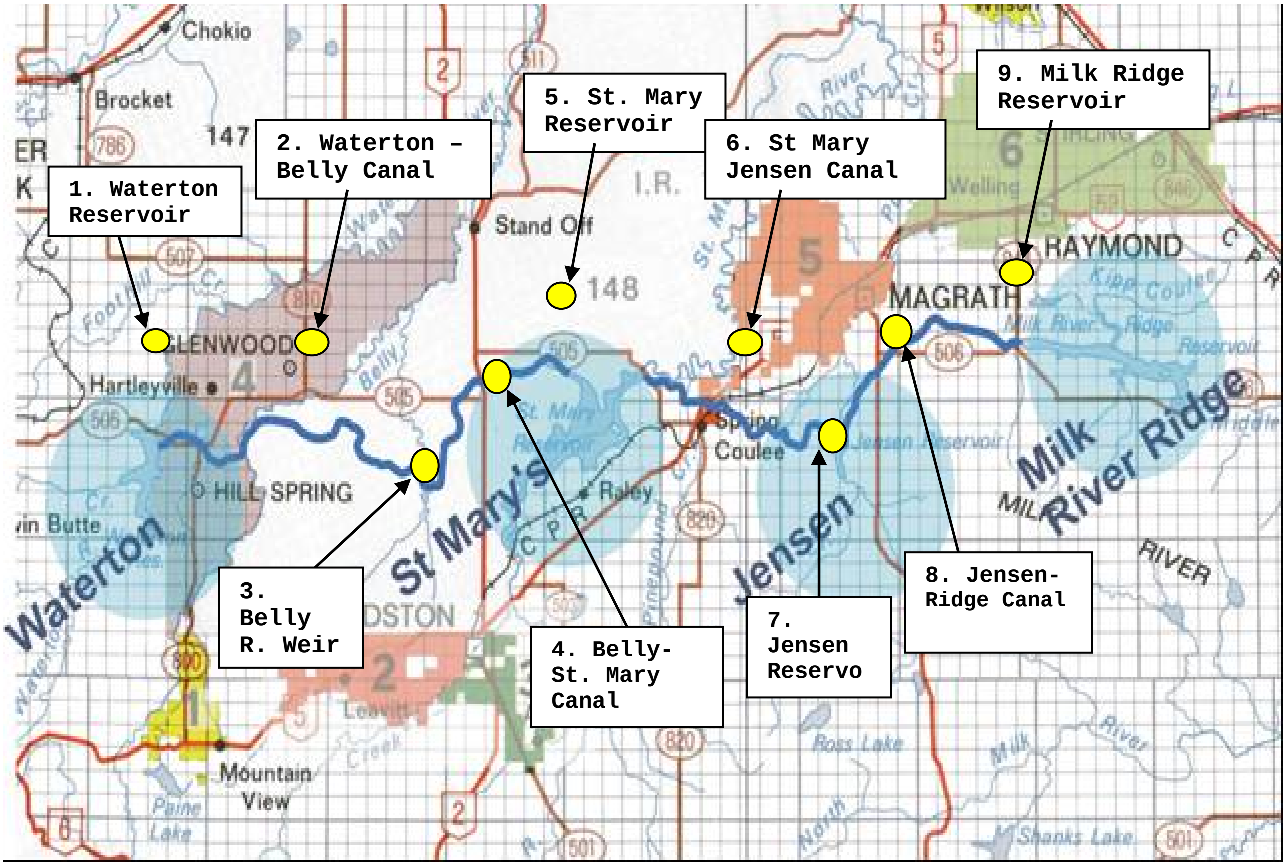
Quick Facts

- **In Alberta, the Government of Canada built the Waterton - St. Mary Headworks system capable of capturing and storing up to 390,000 ac-ft of the flow in the Waterton, Belly and St. Mary Rivers.**
- **This, in combination with off-stream storage within the St. Mary project, provides over 1,100,000 ac-ft of storage. This is conveyed across more than 1,500 miles of canals to supply water to over 500,000 acres of irrigated lands.**

Overview

The Waterton Dam is located on the Waterton River approximately 15 miles northwest of the Town of Cardston and 12 miles southeast of the Town of Pincher Creek in southern Alberta. Dam construction was completed in 1964 by the Government of Canada and initially operated by the PFRA. In 1974, the project was transferred to the Province of Alberta.

The dam is a zoned earth fill dam containing a clay core. It is 183.74 feet high at the deepest section and has a crest length of 2788.7 feet at elevation 3904.8 feet. Photo 8.18 shows the layout of the dam, reservoir, spillway, diversion facility and canal. Photos 8.19 and 8.20 provide an aerial view of the Waterton Dam spillway and the reservoir, respectively.



Map 8.10 - Waterton – St. Mary Headworks Layout.

8.2.2.1 Waterton Dam

Waterton Reservoir

The lowest point of the Waterton Reservoir is at elevation 3740.0 feet. The lowest point of the top of the dam is at elevation 3903.1 feet. Figure 8.6 shows the elevation versus surface area relationship for the reservoir. Figure 8.7 shows the elevation versus storage relationship for the reservoir and Figure 8.8 shows the physical characteristics of the dam.

Photo 8.18 – Waterton Reservoir Location Plan. Photo: Alberta Environment

Photo 8.19 – Waterton Reservoir Spillway. Photo: Alberta Environment

Photo 8.20 – Waterton Reservoir. Photo: Alberta Environment

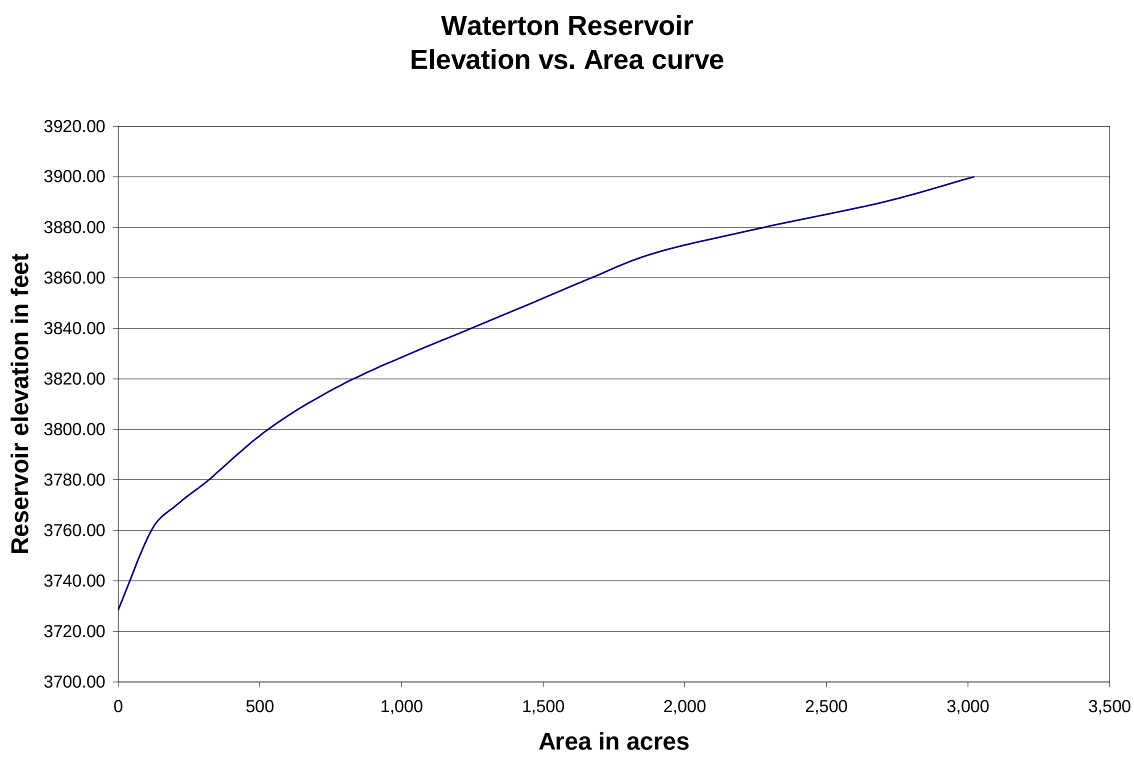


Figure 8.6 - Waterton Reservoir Elevation versus Area Curve.

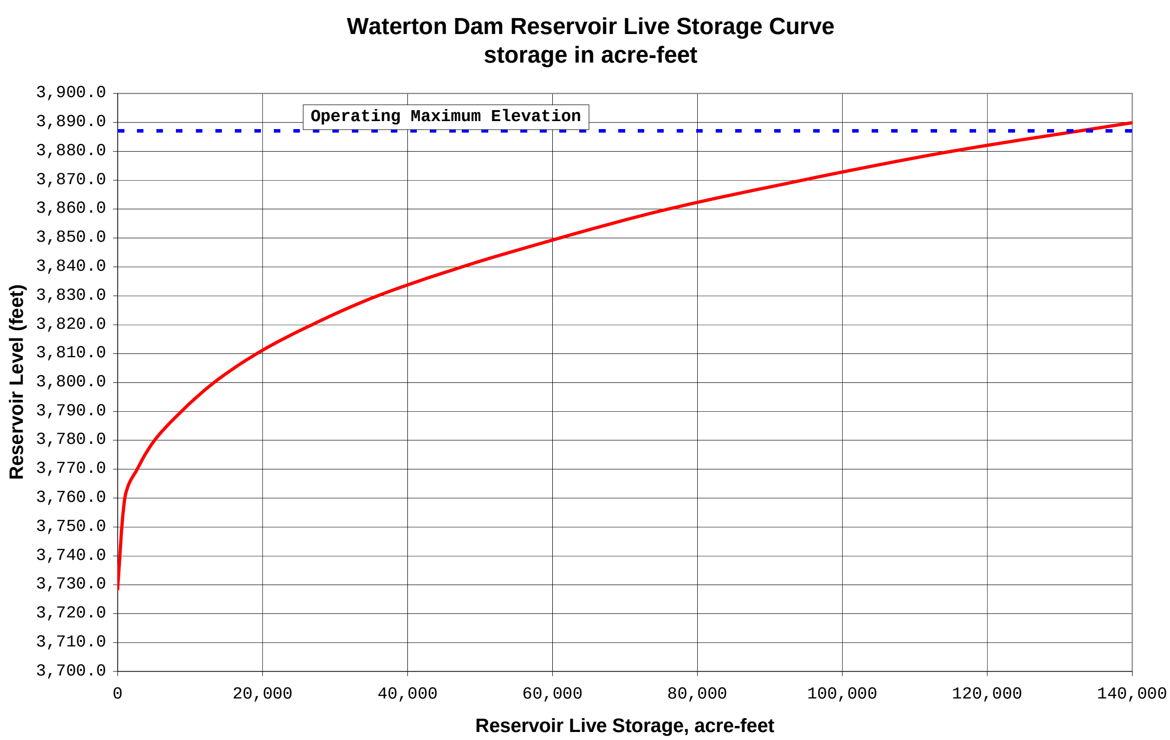


Figure 8.7 - Waterton Reservoir Elevation versus Live Storage.

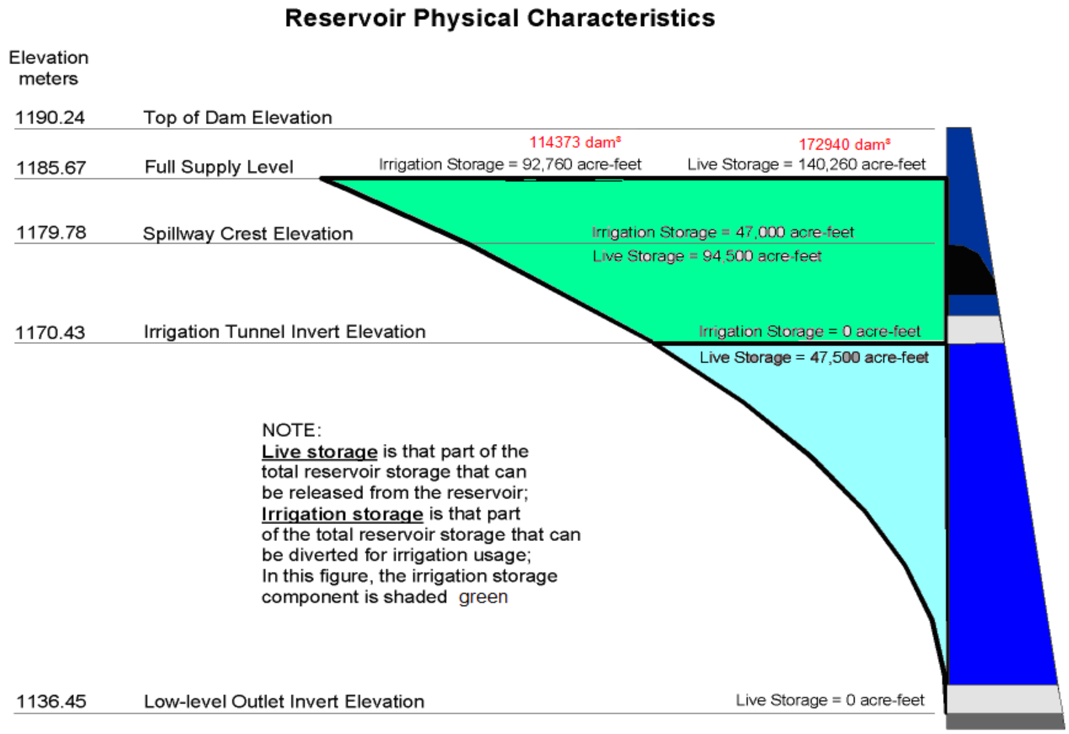


Figure 8.8 Waterton Dam – Physical Characteristics.

Waterton Spillway

Waterton Reservoir's main outlet structure is a spillway with seven gates located on the right abutment of the dam. The spillway has a weir crest elevation of 3870.7 feet with an effective width of 182 feet which transitions to a chute width of 154 feet and ends with a trajectory bucket. The maximum allowable spillway discharge is 65,000 cfs. Exceeding this discharge will create standing waves that overtop the spillway chute walls in the river channel below the spillway. Figure 8.9 shows the maximum discharge versus elevation relationship for Waterton Reservoir.

Waterton Hydropower Facility and Low Level Outlet

A hydropower facility beside the spillway receives water through a 4.5 feet hollow jet valve at the low level outlet in the dam. The valve has a centreline elevation of about 3731.6 feet and a maximum discharge capacity of 1080.6 cfs. However, the maximum operational flow is normally no higher than 706.2 cfs. A one-foot bypass valve is also present at this location.

This valve has a centre line elevation of about 3,729 feet and a maximum discharge capacity of approximately 32 cfs. The hydropower facility is shut down when there is significant flow over the reservoir through the emergency spillway, which normally occurs during flooding conditions. The maximum discharge of the hydroelectric plant is 247 cfs, which is separate of the hollow jet valve capacity.

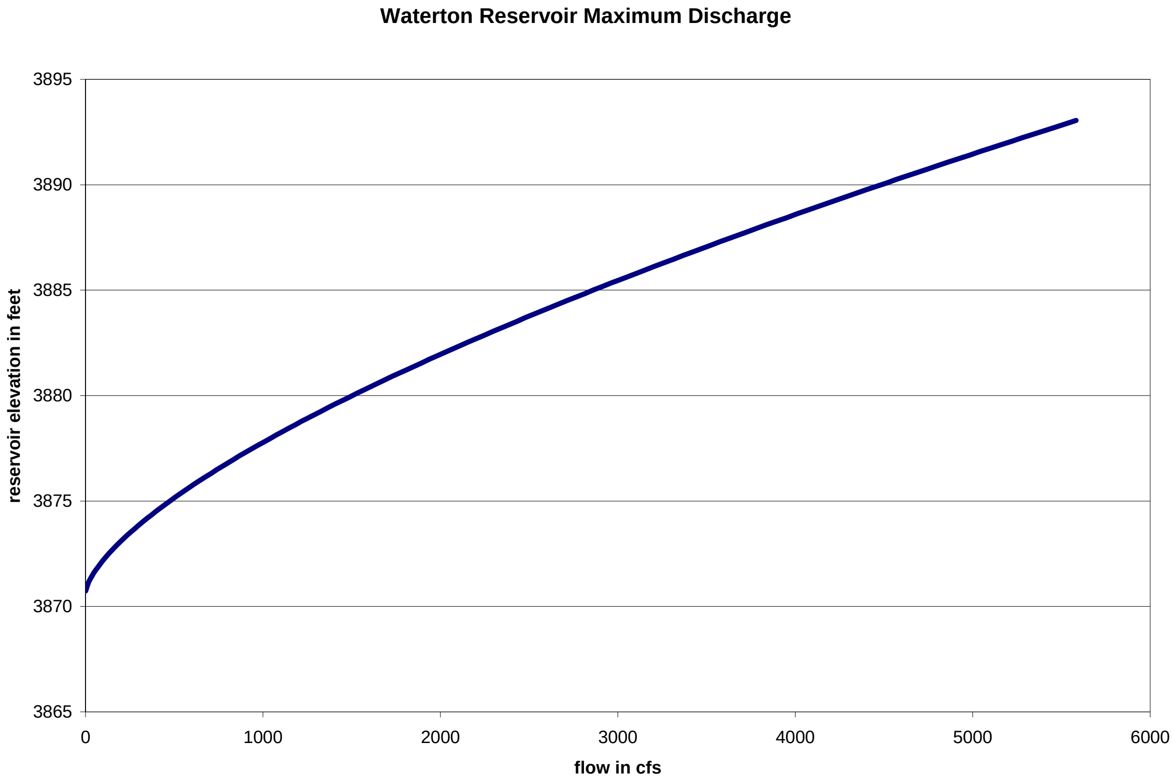


Figure 8.9 - Elevation versus Maximum Discharge for Waterton Dam.

Waterton – Belly Diversion Tunnels

There are five tunnels to divert water from the Waterton Reservoir to the Waterton - Belly Diversion Canal. This is the conveyance system used in conjunction with the Belly River (the river is used as a short stretch of canal) and the Belly-St. Mary canal to transport water to the St. Mary Dam.

Each tunnel is 4.0 feet wide and 6.4 feet high. The tunnels have an invert elevation of 3,840 feet. Although the maximum total capacity through the tunnels is 3,500 cfs, the maximum capacity of the Waterton Belly Diversion Canal is 1,942 cfs.

Waterton – Belly Diversion Canal

Stored water within the Waterton Dam is conveyed to the Belly River via the Waterton-Belly Canal (Photo 8.21). Tables 8.9 and 8.10 list the hydraulic and flow characteristics of the diversion canal from the Waterton Reservoir to the Belly River diversion canal. Diverted flow from Waterton Reservoir to the diversion canal is measured at the Water Survey Canada Station – Waterton-Belly Diversion Canal. The design capacity of this canal was 2,450 cfs but the maximum daily discharge recorded over 32 years was 2012.9 cfs (as of May 17, 1998).

Photo 8.21 – Waterton-Belly Diversion Canal. Photo: Alberta Environment

Table 8.9 – Waterton-Belly Diversion Canal Hydraulic Characteristics.

Parameter	Value
Bed width	40 feet
Full supply depth	11 feet
Channel slope	0.00015
Side slopes	2 to 1
Freeboard	3 feet
Manning's n	0.025

Table 8.10 – Waterton-Belly Diversion Canal Flow Characteristics.

Depth (ft)	Area (ft^2)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Flow (cfs)	Average Velocity (ft/sec)
0.0	0.0	40.0	0.0	0	0.0
1.64	71.0	47.3	5.0	68	1.0
3.28	152.7	54.7	9.1	221	1.4
4.92	245.3	62.0	13.0	446	1.8
6.56	348.5	69.3	16.5	744	2.1
8.20	462.6	76.7	19.8	1116	2.4
9.8	587.4	84.0	22.9	1563	2.7
11.0	681.1	89.1	25.1	1924	2.8

8.2.1.1 Waterton Operations

Purpose

The primary purpose of the Waterton Reservoir is to store water for irrigation use and to divert that water eastward to various irrigation districts and projects through the St. Mary Dam. However, as part of operations, minimum flows must be maintained downstream in the Waterton River.

> ***Quick Facts***
>
> - **Some of the oldest licences in Alberta are held by the St. Mary Irrigation District (168,000 ac-ft with a priority date of 1899) and the Taber Irrigation District (34,000 ac-ft with a priority date of 1899) both of which receive their water from the St. Mary River.**

Water Storage

Some of the essential physical characteristics of the Waterton Dam and Reservoir are shown in Figure 8.10. Although the Design Full storage level of the reservoir is 3,890 feet, the normal operating full supply level used is 3,889.1 feet. At this elevation, the storage capacity of the Waterton Reservoir is about 137,600 ac-ft.

At this level, approximately 89,950 ac-ft of water are available for diversion for irrigation. The remaining 47,650 are available for release into the Waterton River but cannot be diverted into the Waterton-Belly Canal. The normal range shown is defined by the lower and upper quartile data values for the period of record. This figure also shows the fill curves which currently are determined by wet and dry years. Generally, however the Dry Year curve is the curve utilized by operations staff.

Irrigation Clients

Water diverted from the reservoir for irrigation is used primarily by:

- the St. Mary River Irrigation District (SMRID),
- the Taber Irrigation District (TID),
- the Raymond Irrigation District (RID),
- the Magrath Irrigation District (MID),
- the Blood Tribe Agricultural Project (BTAP), and
- the United Irrigation District (UID).

The licences for these major users allow for the volumes shown in Table 8.11.

Normal Diversion Operation

Normally, irrigation begins in late April or early May, and continues until mid-October. Water diverted into the Waterton-Belly Canal is diverted for use by irrigation. Flows downstream into the Waterton River are shown in Figure 8.11. Graphs showing the normal range of the rate of diversion from the Waterton Reservoir as defined by the upper and lower quartile values for the period of record is shown in Figure 8.12.

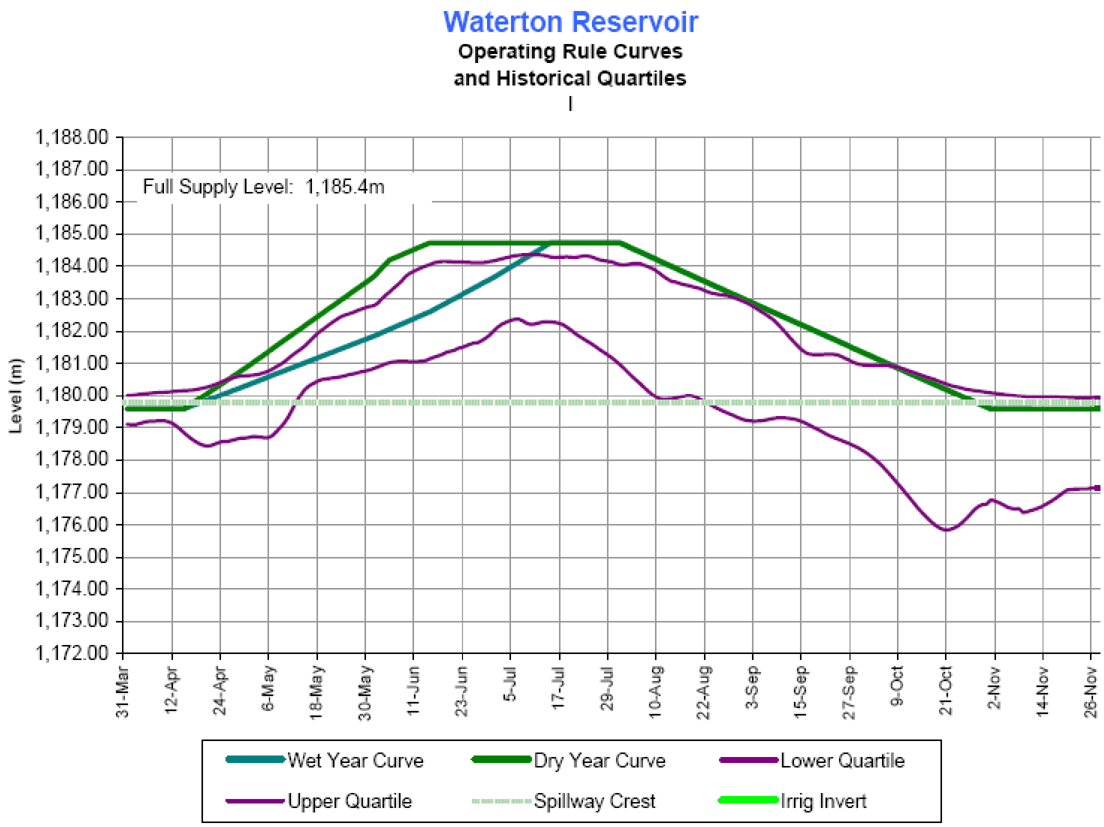


Figure 8.10 – Waterton Reservoir: Operating Rule Curves and Historical Quartiles.

Table 8.11 – Licence Volume to Major Clients of WSMHS.

District	Licensed Volume specifically from the Waterton River (ac-ft)	Licensed Volume from the Waterton River and/or the Belly and/or the St. Mary River (ac-ft)
SMRID	0	553,827
TID	67,500	8000
RID	24,750	26,000
MID	13,500	4000
BTAP	0	40,270
UID	17,000	0

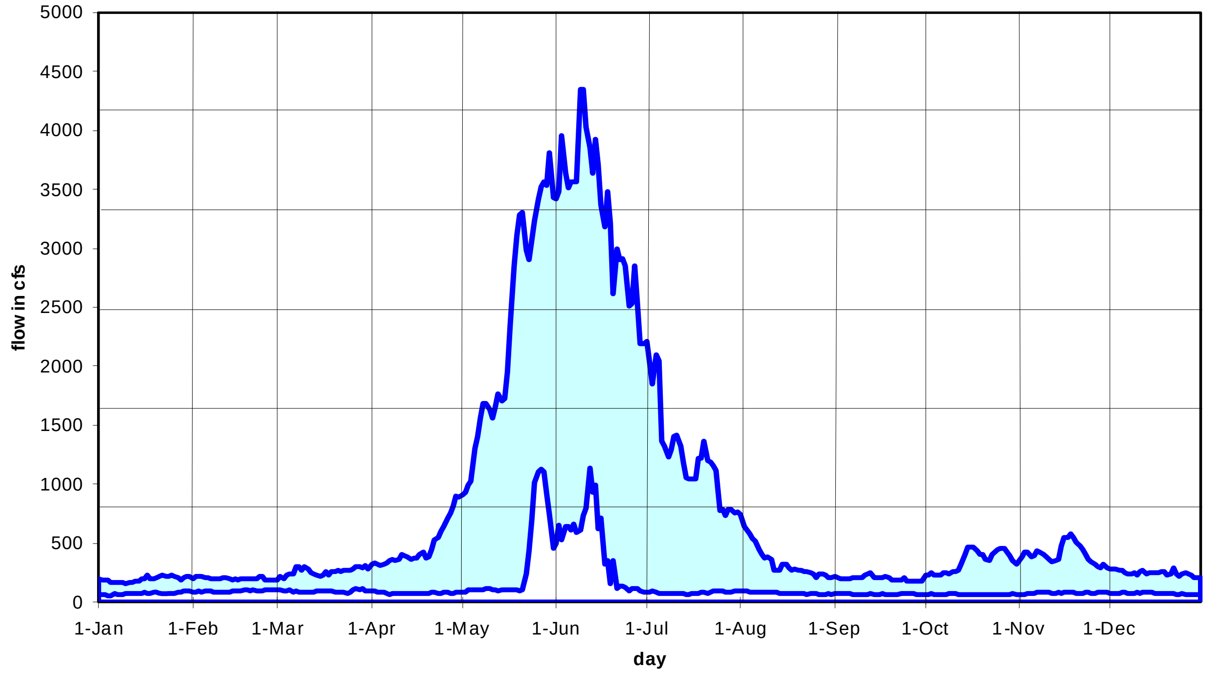


Figure 8.11 – Normal Range of Flow in Waterton River below Waterton Dam.

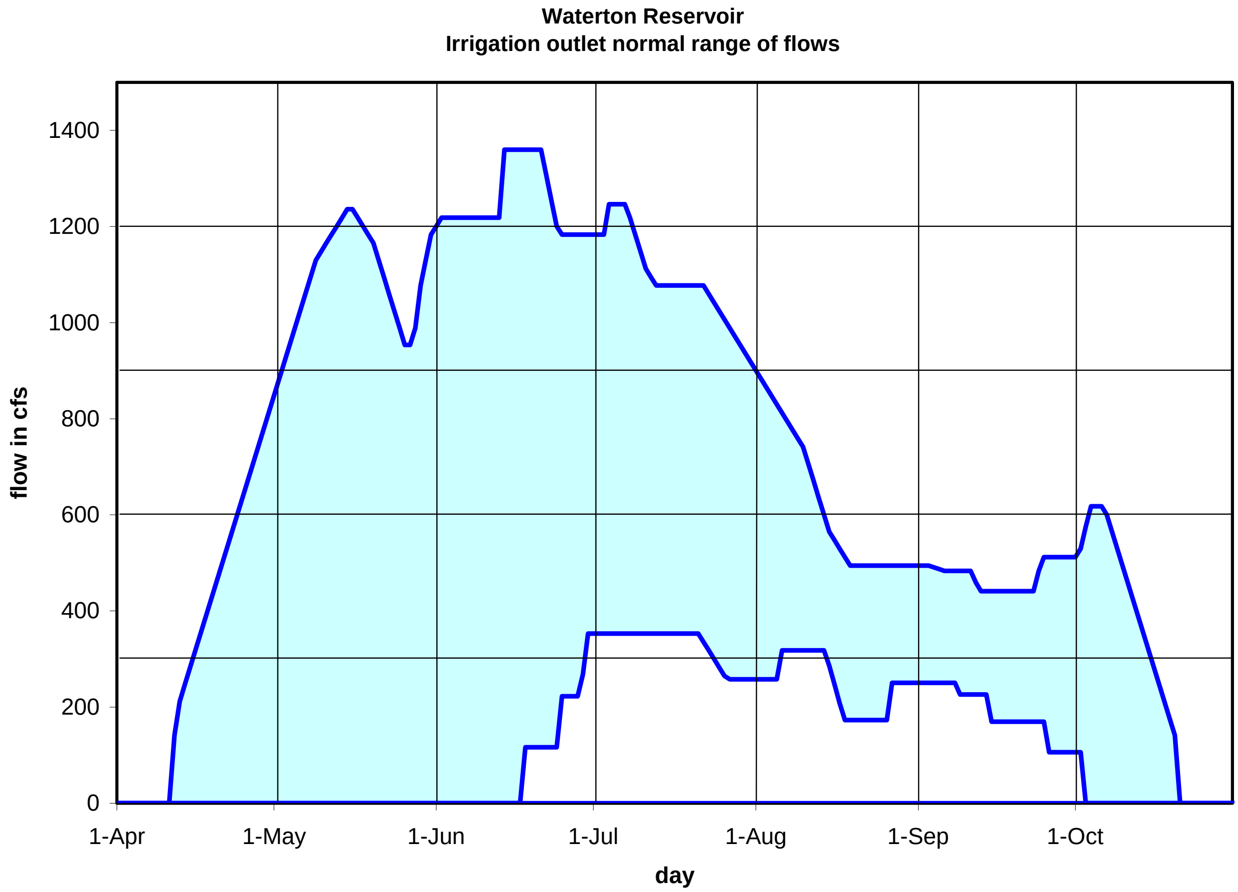


Figure 8.12 – Normal Range of Irrigation Outlet Flows.

Flood Management

The storage capacity of Waterton Reservoir is small relative to the size of major floods flowing into the reservoir. The volume of the 1-in-100 year flood is approximately 240,600 ac-ft. The amount of storage available between the spillway crest level and the maximum-allowable reservoir level is only about 47,000 ac-ft. The flood hydrographs for floods of other return periods are shown in Figure 8.13.

Since the storage capacity is small compared to major floods, the flood control capability of the reservoir is limited. The Waterton Dam is effective at regulating small to medium sized floods, but not very effective at regulating large floods.

Some storage capability is normally reserved in the reservoir for flood inflows until the end of June. Typically, the reservoir reaches Full Supply Level in early July. It is gradually lowered throughout the rest of the summer as water is diverted eastward to satisfy the needs of the major licensed users. For operation during floods, the reservoir level may be allowed to rise as high as 3,891 feet.

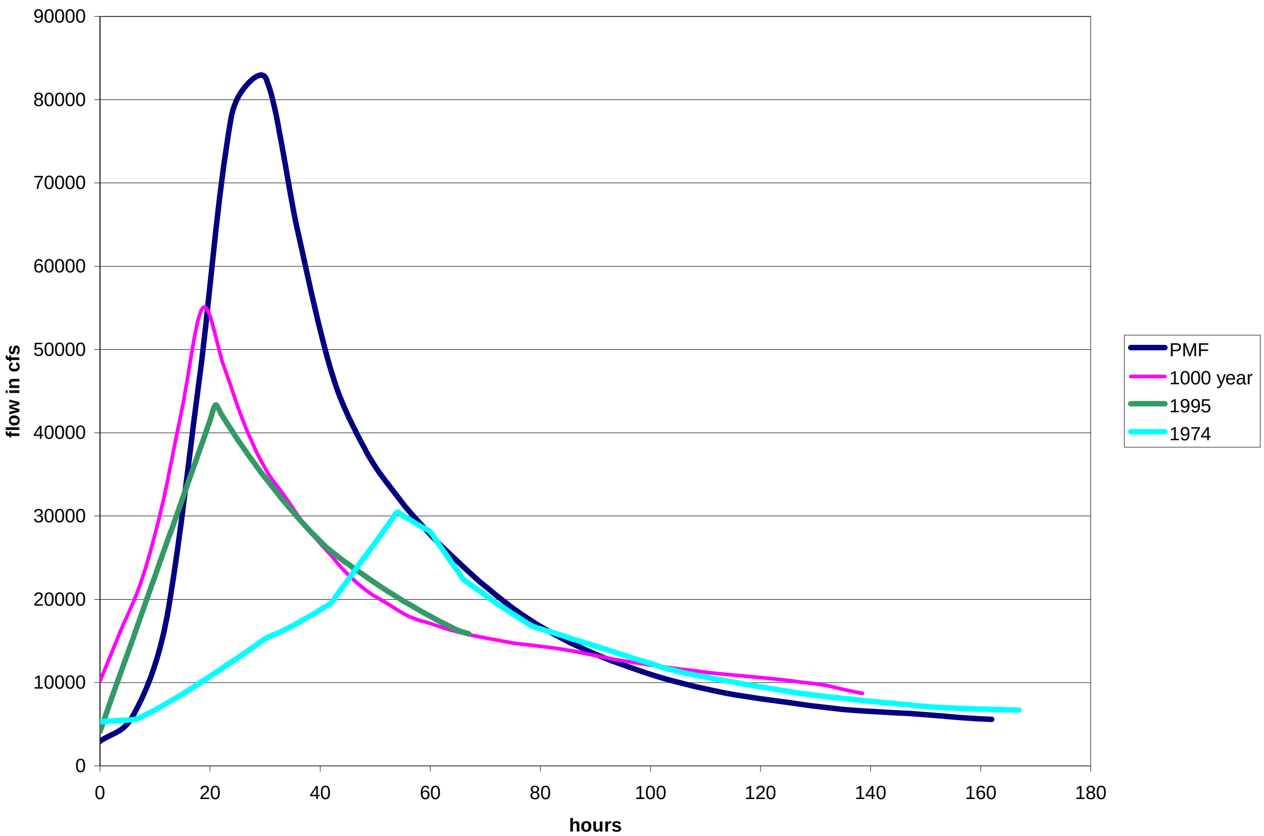


Figure 8.13- Waterton Dam Inflow Flood Hydrographs for Various Return Periods. (PMF = Probable Maximum Flood)

Evaporation Losses

For operational purposes, evaporation losses from the reservoir are estimated in Table 8.12.

Table 8.12 – Estimated Evaporation Losses from the Waterton Reservoir.

Month	Daily Evaporation Loss (inches)
April	0.039
May	0.079
June	0.156
July	0.156
August	0.195
September	0.117
October	0.039
November to March	0.0

Riparian and Aquatic Environment Flow Requirements

The term “riparian flow requirement” refers to the water needs of areas adjacent to the Waterton River including human and non-human needs. The term “aquatic flow requirements” refers to the water needs of life forms in the Waterton River.

Both riparian and aquatic flow requirements associated with releases from the Waterton Reservoir to the Waterton River are currently specified by Alberta Government Order-In-Council Number 615/91 dated September 20, 1991. This order states that a flow of at least 81.2 cfs must be maintained in the Waterton River upstream of its confluence with the Belly River. For operational purposes, this means that during the irrigation season, the minimum rate of release from the Waterton Reservoir to the Waterton River must be 92 cfs. This allows for some consumptive use between the dam and the confluence with the Belly River.

If the natural inflow to the reservoir is less than the specified downstream minimum of 81.2 cfs, it is permissible to reduce the outflow from the reservoir to the river to less than 81.2 cfs, provided that the outflow is always greater than the inflow. The normal range of flow in the Waterton River downstream of the dam was shown previously in Figure 8.11.

Besides the minimum requirements for downstream flows, attempts are made on an annual basis to take opportunities to mitigate downstream environmental impacts by adjusting flows for fish spawning or cottonwood forest regeneration. These sometimes require passing flows greater than the minimum. However, the volume of water is not normally significant as flows are either being reduced at the natural recession limb in the case of cottonwood regeneration which happens only after a severe flooding event, or kept low when trying to keep fish spawning grounds under water.

Winter Operations

During the winter, the spillway is usually used to pass water from the reservoir to the Waterton River downstream of the dam. As a rule, the spillway will either be used throughout the entire winter, passing a minimum flow of 92 cfs, or will not be used at all during that winter. It is considered highly undesirable to use the spillway if the subsurface beneath the concrete spillway slab has become frozen. Passing water over the spillway continuously throughout the winter prevents the subsurface from freezing and the potential for frost heave affecting the spillway chute slab.

Hydroelectric Power Operations

The hydroelectric power plant is owned by a private company, Canadian Hydroelectric Developers, but is operated primarily by the Government of Alberta through Alberta Environment. The production of power from the hydroelectric generator is secondary to the primary purpose of the reservoir which is the storage of water for irrigation. Most of the time, however, the hydroelectric generator turbine is the only facility used to pass water from the reservoir to the Waterton River downstream of the dam to satisfy the riparian and aquatic flow requirements of the river.

8.2.1.2 St. Mary Dam

Overview

The St. Mary Dam in located on the St. Mary River approximately 33 miles upstream of the City of Lethbridge. The St. Mary Dam is a zoned earth filled dam containing a clay core. It has a top width of 36 feet, a crest length of 2,536 feet, a height of 203.4 feet and a crest elevation of 3,633.3 feet. The length of the reservoir is 16.7 miles. The St. Mary Reservoir and spillway is shown in Photos 8.22 and 8.23.

Photo 8.22 – St. Mary Reservoir. Photo: Alberta Environment

Photo 8.23 – St. Mary Spillway. Photo: Alberta Environment

St. Mary Reservoir

The St. Mary Reservoir was created by the construction of the St. Mary Dam. The lowest point of the reservoir is at an elevation of 3,447.82 feet. Figure 8.14 shows the elevation versus surface area relationship for the reservoir.

Figure 8.15 shows the elevation versus storage relationship for the reservoir. Inflows to the dam are from the St. Mary River (flowing from the headwaters in Montana in the south) and the Belly-St. Mary Canal (carries water from the Belly River and water diverted from the Waterton River through the Waterton Belly canal).

St. Mary Spillway

The original spillway for St. Mary Reservoir was replaced in 1999 by a flip bucket spillway with a maximum discharge capacity of approximately 94,290 cfs. The new spillway has four gates located on the south abutment of the dam and a weir crest elevation of 3,599.4 feet. Figure 8.16 shows the maximum discharge versus elevation relationship for St. Mary Reservoir.

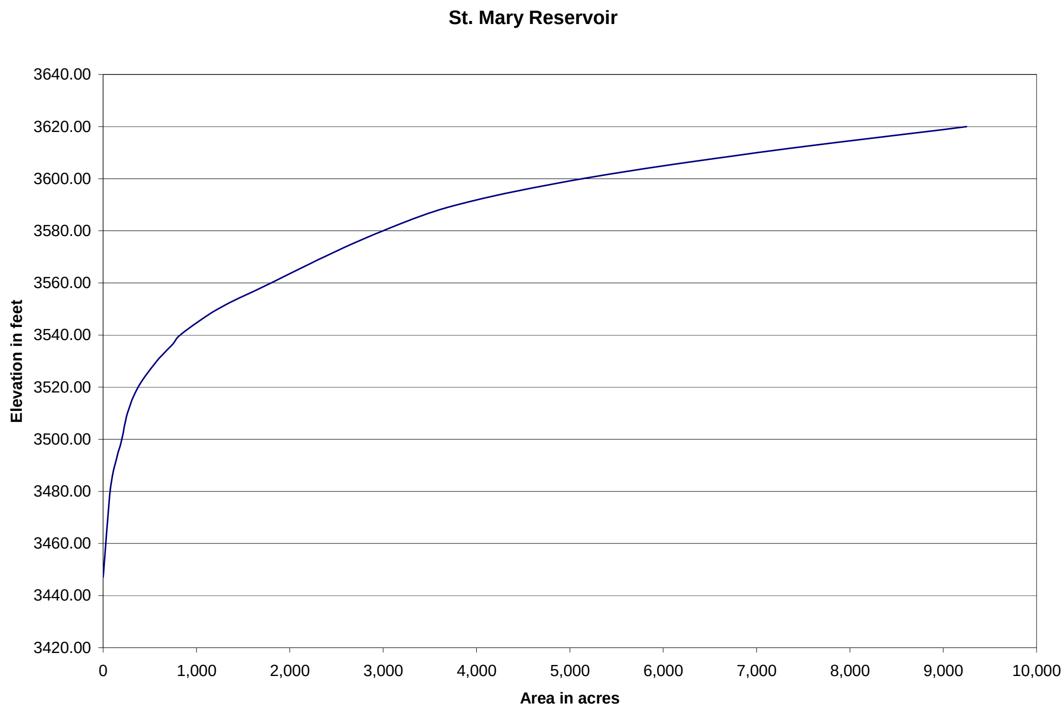


Figure 8.14 – St. Mary Reservoir Elevation versus Surface Area.

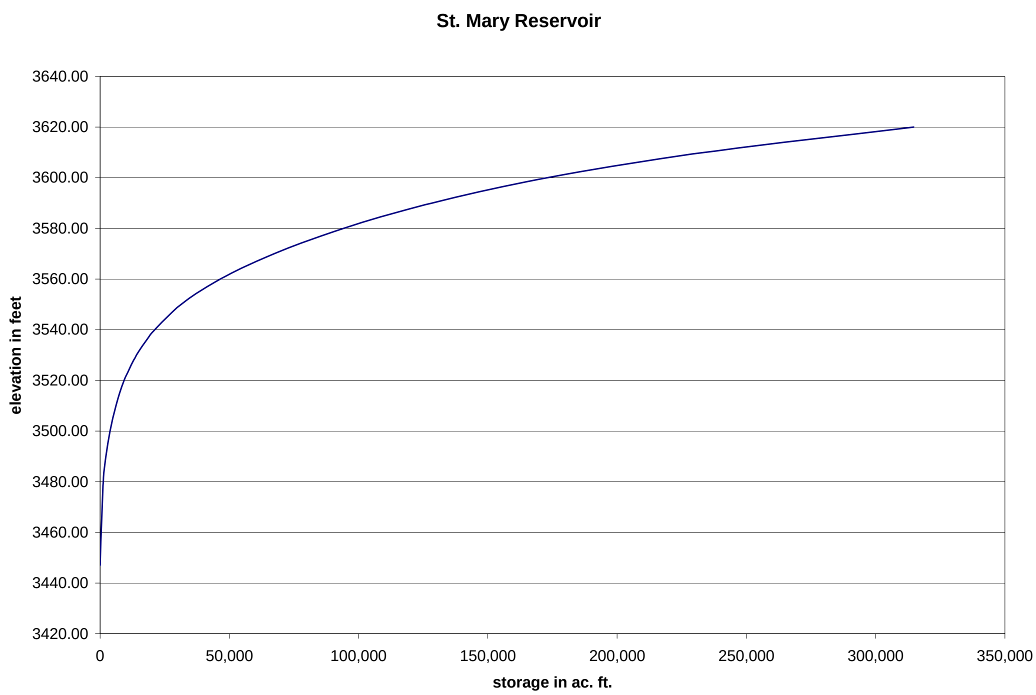


Figure 8.15 – St. Mary Reservoir Elevation versus Capacity.

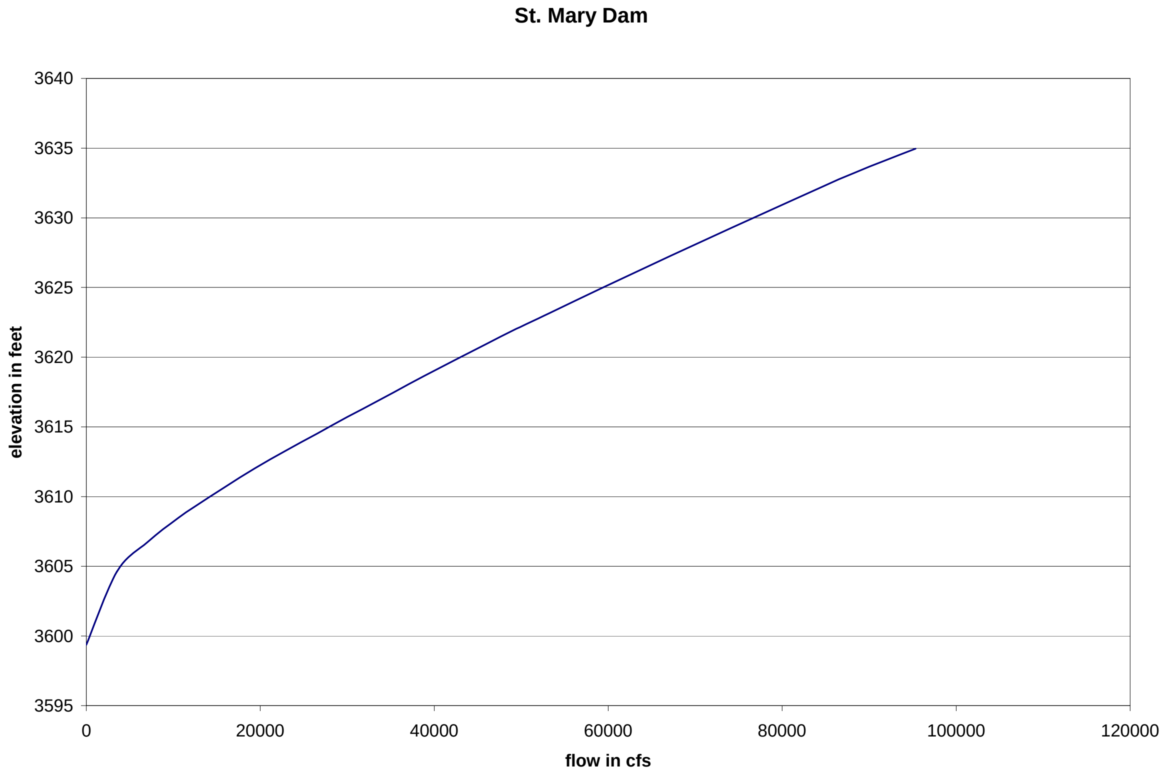


Figure 8.16 – St. Mary Maximum Reservoir Elevation versus Spillway Discharge.

St. Mary Low Level Outlet Tunnel

Riparian flows are released into the St. Mary River on a year round basis via the low-level outlet tunnel located on the south abutment of the dam. Canadian Hydro Developers added a three-megawatt hydroelectric power plant to the low-level outlet tunnel in 1992 and the power produced is fed into the TransAlta Utilities power grid.

Irrigation Tunnel Outlet and Canals

On the south abutment of the dam, an outlet supplies water into the St. Mary-Jensen Canal. This operates annually between mid-April to mid-October. If heavy precipitation occurs in this area, substantial runoff will enter the main canals. To prevent the possibility of the canal banks being overtopped, releases are frequently reduced through the canal system during a major storm event. On the upstream side, local runoff would flow into the Belly-St. Mary Canal and would be transported to the St. Mary Reservoir.

The St. Mary-Jenson Canal (Photo 8.24) has a maximum flow capacity of 3,200 cfs. The canal flows eastward through the Jensen Reservoir (Photo 8.25) and into the Milk River Ridge Reservoir (Photo 8.26 to 8.28) which form the rest of the headworks of the Waterton St. Mary River Irrigation system. The water diverted supplies the St. Mary, Magrath, Raymond and Taber Irrigation Districts as well as other domestic and municipal uses. The St. Mary Irrigation District is the largest irrigation district in Alberta.

Photo 8.24 – St. Mary-Jenson Canal. Photo: Alberta Environment

Photo 8.25 – Jenson Reservoir. Photo: Alberta Environment

Photo 8.26 – Milk River Ridge Reservoir. Photo: Alberta Environment

Photo 8.27 – Milk Ridge Reservoir. Photo: Alberta Environment

Photo 8.28 – North Outflow from the Milk River Ridge Reservoir.
Photo: Alberta Environment

8.2.1.3 St. Mary Reservoir Operation

Overview

The St. Mary Reservoir is governed by operational rules that maximize the benefit of the available water storage while minimizing the potential risks associated with the retention of a large volume of water. Figure 8.17 shows the normal range of reservoir elevation and the fill curve used by the operators of this structure. This figure also shows the previously used wet and dry year fill curves together with the recently established fill curve. In future years, the wet and dry year curves will no longer be used. The wet and dry year curves were established before the fully automated replacement spillway and gate structure were installed.

The storage capacity of the St. Mary Reservoir at its Full Supply Level of 3,620.6 feet is about 320,900 ac-ft. At this level, approximately 299,402 ac-ft of water is available for diversion for irrigation: the remaining 21,492 ac-ft is available for release into the St. Mary River but cannot be diverted into the St. Mary-Jensen Canal. The normal range of storage and elevation is shown in Figure 8.18.

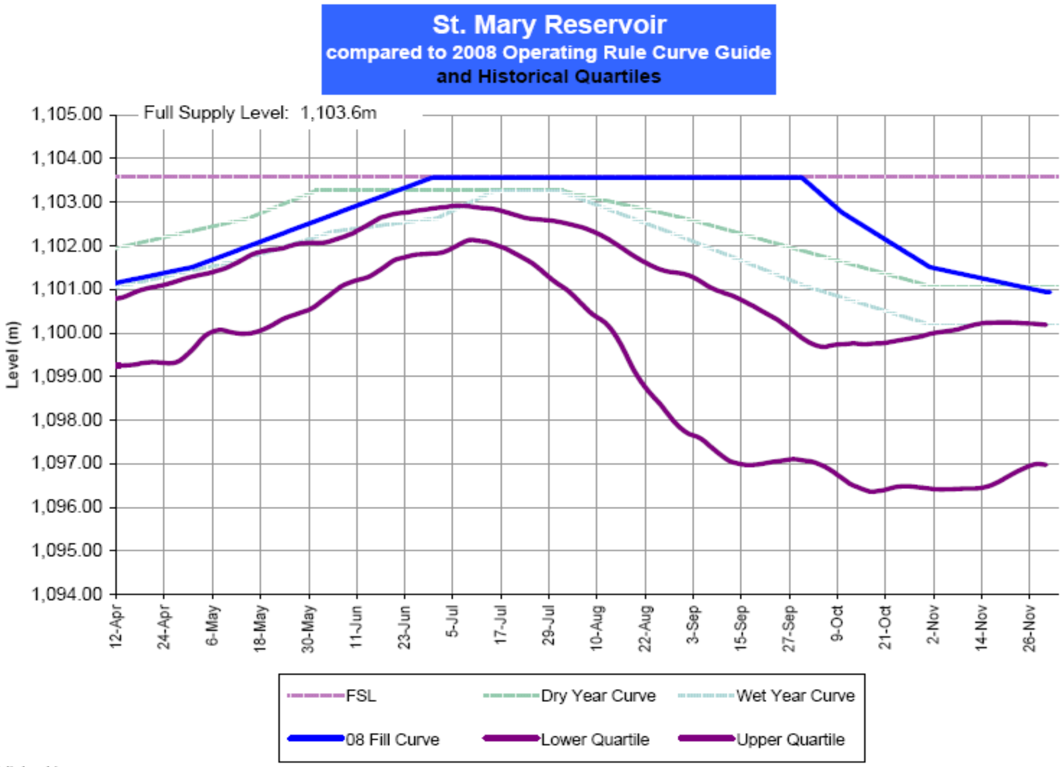


Figure 8.17 – St. Mary Reservoir Operating Rule Curves and Historical Quartiles.

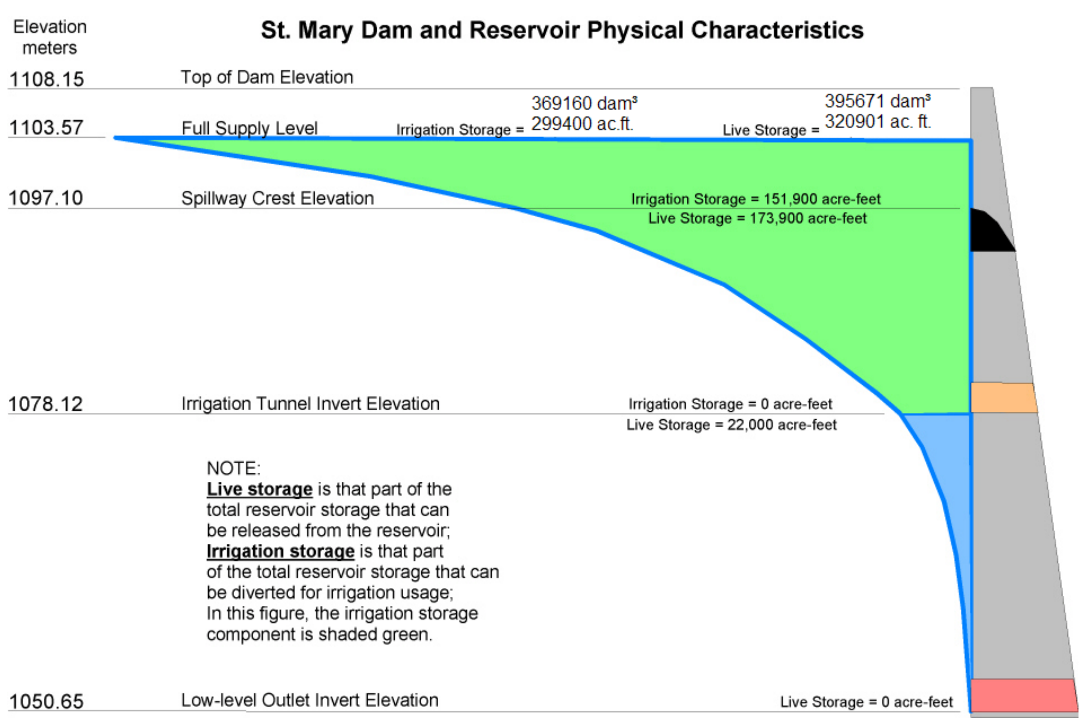


Figure 8.18 – St. Mary Dam and Reservoir Physical Characteristics.

Irrigation Clients

Water diverted from the St. Mary Reservoir for irrigation is used primarily by:

- the Magrath Irrigation District (MID),
- the Raymond Irrigation District (RID),
- the St. Mary River Irrigation District (SMRID), and
- the Taber Irrigation District (TID).

The licences for these major users allow for the volumes shown in Table 8.13.

Table 8.13 – Licensed Volumes for Major Clients.

District	Licensed Volume specifically from the St. Mary River (ac-ft)	Licensed Volume from Waterton and/or Belly and/or the St. Mary River (ac-ft)
MID	13,500	4000
RID	24,750	26,000
SMRID	168,173	553,827
TID	67,500	8000

Normal Diversion Operations

Irrigation deliveries normally begin in late April or early May, and continue until mid-October. Water is diverted from the St. Mary Reservoir into the St. Mary-Jensen Canal. A graph of the normal range of delivery for this period, as defined by the upper and lower quartile values for the period of record, is shown in Figure 8.19.

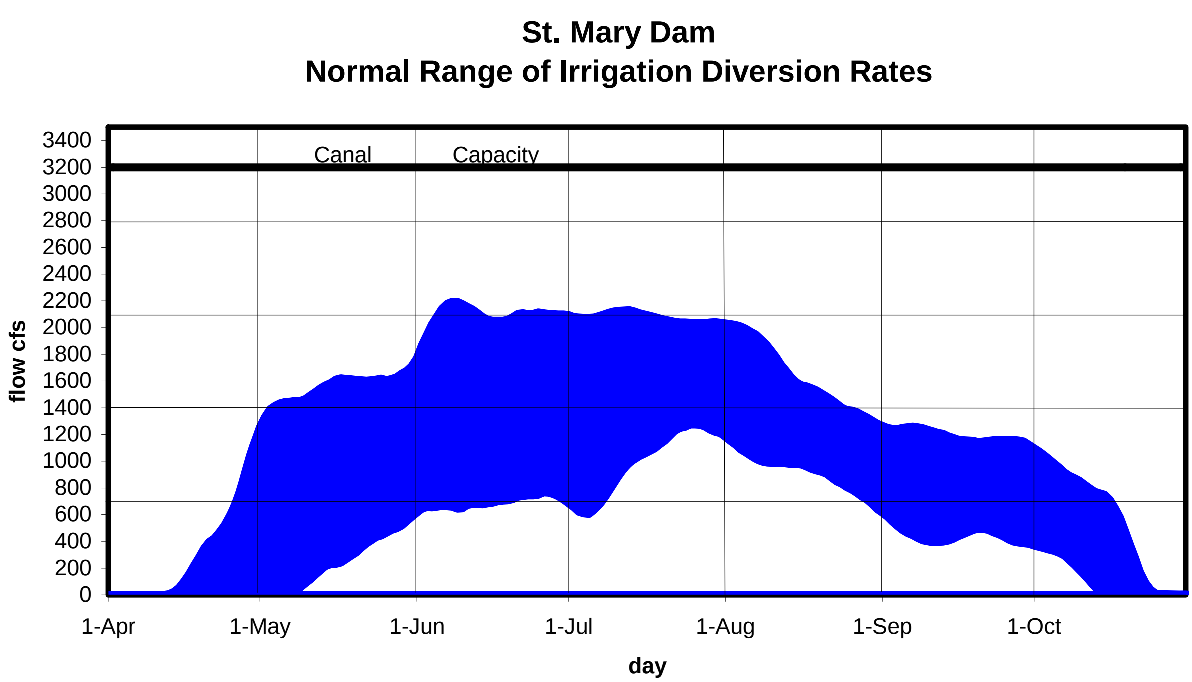


Figure 8.19 – Normal Irrigation Delivery from St. Mary Dam.

Flood Management

Since the St. Mary Reservoir storage capacity is small relative to the size of major floods, flow into the reservoir flood control is relatively limited. The volume of the 1-in-100 year flood is approximately 250,000 ac-ft whereas the amount of storage available between the spillway crest level and the maximum-allowable reservoir level is only about 141,000 ac-ft.

Some storage capability is normally reserved in the reservoir for flood management until the end of June. Typically, the reservoir reaches Full Supply Level in early July. It is then gradually lowered throughout the summer as water is diverted eastward to satisfy the needs of the major licensed users. During flood operations, the reservoir level may be allowed to rise as high as 3,620.7 feet.

Evaporation losses

For operational purposes, evaporation losses from the St. Mary Reservoir are estimated and shown in Table 8.14.

Table 8.14 – Estimated Evaporation Losses from the St. Mary Reservoir.

Month	Daily Evaporation Loss (inches)
April	0.039
May	0.079
June	0.156
July	0.156
August	0.195
September	0.117
October	0.039
November to March	0.000
Annual Total	**24.000**

Riparian and Aquatic Environment Flow Requirements

The term “riparian flow requirement” refers to the water needs of areas adjacent to the St. Mary River including human and non-human needs. The term “aquatic flow requirements” refers to the water needs of life forms in the St. Mary River.

Both riparian and aquatic flow requirements that must be maintained in the St. Mary River downstream from the St. Mary Reservoir are specified by Alberta Government Order-In-Council Number 615/91 dated September 20, 1991. The order states that a flow of at least 97 cfs must be maintained in the St. Mary River upstream of its confluence with the Oldman River. For operational purposes, this means that the minimum rate of release from the St. Mary Reservoir to the St. Mary River must be 97 cfs.

If the natural inflow into the reservoir is less than the specified downstream flow of 97 cfs, it is permissible to reduce the outflow from the reservoir to the river to less than 97 cfs provided that the outflow is always greater than the inflow. The normal range of river flow in the St. Mary River downstream of the dam is shown in Figure 8.20.

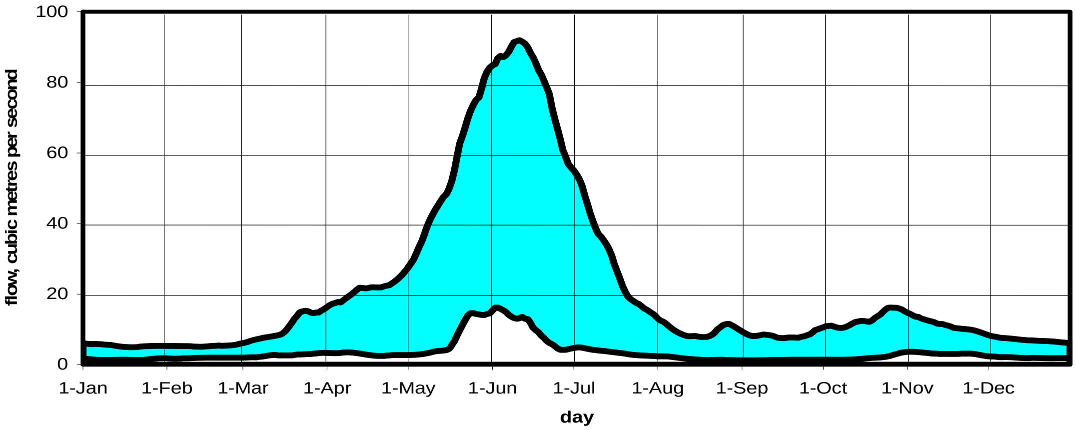


Figure 8.20 – Normal Flows downstream of St. Mary Dam.

Hydroelectric Power Operations

The hydroelectric power plant is owned by Canadian Hydroelectric Developers, a private company. However, the plant is operated primarily by the Government of Alberta through Alberta Environment.

These hydroelectric power operations have a licence that permits them to utilize releases, but do not have a call on water for the specific purpose of power production. Rather, the hydroelectric generator turbine relies on (and most of the time is the only facility used) water being passed from the reservoir to meet aquatic flow requirements of the St. Mary River downstream of the dam.

8.2.2. Alberta Irrigation Infrastructure and Irrigation

8.2.2.1 Irrigation in Alberta

Irrigation in Alberta, especially the southern portion of the province including the Milk and St. Mary River Basins, has an interesting and colorful history that spans more than a century. The irrigation industry has experienced periods of great optimism, bitter disappointments, struggles for survival and incredible economic expansion opportunities.

Irrigation in Alberta is now well established and is a progressive part of Alberta's agricultural community. Agriculture is not the only benefactor of the development of irrigation in Alberta. A variety of water uses have been integrated into the province's development including wildlife conservation, recreation, hydro power and water supplies for communities, industries, livestock and domestic uses. Crop diversity and value-added commercial enterprises are encouraged and are increasing within the southern portion of the province.

The irrigated area in southern Alberta has steadily increased over the last century (Figure 8.21). This expansion has been based on major changes in technology and infrastructure management. The past half century marks a period of emerging technology advancements both on the farm and at the district level and resulted in unprecedented expansion of the irrigated area.

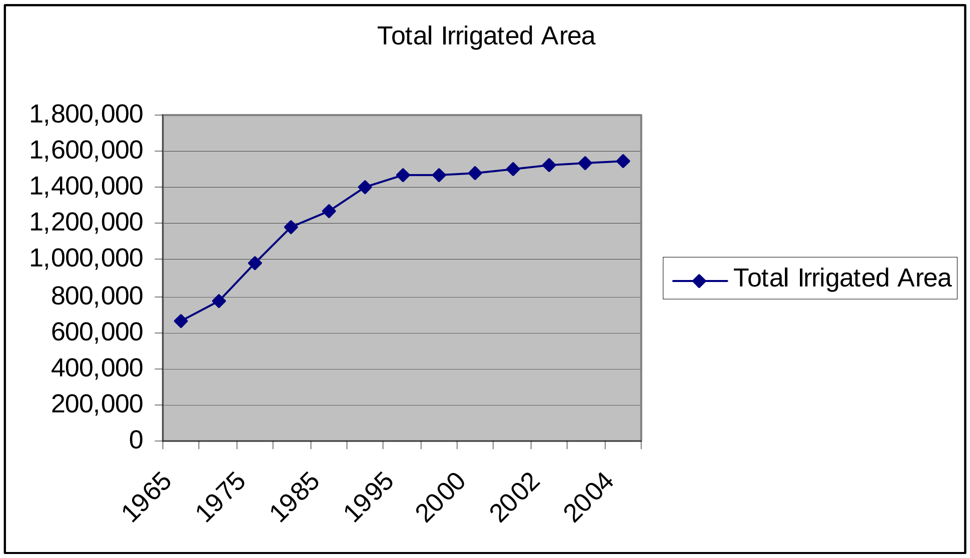


Figure 8.21 – Irrigation expansion in Alberta [Acres].

The Milk and St. Mary Rivers in the south-western portion of Alberta support irrigation development on approximately 600,000 acres of land. These lands are licensed under the Alberta *Water Act* to both private irrigators and irrigation districts. Lands covered under the irrigation districts are summarized in Table 8.15 and are shown on Map 8.11.

Table 8.15 – Irrigation Acres for the Milk River and St. Mary Project.

District	2007 Irrigated Acres
Milk River	
Milk River mainstem	8,069
Milk River tributary streams	10,754
Total Milk River	**18,823**
St. Mary River:	
Magrath MID	18,300
Raymond RID	46,306
Taber TID	82,804
St. Mary SMRID	372,996
Total St Mary River Projects	**520,406**

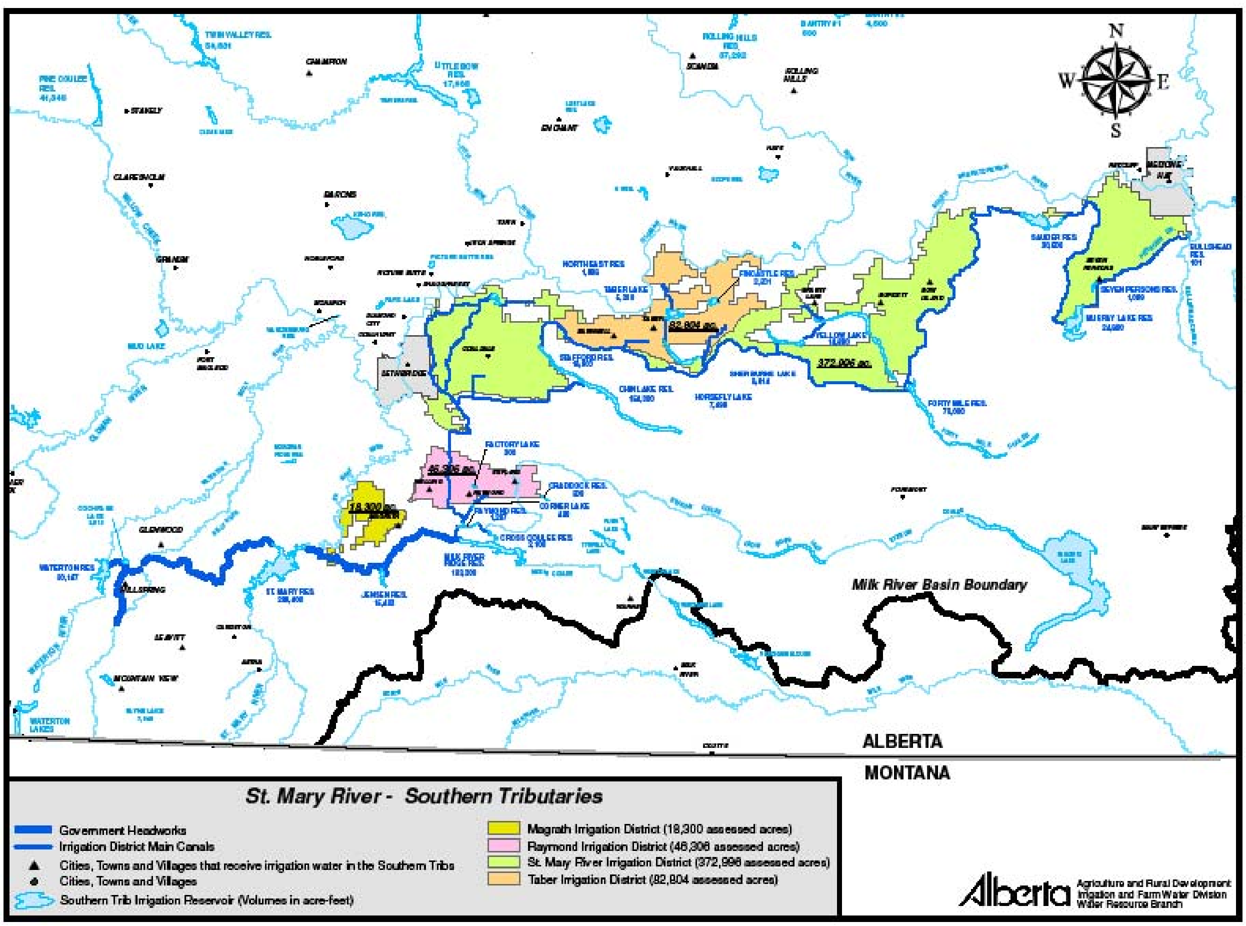
The Milk River portion of irrigated production in Alberta has no water storage or government supported infrastructure within the boundaries of Alberta. Therefore, both irrigation and domestic supplies are dependent on run of the river natural flows. About 8,069 acres, which derive their water directly from the Milk River, often depend on water delivered by infrastructure constructed within Montana.

Irrigation Infrastructure

The irrigated area within Alberta that is supported by flows from the St. Mary River has a significant water storage and distribution system. This system has seen significant government support over the life of the project and is an important part of the communities and water management system within Alberta.

The government supported infrastructure is dominated by a number of major diversion structures and reservoirs including Waterton Reservoir, St. Mary Reservoir and Ridge Reservoir. In addition to these government operated structures, there are a number of additional major structures which have been constructed by government and now operated and maintained privately. These include Chin Reservoir, Forty Mile Reservoir, Murray Reservoir and Sauder Reservoir (see Map 8.11) along with fifteen smaller storage and operating reservoirs.

When combined, the St. Mary project is supported by a capacity of close to 1,100,000 ac-ft of storage. The system also has a major diversion structure on the Belly River which when combined with the Waterton and St. Mary reservoirs and adjoining canal system ties three southwestern Alberta rivers into a single major irrigation delivery system.



Map 8.11 - St. Mary River Projects Irrigation Headworks and Irrigation District Works.

Once the water leaves the river through storage it is delivered to the irrigated areas of southern Alberta through 1,500 miles of canals and laterals. Most of these canals and laterals are operated by one of the four irrigation districts which receive their water from this irrigation infrastructure. These districts include the Magrath, Raymond, St. Mary and Taber Irrigation Districts.

Operation and maintenance of the canal and lateral irrigation distribution system is the responsibility of the irrigation districts. Annual water rates are charged by the districts to cover the costs associated with operations, maintenance, administration and rehabilitation of the districts. The annual rate is based on a per acre charge which is levied against the land and is recoverable under the direction of the *Irrigation District Act*.

Studies undertaken in the early 1960s indicated that the irrigation delivery system was deteriorating considerably and that seepage and canal failure events were increasing at an unacceptable rate. The result of these studies was the implementation of a cost-shared rehabilitation program. The capital cost of rehabilitation of irrigation district infrastructure is shared between the irrigation districts (25%) and the province of Alberta (75%).

The Irrigation Rehabilitation Program has been in place since 1969 and over this period, approximately 63% of the irrigation infrastructure has been rehabilitated and is now considered to be in good condition. Salinity due to irrigation seepage was estimated to effect close to 20% of the irrigated lands in 1970. Through continued rehabilitation of the irrigation delivery system and on-farm irrigation system improvements, salinity now affects less than 2% of the lands.

Keeping these works in this condition has required a large investment by both the districts and the province. Figure 8.22 shows the annual and accumulated lengths of rehabilitated canals and laterals and the different methods used in the rehabilitation. A total of 640 million dollars has been invested by the province and an additional 152 million dollars has been contributed by the irrigation districts. The irrigation districts and the province of Alberta continually update a capital improvements data base. At present, the estimated value of the four irrigation districts supplied by water from the St. Mary project is $1.24 billion.

Government support of irrigation infrastructure is limited to the delivery, storage and management of the water supplies. The cost of purchasing on-farm irrigation infrastructure is the full responsibility of the producer/owner.

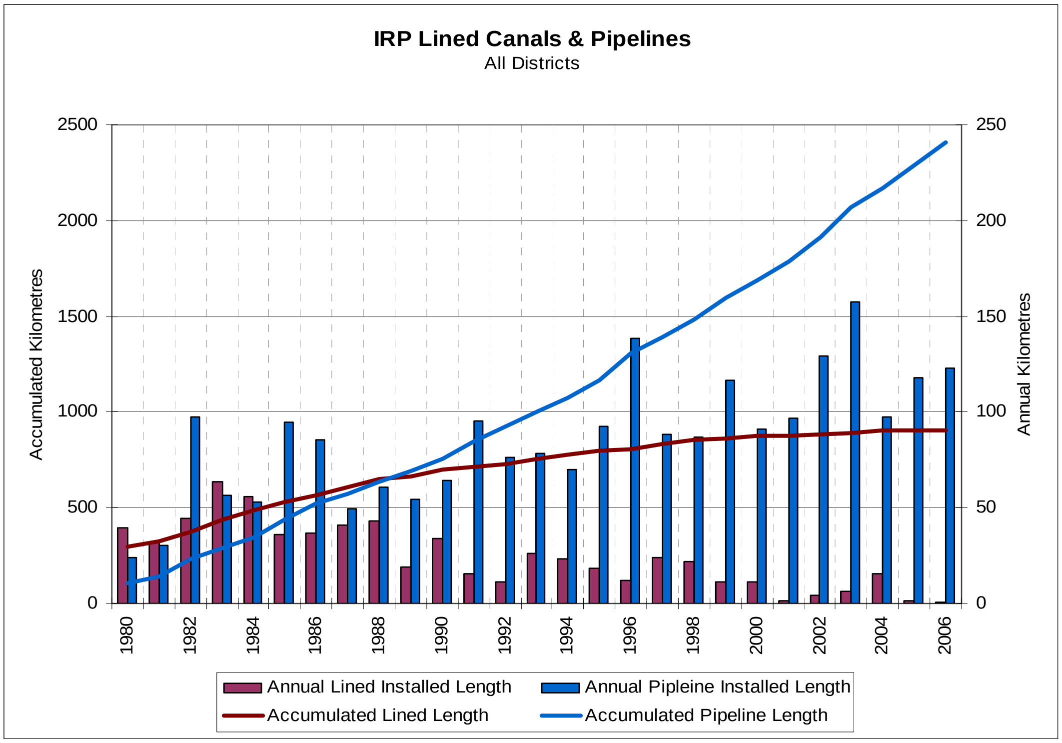


Figure 8.22 – Annual irrigation rehabilitation lengths of pipe and lined canals.

Legislation

In Alberta, there are two Legislative Acts used for the purpose of allocating and administering water use within irrigation districts. The two Acts include the *Water Act* (1999) and the *Irrigation Districts Act* (1996). As stated within Alberta's *Water Act:*

"The purpose of this Act is to support and promote the conservation and management of water, including the wise allocation and use of water [within the province of Alberta]."

The *Water Act* outlines the rights of a person/company to divert and use water and the priority of rights which are attached to the right to divert. The Department of Environment is the administrator of the *Water Act* in Alberta. The only exemption to divert water under the Act is for household purposes: if a person owns or occupies land that adjoins a river, stream, lake or natural water course. All other users must comply with the Act and hold a valid licence to divert and use water.

Licensing of water in Alberta is based on a British system of prior rights commonly referred to as first-in-time, first-in-right. To obtain a licence for irrigation purposes, the land must be deemed irrigable through a land irrigability classification. The applicant must have a development plan through an agricultural feasibility report and must identify a diversion location. There must be a determination of the volume and rate at which the land will be supplied water. A licence will not be issued for irrigation development until all of these needs have been met. Licences for irrigation purposes can be held by an individual producer or can be held for the use of others as is done by the irrigation districts.

Licences for irrigation purposes were issued in Alberta as early as the 1890s. Some of the oldest licences are held by the irrigation districts. See Table 8.16 for details on licence volumes, dates which licences were issued and the volumes of water actually diverted to each of the districts over the past eight years.

Table 8.17 provides a summary of the total irrigation diversions and area irrigated along with average water application during the 2000 to 2007 period. Due to water supply concerns, the Milk River basin was closed to accepting new applications for water licences in 1988. The St. Mary River basin was closed to new applications in 2003.

Administratively, the irrigation districts hold a licence under the *Water Act* and operate as a district using the *Irrigation District Act*. The purpose of the *Irrigation District Act* is to provide for the formation, dissolution and governance of irrigation districts in order that the management and delivery of water in the district occur in an efficient manner that provides for the needs of the users.

There are four irrigation districts which receive their water allocations directly from the St. Mary River basin and an additional four districts which share water from other basins connected to the St. Mary River system. The *Irrigation Districts Act* also identifies expansion limits and water agreements, financial implications as well as the election of boards and the general administration of an irrigation district. Figure 8.23 outlines the authority and operations of both private and irrigation district licence-holders.

Table 8.16 – District Water Licences and Diverted Volumes.

DISTRICT	**MID**	**RID**	**SMRID**	**TID**
WATER SOURCE	**Waterton, Belly and St. Mary Rivers**	**SMRID main canal**	**Waterton, Belly and St. Mary Rivers**	**SMRID main canal**
EXPANSION LIMITS(acres)	18,300	46,500	372,000	82,200
LICENCED ALLOCATION (acre-feet)	1899 – 9,200 1950 – 20,800 1991 – 4,000 Total – 34,000	1899 – 12,200 1950 – 42,800 1991 – 26,000 Total – 81,000	1899 – 168,000 1950 – 332,000 1991 – 222,000 Total – 722,000	1899 – 34,000 1950 – 116,000 1991 – 8,000 Total – 158,000
Year	**Volume of Water Diverted (acre-feet)**			
2000	35,375	58,202	562,100	140,046
2001	21,173	40,207	426,400	94,770
2002	10,788	23,552	263,700	53,324
2003	20,711	49,723	385,300	86,500
2004	12,391	28,224	327,800	64,399
2005	8,859	27,046	306,300	72,487
2006	14,114	37,049	354,500	82,448
2007	18,238	47,322	419,600	100,907

Table 8.17 – Depth of Water Diverted for District within the St. Mary Project.

Year	Total Irrigated Acreage	Volume of Water Diverted (ac-ft)	Depth of Water Diverted per acre (ac-ft/ ac.)
2000	489067	795723	1.63
2001	473165	582550	1.23
2002	470236	351364	0.75
2003	485930	542234	1.12
2004	482312	432814	0.90
2005	473773	414692	0.88
2006	466422	488111	1.05
2007	480252	586067	1.22

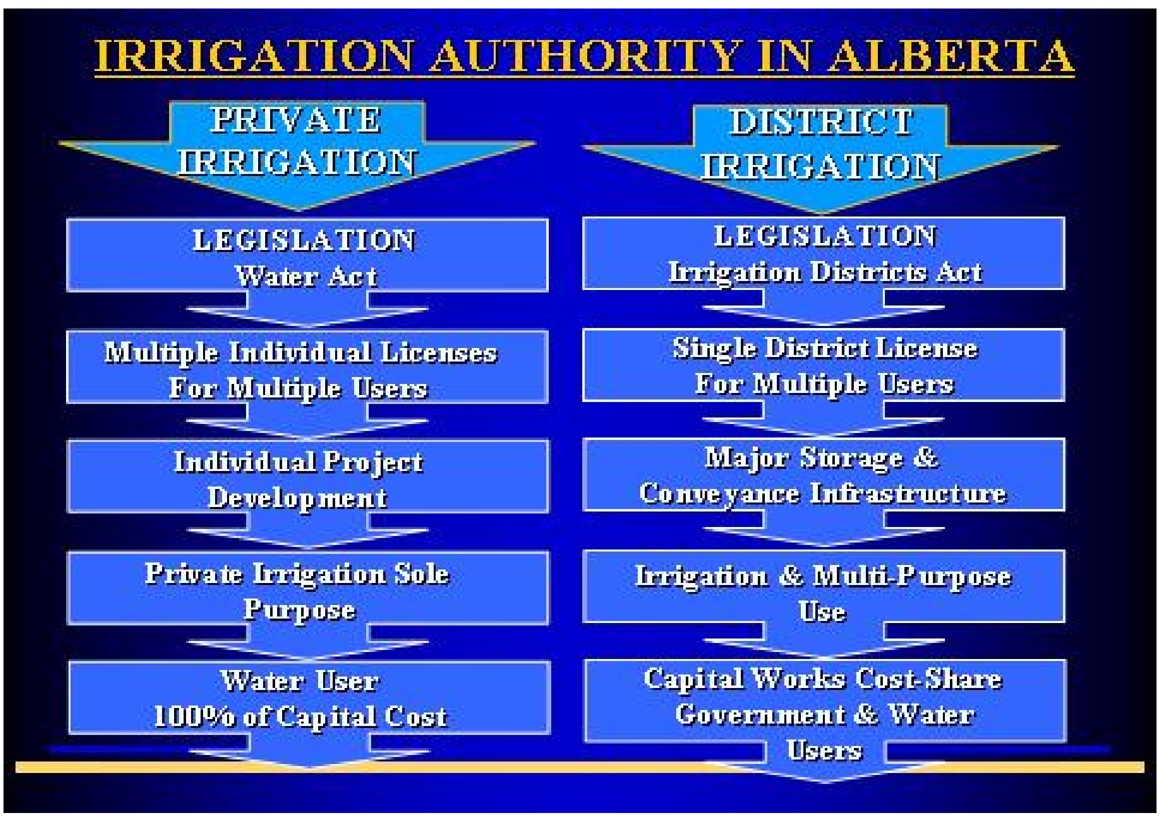
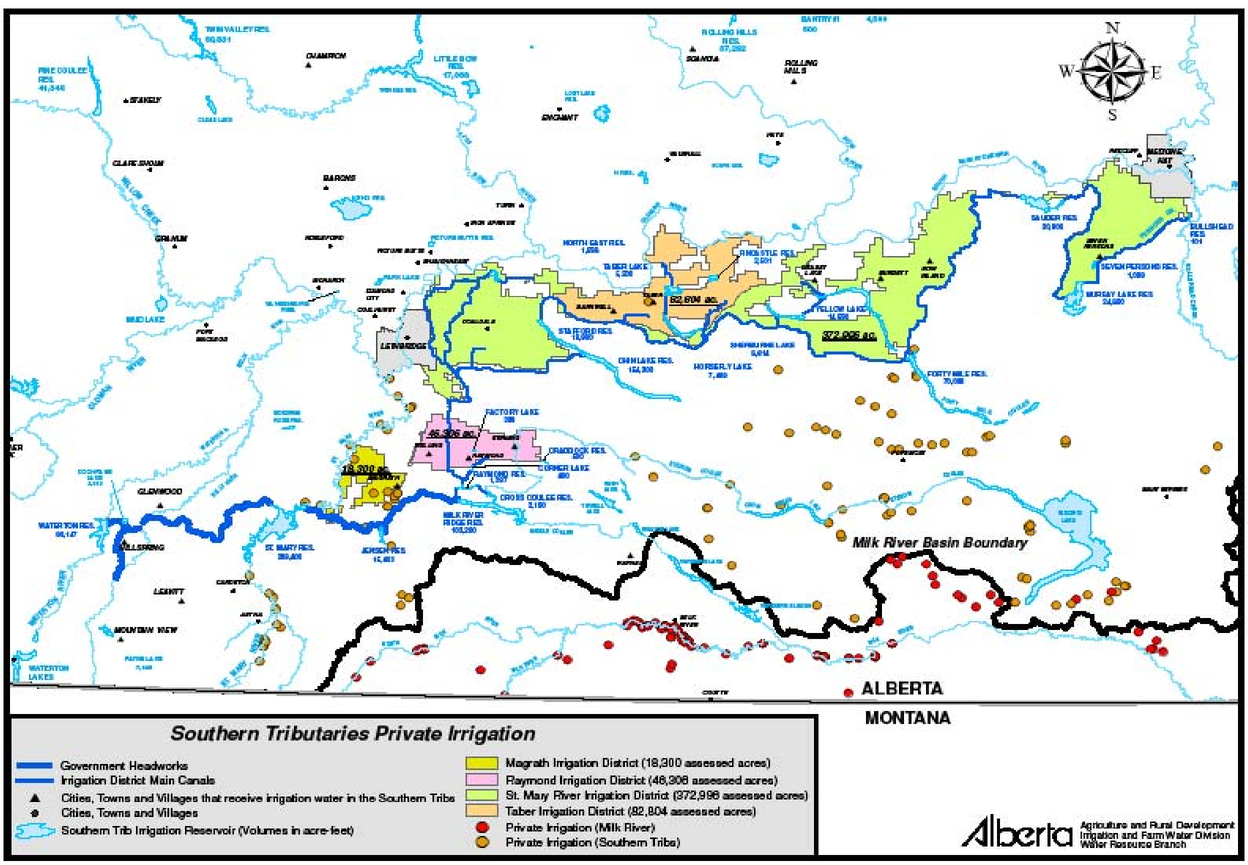


Figure 8.23 – Irrigation authority in Alberta.

The southern most part of Alberta, where the majority of irrigation takes place, has an annual moisture deficit of 9.8 inches to 19.7 inches during the crop growing season. Because of the Chinook winds, this region's climate is well suited to feeding cattle and growing high quality specialty crops.

Almost 35% of Alberta's gross domestic product in processing industries is directly tied to irrigated production. This includes about 45 processors that employ more than 5,000 people, which rely on irrigation water and specialty crops produced on irrigated land. Most of the specialty crop processing and production is located within the region supplied by the St. Mary River.

The ratio of agricultural processing to primary production is 2.66 in the irrigated area compared with 1.05 for other parts of the province. The proportion of southern Albertans engaged in value-added agricultural processing is twice the provincial average. The irrigation storage and distribution system (off the Milk and St. Mary Rivers) also provides water for about 24 towns and villages consisting of more than 32,000 individuals (see Map 8.12). In addition, over 4,000 rural residents obtain water through irrigation district infrastructure, and participate in domestic water agreements. Irrigation water is delivered to industries, processors, parks, golf courses and other recreation facilities. Countless livestock operations depend on irrigation water to sustain their operations.



Map 8.12 – Location of private irrigation projects.

On-Farm Irrigation

Once water is delivered to the producer, it is their responsibility to develop the method of irrigation used to apply water to the crop. In the areas irrigated by water diverted from the St. Mary and Milk Rivers, the majority of irrigators use low pressure sprinkler irrigation methods. Table 8.18, shows the acreage irrigated by the various methods of water application within the St. Mary Irrigation Districts and the private irrigation systems delivered through the Milk River.

Of the total irrigated acres, 369,000 or 74% apply the irrigation water through pivot sprinkler systems. Wheel move irrigation systems account for an additional 100,000 acres or 20%. The remaining 6% of the irrigated area uses gravity (flood) methods to apply water for crop use. Figure 8.24 shows the trend in irrigation practice for all of Alberta.

Table 8.18 – On-Farm Irrigation Systems.

District	Pivot		Wheelmove		Gravity	
	Acres	% of Area	Acres	% of Area	Acres	% of Area
Milk River Main Stem	4572	56.0	2939	36.0	653	8.0
Milk River Basin					10659	100
Magrath	7064	42.9	7009	38.3	3440	18.8
Raymond	17874	38.6	24172	52.2	4260	9.2
Taber	60530	73.1	18962	22.9	3312	4.0
St. Mary	302873	81.2	57068	15.3	13055	3.5

As indicated, producers have been quick to adopt new technologies to operate their farms as they become available. The reason for this quick adoption rate is most likely due to a number of factors including:

- Farm families are getting smaller,
- the labour force available to the farm industry is shrinking,
- the size of farms is increasing, and
- the lifestyle of the producer has changed.

Development within the Milk River basin mirrors what has happened in the irrigation districts. In most cases, the adoption of new technologies has been driven by the cost of energy. The cost of lifting water from the Milk River valley to some of the upper benches is extremely high and the use of low pressure technology sprinkler systems is a must.

Many producers have replaced older, inefficient systems with low-pressure pivot irrigation systems, which greatly increase on-farm irrigation efficiencies. As a result, on-farm efficiencies have improved from approximately 34% in 1965 to 74% in 2005. As producers continue the conversion of irrigation systems, on-farm efficiency is expected to increase to 78% within the next decade. Photos 8.29 and 8.30 show a typical irrigation pump site and typical back-flood irrigation system, respectively.

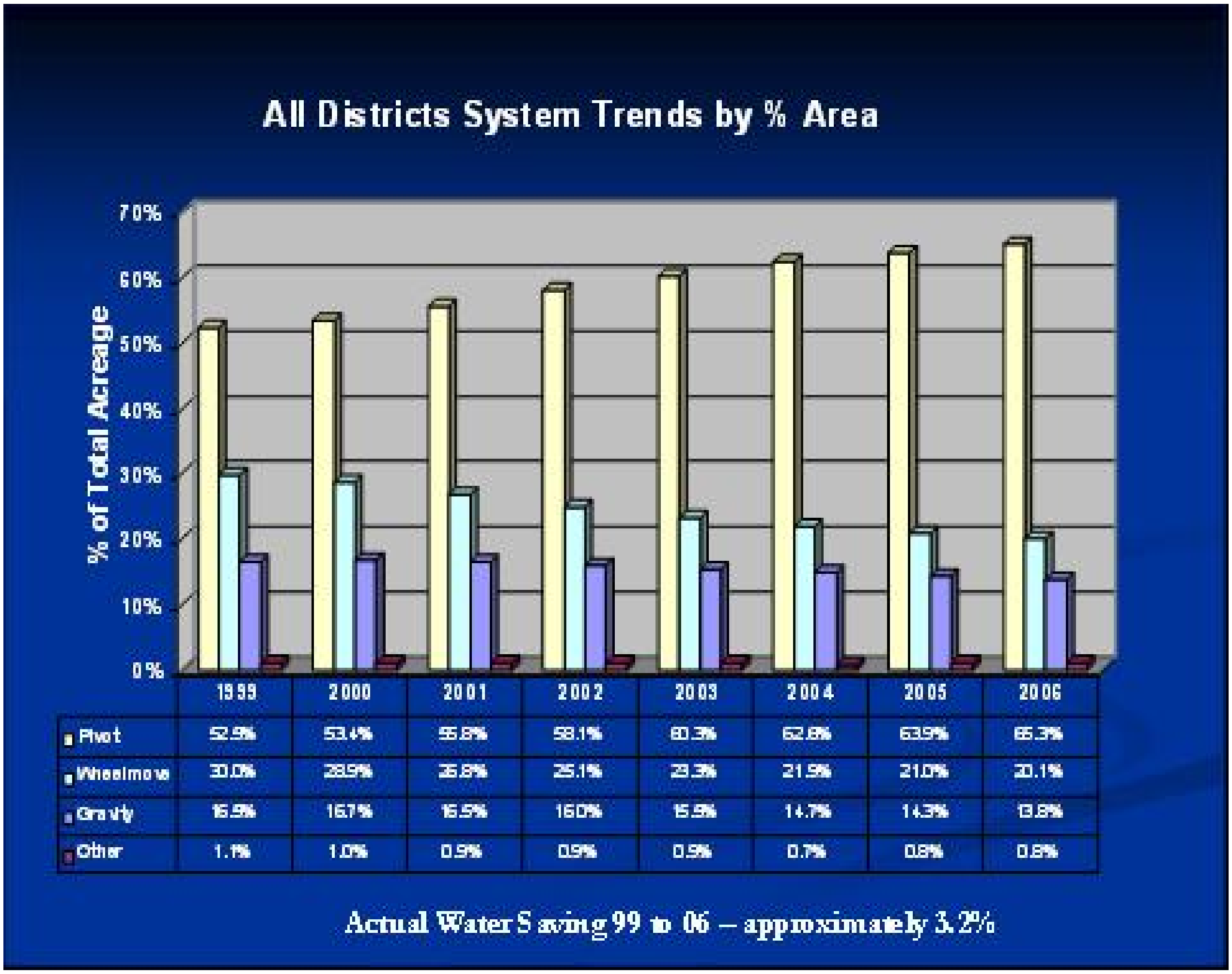


Figure 8.24 – On-farm irrigation system use.

Photo 8.29 – Typical irrigation pump site on the Milk River.
Photo: Alberta Agriculture and Rural Development

Photo 8.30 – Typical back-flood irrigation system.
Photo: Alberta Agriculture and Rural Development

Cropping Patterns

The Milk River Basin is dominated by course grain and forage production in support of the livestock industry. Livestock and the cow-calf industry has been the dominant agriculture production in the area since the first development. The significance of irrigation as an assured source of feed supplies has resulted in this area having a higher carrying capacity and increased population when compared to areas just outside this irrigated area and similar climactic regions of southern Alberta. Although climate conditions are similar to areas of Alberta which produce numerous special crops, processors and other industries have not been established in the area.

There are 8,000 plus acres in the Milk River basin that are supplied water which is pumped directly off the main stem of the Milk River. These acres have the greatest potential for crop diversity due to a somewhat assured supply of water. Areas off the main stem are subject to prolonged droughts and localized runoff to support irrigation needs. Therefore, these areas are generally used for forage production. Photos 8.31 through 8.40 show a typical main stem irrigation development and off-stream developments.

Irrigators in the organized irrigation districts, who receive water from the St. Mary River project, have very diverse cropping patterns with close to 50 different crops grown in the area. Course grains and forage crops are the dominant crops in the area but the number of processors and value-added production continues to increase in the area. At the present time, there are approximately 45 processors within the irrigated area. Figure 8.25 shows the changes in cropping patterns over the past decade.

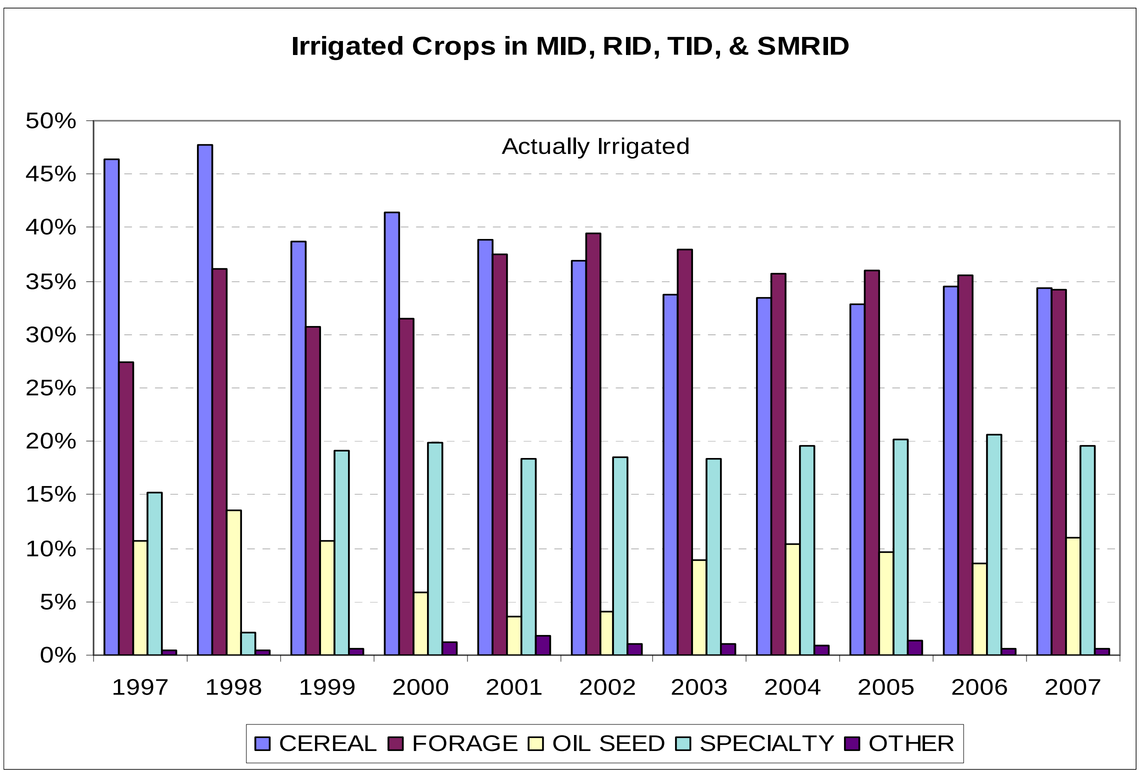


Figure 8.25 – Irrigated Crops within the St. Mary Projects area.

As stated earlier, approximately 94% of the irrigated area uses some form of sprinkler irrigation, within the irrigation districts. The pumping systems utilize either electricity or natural gas as the energy source and are split almost equally between the two sources. A typical natural gas (Photo 8.31) and electric (Photo 8.32) irrigation pumping system, as well as other aspects of irrigation infrastructure (Photos 8.33 – 8.40), are shown below.

Irrigation in Alberta has continued to expand and the province has become one of the world's leaders in technology development and water management operations. Government support and the leading edge risk-takers on the farm have all contributed to the success of the irrigation industry and the value-added production which we see today.

Photo 8.31 – Natural Gas pumping unit.
Photo: Alberta Agriculture and Rural Development

Photo 8.32 – Electric Pumping Unit.
Photo: Alberta Agriculture and Rural Development

Photo 8.33 – Typical Irrigation District Pipeline Inlet.
Photo: Alberta Agriculture and Rural Development

Photo 8.34 – Typical Irrigation Drop Structures.
Photo: Alberta Agriculture and Rural Development

Photo 8.35 – Typical Irrigation Check Structure.
Photo: Alberta Agriculture and Rural Development

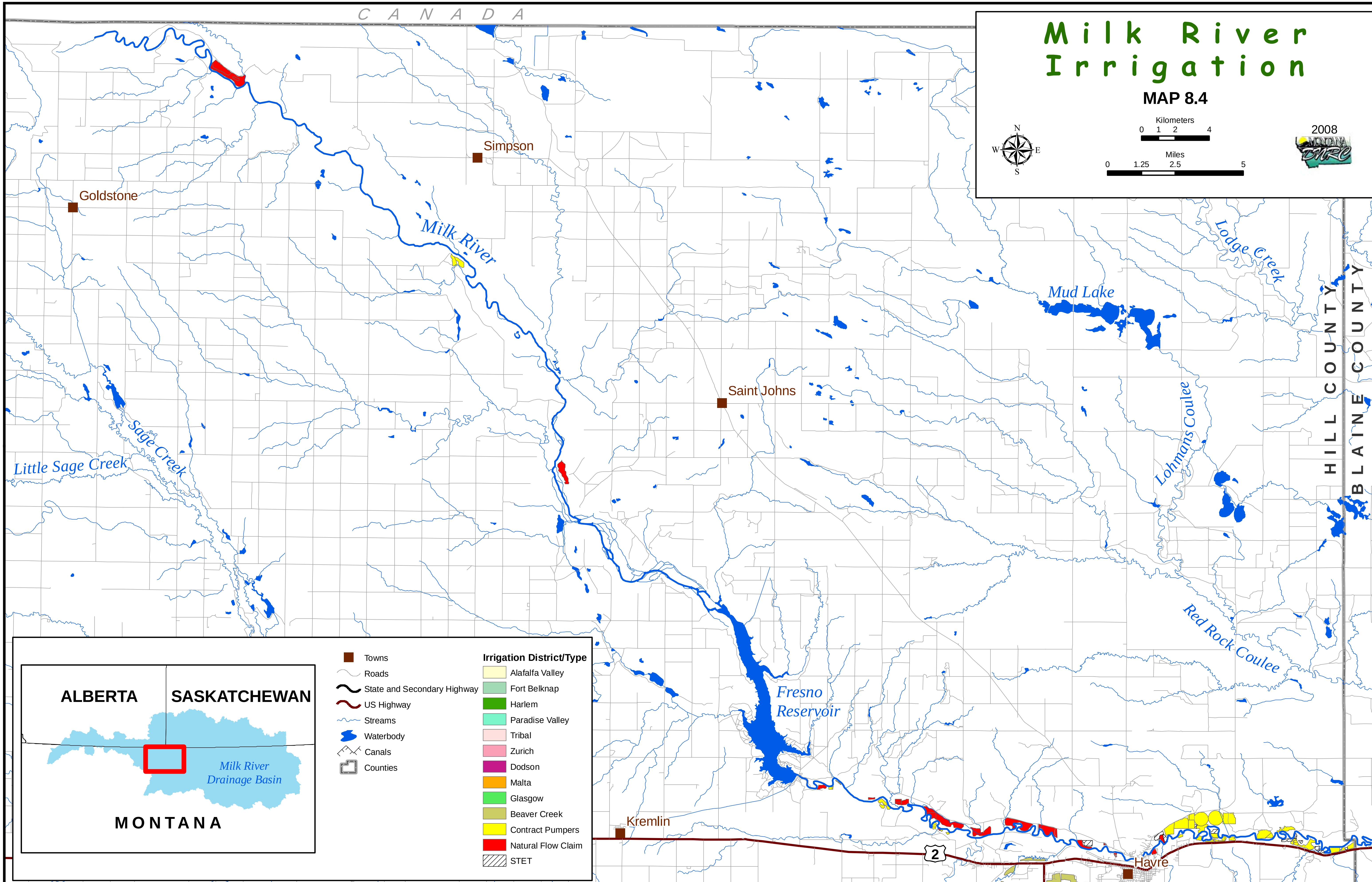
Photo 8.36 – Typical Un-rehabilitated Canal.
Photo: Alberta Agriculture and Rural Development

Photo 8.37 – Irrigation Pipeline Installation.
Photo: Alberta Agriculture and Rural Development

Photo 8.38 – Typical Irrigation Delivery off a Pipeline System.
Photo: Alberta Agriculture and Rural Development

Photo 8.39 – Irrigation Canal with Poly and Gravel Armour Lining.
Photo: Alberta Agriculture and Rural Development

Photo 8.40 – Typical Irrigation Return Flow and Measurement Site.
Photo: Alberta Agriculture and Rural Development


Milk River Irrigation
MAP 8.4
Kilometers
0 1 2 4
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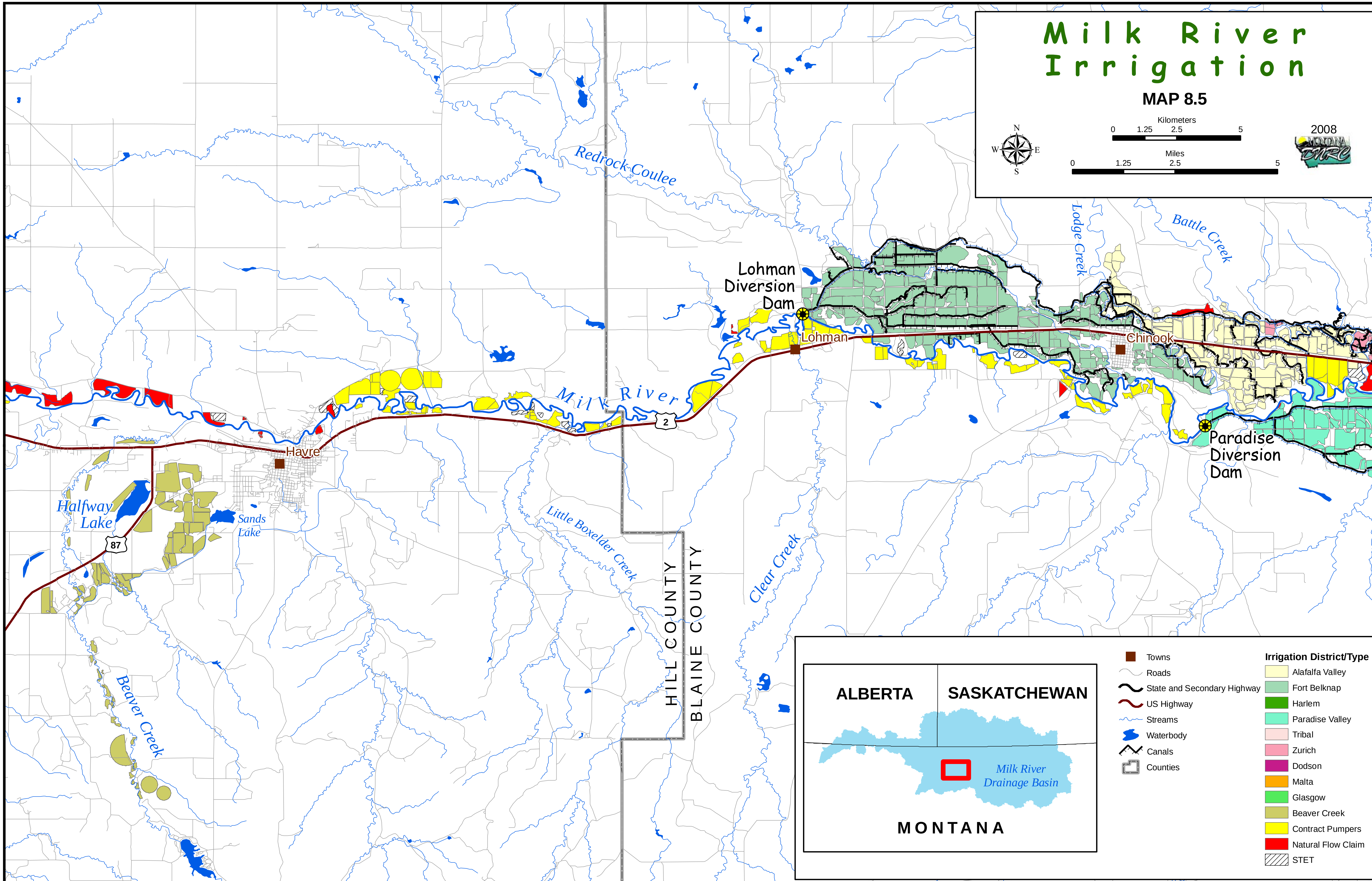
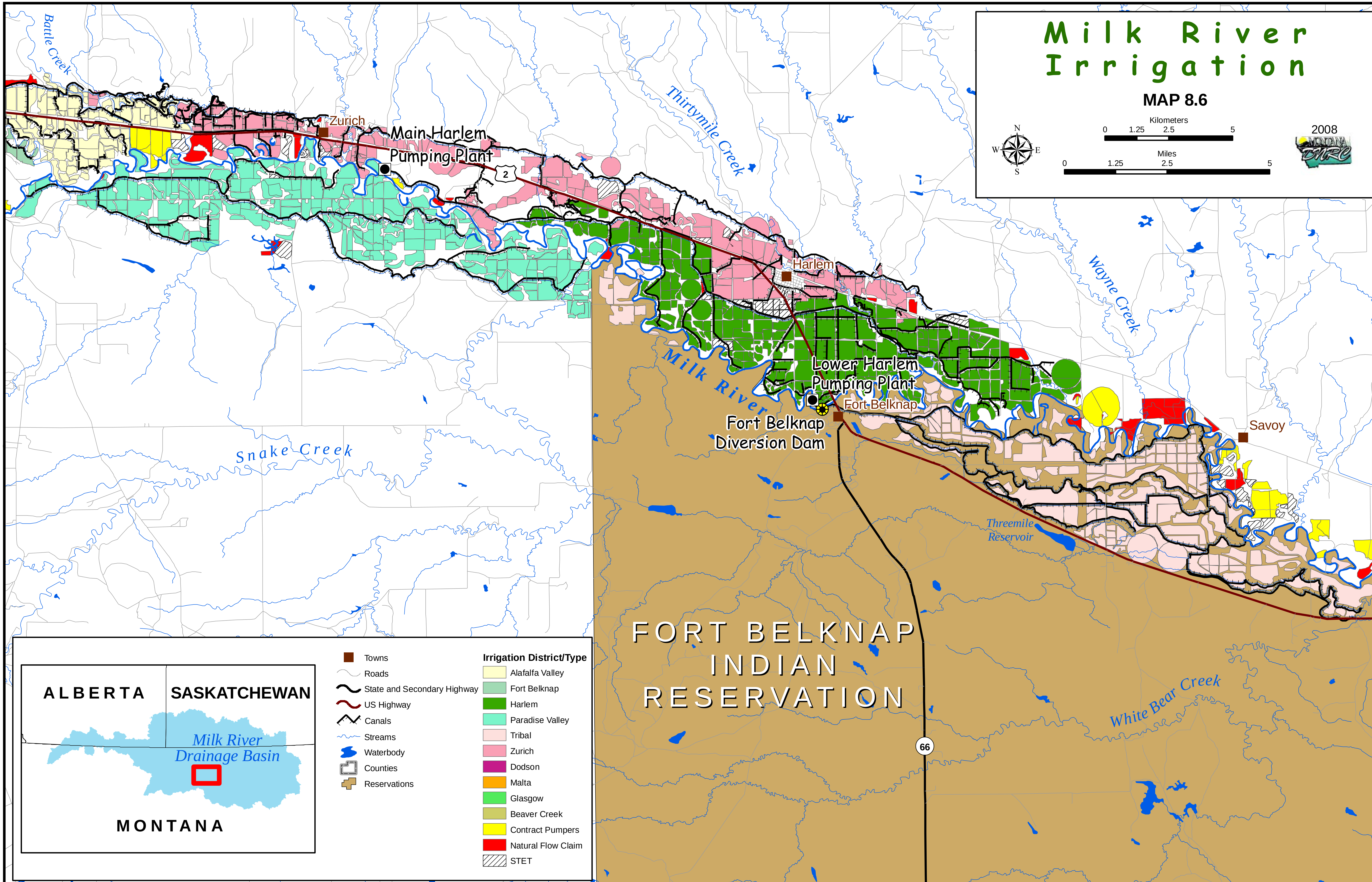
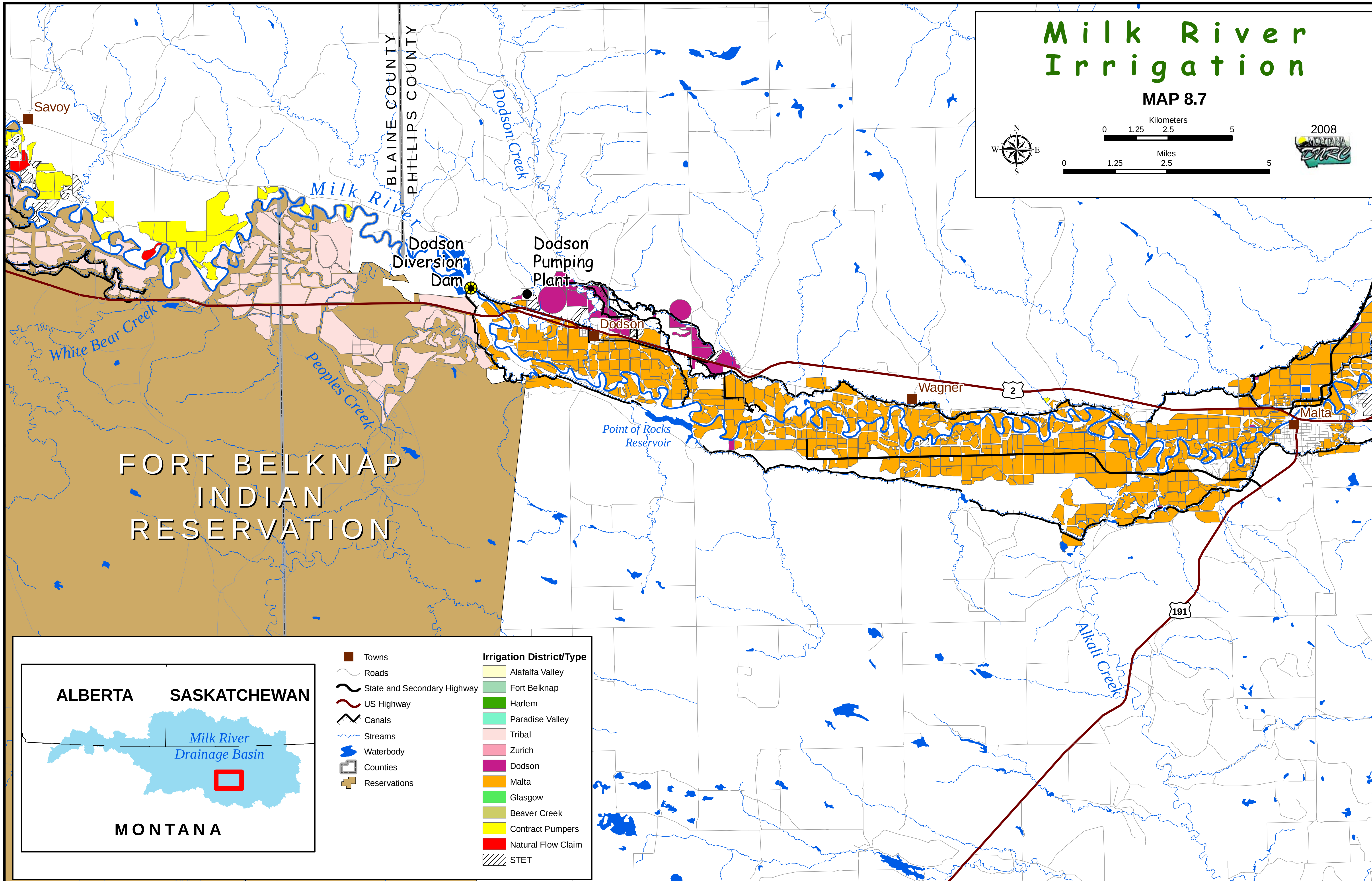
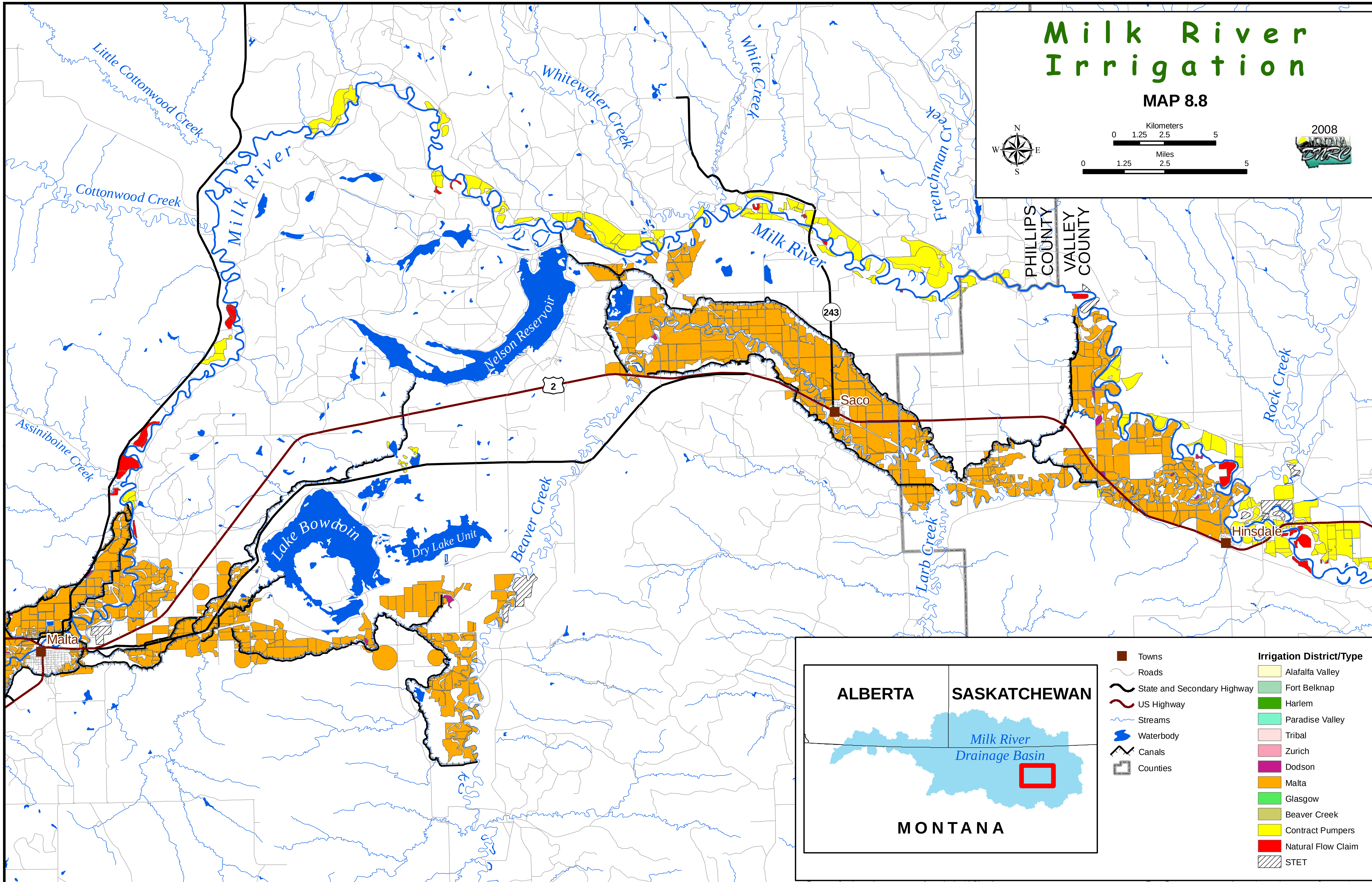
Mud Lake
Lodge Creek
Lohmans Coulee
Sage Creek
Little Sage Creek
Fresno Reservoir
Red Rock Coulee
HILL COUNTY
BLAINE COUNTY
2
ALBERTA
SASKATCHEWAN
MONTANA
Milk River Drainage Basin
Towns
Roads
State and Secondary Highway
US Highway
Streams
Waterbody
Canals
Counties
Irrigation District/Type
Alafalfa Valley
Fort Belknap
Harlem
Paradise Valley
Tribal
Zurich
Dodson
Malta
Glasgow
Beaver Creek
Contract Pumpers
Natural Flow Claim
STET

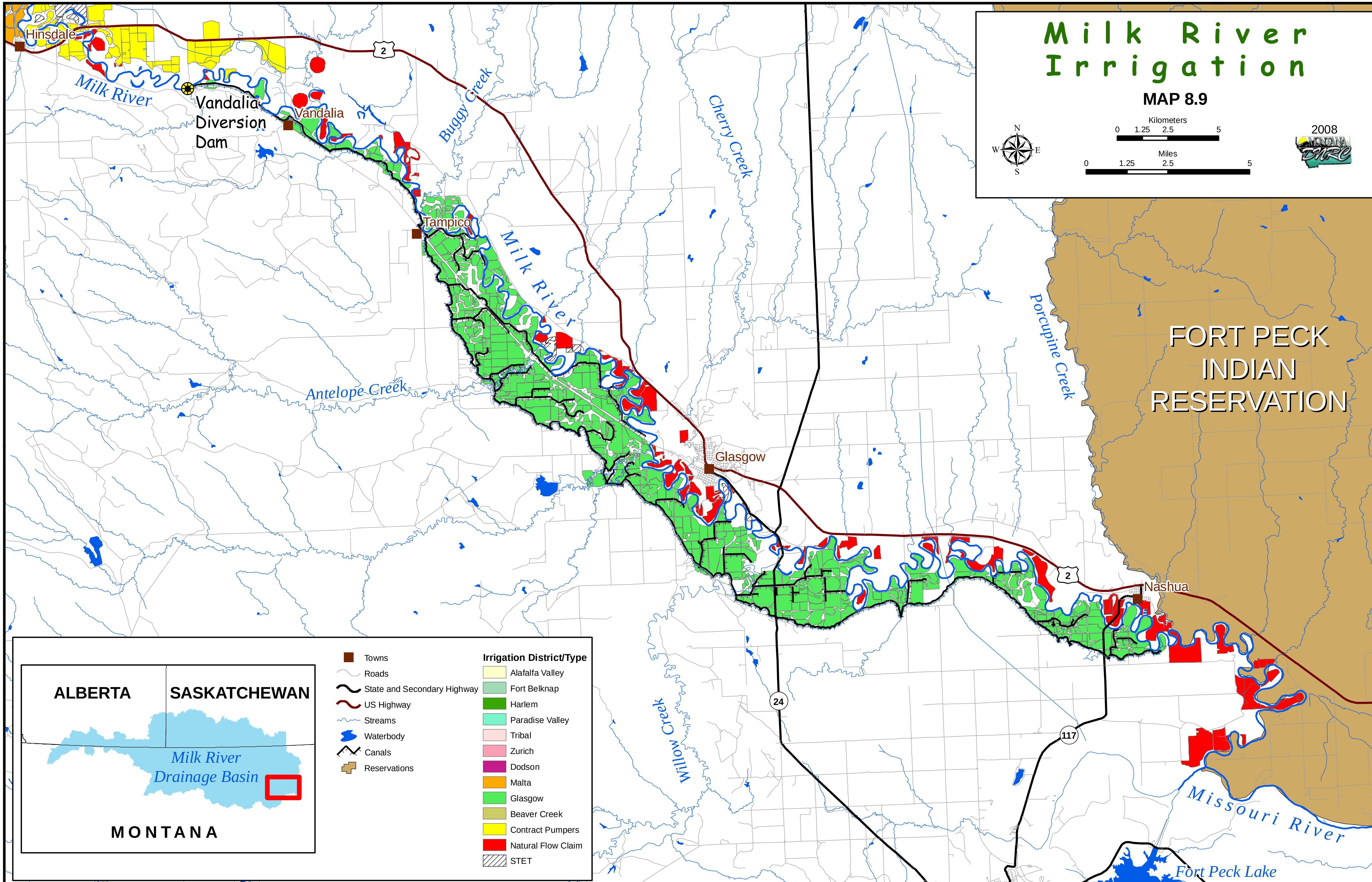


Milk River Irrigation
MAP 8.5
Kilometers
0 1.25 2.5 5
Miles
0 1.25 2.5 5
2008
N S E W
Redrock Coulee
Lodge Creek
Battle Creek
Lohman Diversion Dam
Lohman
Chinook
Milk River
Havre
Halfway Lake
Sands Lake
Little Boxelder Creek
Clear Creek
Beaver Creek
Paradise Diversion Dam
HILL COUNTY
BLAINE COUNTY
2
87
ALBERTA
SASKATCHEWAN
MONTANA
Milk River Drainage Basin
Towns
Roads
State and Secondary Highway
US Highway
Streams
Waterbody
Canals
Counties
Irrigation District/Type
Alafalfa Valley
Fort Belknap
Harlem
Paradise Valley
Tribal
Zurich
Dodson
Malta
Glasgow
Beaver Creek
Contract Pumpers
Natural Flow Claim
STET


Milk River Irrigation
MAP 8.6
Kilometers
0 1.25 2.5 5
Miles
0 1.25 2.5 5
2008
N
S
E
W
Battle Creek
Zurich
Main Harlem Pumping Plant
2
Thirtymile Creek
Harlem
Wayne Creek
Milk River
Lower Harlem Pumping Plant
Fort Belknap
Fort Belknap Diversion Dam
Savoy
Snake Creek
Threemile Reservoir
FORT BELKNAP INDIAN RESERVATION
White Bear Creek
66
ALBERTA
SASKATCHEWAN
Milk River Drainage Basin
MONTANA
Towns
Roads
State and Secondary Highway
US Highway
Canals
Streams
Waterbody
Counties
Reservations
Irrigation District/Type
Alafalfa Valley
Fort Belknap
Harlem
Paradise Valley
Tribal
Zurich
Dodson
Malta
Glasgow
Beaver Creek
Contract Pumpers
Natural Flow Claim
STET


Milk River Irrigation
MAP 8.7
Kilometers
0 1.25 2.5 5
Miles
0 1.25 2.5 5
N
W
E
S
2008
Savoy
BLAINE COUNTY
PHILLIPS COUNTY
Dodson Creek
Milk River
Dodson Diversion Dam
Dodson Pumping Plant
Dodson
White Bear Creek
Peoples Creek
Wagner
2
Malta
Point of Rocks Reservoir
FORT BELKNAP INDIAN RESERVATION
191
Alkali Creek
ALBERTA
SASKATCHEWAN
Milk River Drainage Basin
MONTANA
Towns
Roads
State and Secondary Highway
US Highway
Canals
Streams
Waterbody
Counties
Reservations
Irrigation District/Type
Alafalfa Valley
Fort Belknap
Harlem
Paradise Valley
Tribal
Zurich
Dodson
Malta
Glasgow
Beaver Creek
Contract Pumpers
Natural Flow Claim
STET


Milk River Irrigation
MAP 8.8
Kilometers
0 1.25 2.5 5
Miles
0 1.25 2.5 5
2008
N
S
E
W
Little Cottonwood Creek
Cottonwood Creek
Milk River
Whitewater Creek
White Creek
Frenchman Creek
Milk River
PHILLIPS COUNTY
VALLEY COUNTY
Nelson Reservoir
243
2
Saco
Assiniboine Creek
Rock Creek
Beaver Creek
Lake Bowdoin
Dry Lake Unit
Larb Creek
Hinsdale
Malta
ALBERTA
SASKATCHEWAN
Milk River Drainage Basin
MONTANA
Towns
Roads
State and Secondary Highway
US Highway
Streams
Waterbody
Canals
Counties
Irrigation District/Type
Alafalfa Valley
Fort Belknap
Harlem
Paradise Valley
Tribal
Zurich
Dodson
Malta
Glasgow
Beaver Creek
Contract Pumpers
Natural Flow Claim
STET



Milk River Irrigation
MAP 8.9
Kilometers
0 1.25 2.5 5
Miles
0 1.25 2.5 5
N
S
E
W
2008
Hinsdale
Milk River
Vandalia Diversion Dam
Vandalia
Buggy Creek
Cherry Creek
Tampico
Milk River
Antelope Creek
Glasgow
Porcupine Creek
FORT PECK INDIAN RESERVATION
Nashua
Willow Creek
Missouri River
Fort Peck Lake
2
24
117
ALBERTA
SASKATCHEWAN
Milk River Drainage Basin
MONTANA
Towns
Roads
State and Secondary Highway
US Highway
Streams
Waterbody
Canals
Reservations
Irrigation District/Type
Alafalfa Valley
Fort Belknap
Harlem
Paradise Valley
Tribal
Zurich
Dodson
Malta
Glasgow
Beaver Creek
Contract Pumpers
Natural Flow Claim
STET

9.0 Water Supply and Management Models

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This chapter provides a general understanding of hydrologic (water supply management) models and hydroclimatic data that have been used by each jurisdiction in the past. It provides a description of previous hydrologic or water supply management investigations that have been carried out; identifying what was looked at, what model was used and what hydroclimatic data was available. These models could be used singly or in combination with other models to evaluate the performance (yield, irrigation deficit, apportionment status, etc.) for the breadth of administrative or structural options the Montana-Alberta Project Team may wish to consider. The final section proposes that a single model be developed and used by both jurisdictions to evaluate water management scenarios for the St. Mary and Milk River system.

9.1 Montana Water Supply and Management Models

9.1.1 USBR Milk River Project Operations Model

Quick Facts

- **The USBR uses a monthly reservoir operations model and several spreadsheet models to produce operating plans and forecasts for the reservoirs and canals of the Milk-St. Mary River system.**
- **These models are also used to forecast and manage deliveries of water to Montana's Milk River Project irrigation districts, contract pumpers, and the Tribes of the Fort Belknap Reservation.**

The U.S. Bureau of Reclamation (USBR) uses a monthly reservoir operations model and several spreadsheet models in its day-to-day operations of the Milk-St. Mary River system. The reservoir operations model is used to produce operating plans and forecasts for Sherburne Reservoir, St. Mary Canal, St. Mary River at the International Boundary, Fresno Reservoir, Nelson Reservoir and Lake Bowdoin. It is also used to forecast and manage water deliveries to the irrigation districts, contract pumpers and Fort Belknap Tribes. Water supply outlooks for the upcoming 12 months are produced with the model for most probable (forecasted), minimum probable (about 80th percentile exceedence conditions based on forecast) and maximum probable (about 10th percentile exceedence conditions based on forecast).

During the fall and early winter before snowpack data are available, the USBR uses current storage, recent streamflow trends and historic flow data to estimate what conditions and operations might be during the upcoming 12 months. As better snow pack data become available later in the winter and during the early spring, runoff forecasts for the St. Mary River and Milk River are developed by the U.S. Natural Resources Conservation Service (USNRCS). These forecasts are then input to the model as the April-July water volumes for the St. Mary River and March-July volumes for the Milk River. Model runs are made for the input volumes that would be representative of most probable, minimum probable and maximum probable conditions. Plans depict how the system would be operated under these conditions.

Spreadsheet models also are used by the USBR to generate input data for the monthly operations model and to fine-tune operations during the irrigation season. There are spreadsheets for forecasting the most probable inflows to Fresno and Sherburne Reservoirs under various conditions and a spreadsheet for forecasting the natural flows of the St. Mary River at the International Boundary. Additional spreadsheets are used during the irrigation season to fine-tune operations on a day-to-day basis, given real-time streamflow data, apportionment balances and anticipated tributary inflows.

9.1.2 USBR HYDROS Planning Model

The USBR, with the assistance of the Montana Department of Natural Resources and Conservation (DNRC), Montana Reserved Water Rights Compact Commission, and Fort Belknap Tribes developed a detailed monthly planning model of the Milk-St. Mary River system during the 1990s. The model was built with USBR HYDROSS (Hydrologic River Operation Study System) modeling software. It is a water accounting model with a graphical user interface, which replaces the earlier Fortran-based OPMILK model developed by the USBR and DNRC during the 1980s.

The HYDROS model includes all of the major rivers, tributary streams, reservoirs and major canals and irrigation in the system. Input "natural flow" hydrologic data for the model was developed for the 62-year time period from 1928-1989 for the St. Mary River, Milk River, and for the major Milk River tributaries. Crop irrigation requirements for various management factors were also developed as input data for each year during this period. Irrigated acreage and priority date input files for the irrigation districts, Tribes, contract pumpers, and other water-right holders were identified. Reservoir evaporation was input for each reservoir, for each month of the period. The model runs on a monthly time step and is available, although the input data probably should be updated to include hydrologic data for the more recent years.

The model initially was used in the negotiation of the Water Compact with the Fort Belknap Tribes. Various scenarios were analyzed with the goal of finding ways to provide the Tribes with their senior water rights while maintaining the water supply for other Milk River water users. More recently, the model has been used to assess how various water management and infrastructure changes might be used to increase the reliable water supply in the Milk River in Montana, relative to baseline conditions. It also could be used to model the effects of a new Canadian reservoir on the Milk River, and associated expansion of the acres irrigated from the Milk River in Canada.

Quick Facts

- **The USBR's HYDROS model was developed in the 1990s using a 62-year time period (1928-1989) to assess how various water management and infrastructure changes might increase the reliable water supply in the Milk River in Montana.**
- **The State of Montana is using CADWES RiverWare software to develop a new planning model of the Milk-St. Mary River system. It simulates operations of the upper St. Mary and Milk River system on a daily time-step for the 1959-2003 period.**

9.1.3 Montana DNRC RiverWare Model of Milk-St. Mary River System

The Montana DNRC is developing a model of the Montana portion of the St. Mary-Milk River systems using the CADWES RiverWare software. The model simulates operations of the upper St. Mary River system to meet the goals of maximizing diversions down the St. Mary Canal while meeting international apportionment requirements. The model is composed of objects (such as reservoirs, canals and river reaches), hydrologic data, and "rules" that specify how the system is operated. The model links the St. Mary Canal with the Milk River system, and includes all of the major reservoirs and canals in the Milk River system. The model runs on a daily time step, simulating operations of the systems with hydrologic data from the 1959 through 2003 period. Figures 9.1 through 9.3 are a schematic of the model. A sample rule is presented in Figure 9.4.

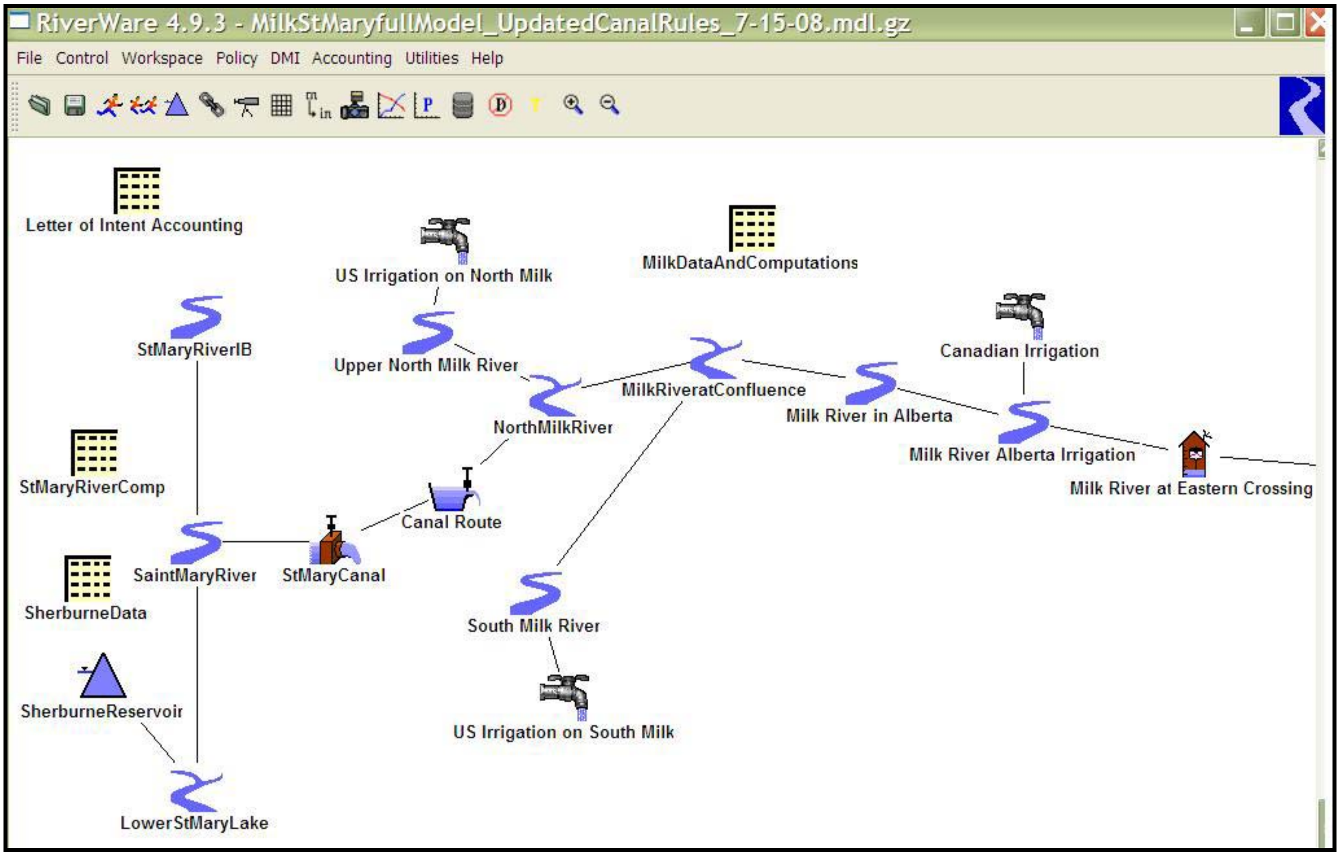

Figure 9.1 – St. Mary-Milk River system RiverWare model schematic.

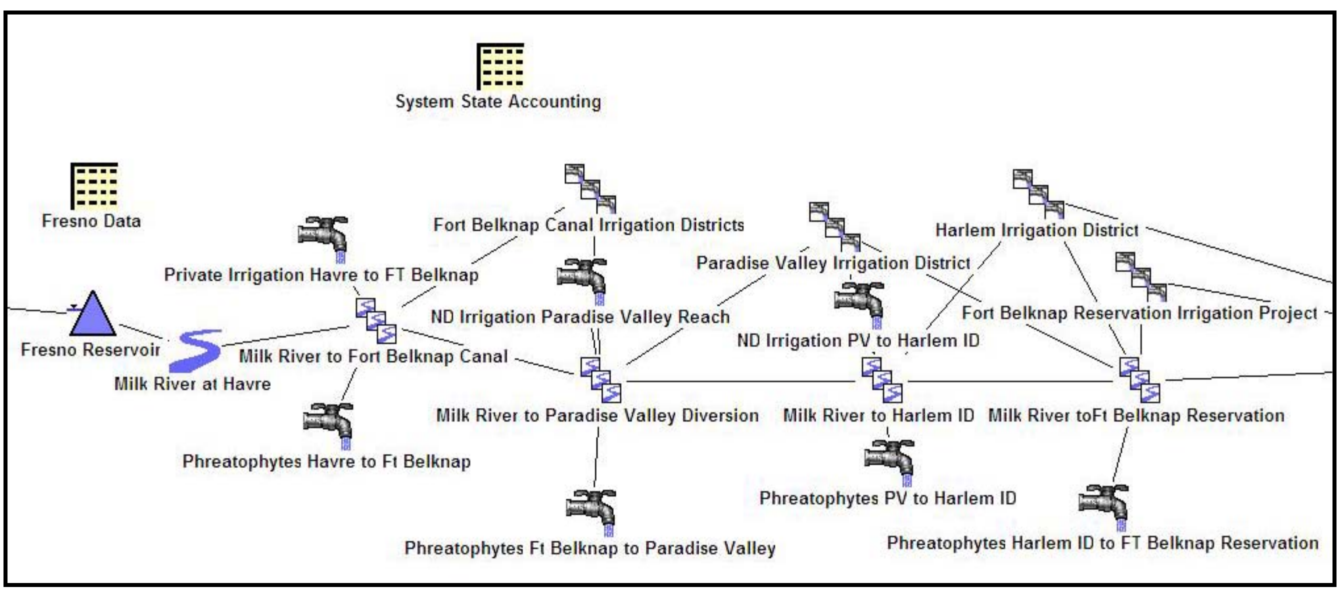

Figure 9.2 – St. Mary-Milk River system RiverWare model schematic (continued).

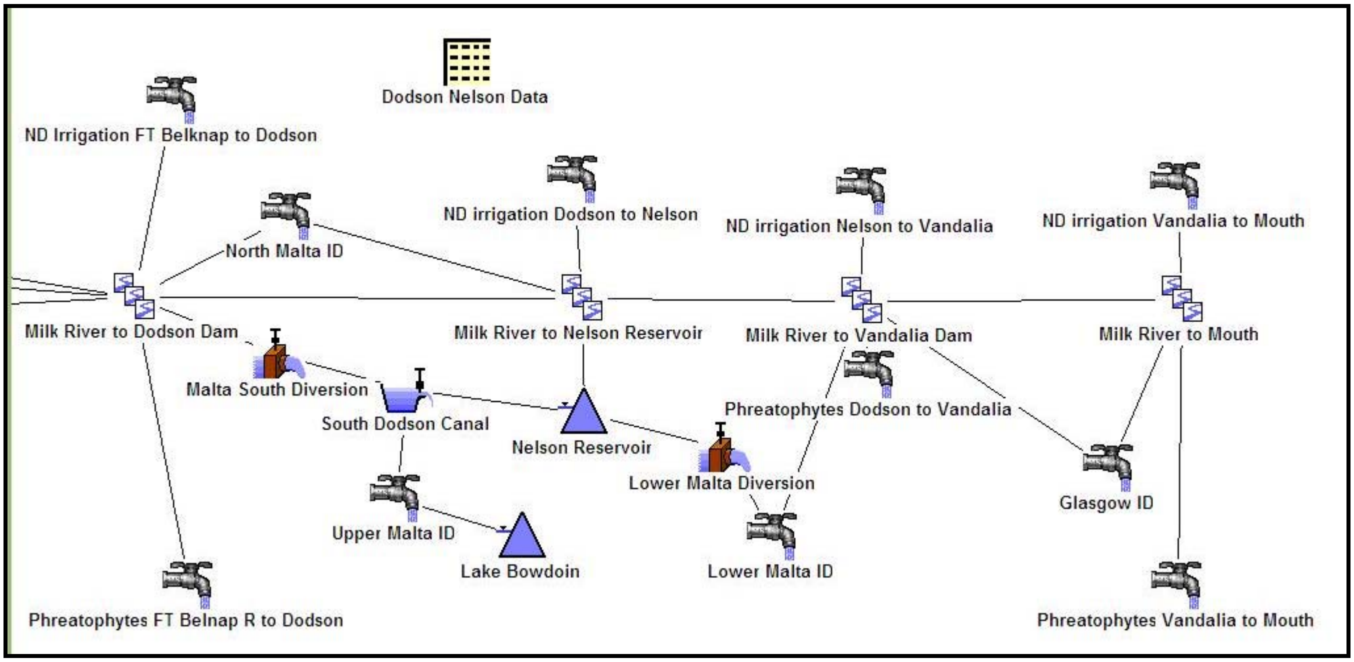

Figure 9.3 – St. Mary-Milk River system RiverWare model schematic (continued).

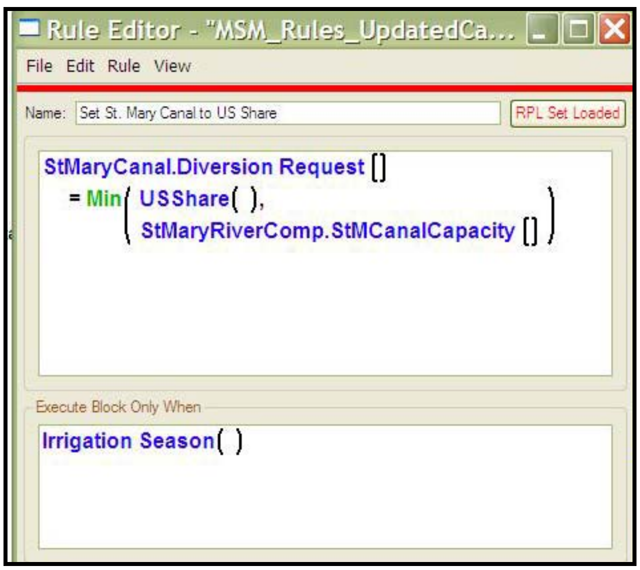

Figure 9.4 – St. Mary-Milk River System RiverWare model sample rule.

The RiverWare model is a planning model. It can be used to model system operation scenarios, or it could be run to analyze structural modifications, such as increasing the capacity of the U.S. St. Mary Canal. This model will likely be used for planning work on the U.S. St. Mary Canal rehabilitation, such as feasibility studies and *National Environmental Policy Act* related work, in the future. There also is the potential for modifying the model so that it can be used for forecasting and operations ranging from seasonal to daily.

Some sample analyses that have been done using output from the model are presented below. Table 9.1 summarizes what annual canal deliveries of the U.S. share might be with optimal use of a rehabilitated 650 cfs canal, and how deliveries might increase with expanded canal capacities. Table 9.2 contains model output summary to assess how canal deliveries might be affected by the establishment of a winter minimum release from Sherburne Reservoir. All model scenarios assume that the United States would only have access to its share of St. Mary River flows, and they include the 2001 *Letter of Intent* water described in Chapter 5.

Table 9.1 – Modeled St. Mary Canal deliveries in acre-feet for various capacities (based on 1959-2003 hydrologic data).

	Modeled Annual Canal Delivery AF		
	650 CFS canal	**850 CFS canal**	**1,050 CFS canal**
Exceeded 10 percent of time	255,800	274,300	294,200
Median	218,300	231,900	233,800
Exceeded 90 percent of time	159,500	161,200	161,300
Average gain over 650 CFS canal		11,300	17,000

Table 9.2 – Modeled St. Mary Canal deliveries in acre-feet for various winter minimum release rates from Sherburne Reservoir (based on 1959-2003 hydrologic data).

	Modeled Annual Canal Delivery AF		
	0 CFS release	**10 CFS release**	**25 CFS release**
Exceeded 10 percent of time	255,800	254,600	253,100
Median	218,300	215,200	208,600
Exceeded 90 percent of time	159,500	156,600	152,900
Average change compared to 0 release		-2,100	-5,800

9.2 Alberta Water Supply and Management Models

9.2.1 Water Supply and Management in Alberta

Over the past 100 years, Alberta has experienced a significant level of development in its water management infrastructure as well as growth in the demand and consumptive use of its water resources. As a result, past performance of water management infrastructure is not necessarily representative of future performance and historical flows on a particular water course are not necessarily representative of future flows or water availability.

The water management infrastructure that has been developed in Alberta is complex and has had an increasing impact on observed flows over time. Due to this complexity, in the 1970s Alberta Environment (AENV) began using water supply and management models in combination with a historical set of natural flows to simulate water management within the South Saskatchewan Basin. These models are used to assess the potential implication and performance of various planning alternatives and to support water allocations decisions.

In general, the models that are used for these purposes are considered "water accounting models", rather than hydrologic models that simulate the rainfall runoff process. Models are designed to represent the "current" physical layout of the channels, water management infrastructure (diversion canals, storage reservoirs, etc), physical constraints (storage capacity, canal capacities, reservoir filling curves, etc) and legal/regulatory constraints or policies (licensed allocations, priority of rights, apportionment, etc). A set of historical natural flows is then applied to the model along with historical demands for each project. The model then conducts water accounting for each simulation time step to assess the historical performance of the system in meeting desired objectives over the simulation period.

This simulation of performance for the current level of development often forms what is termed as the "base case". Planning alternatives and/or requests for new water allocations are then evaluated. This is done by modifying the physical model to incorporate the potential changes that would be introduced by the alternative and applying the same set of historical natural flows and demands to the model to assess how the system performs under the proposed changes relative to the "base case".

Quick Fact

- **Alberta Environment uses water "accounting" models to assess various planning alternatives and to support water allocations decisions.**
- **To support modeling, AENV has developed a set of weekly historical natural flows for the 1912 to 2001 period. This includes data for more than 100 sites within the South Saskatchewan River basin, including the St. Mary Basin and six sites in the Milk River Basin.**

To support this level of modeling, AENV developed a set of weekly historical natural flows for the 1912 to 2001 period. This includes over 100 sites within the South Saskatchewan River Basin, (including the St. Mary River Basin) and 6 sites in the Milk River Basin. As well, it includes historical weekly precipitation and evaporation estimates for various locations across the basins. However, as the 1912 to 1927 period generally represents a relatively wet period within southern Alberta, the water management models generally simulate system performance solely for the1928-2001 period. Figure 9.5 and Table 9.3 provide an example of a water management model and its water accounting process for a simple system comprised of a single input a storage reservoir and two demands.

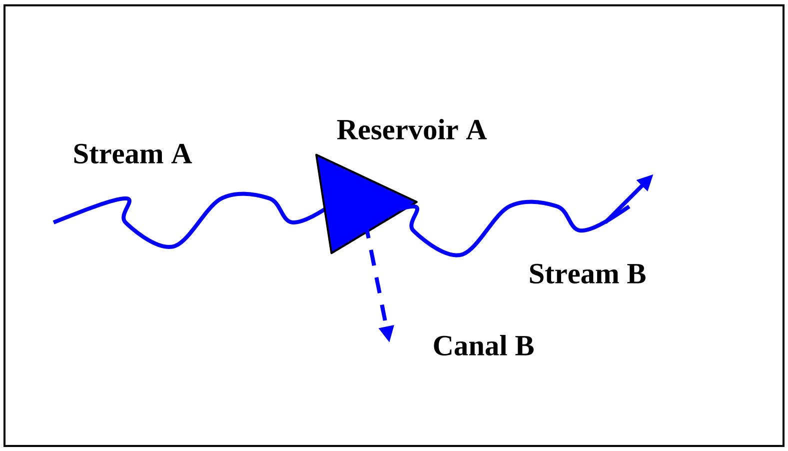

Figure 9.5 – Example of Water Management Model layout.

Within the above example, Stream A, which has a historical natural flow as indicated in Table 9.3, flows into Reservoir A, which has a storage capacity of 90 units. Reservoir A is then required to maintain, as a first priority, an instream flow of 20 units, and meet the second priority the demands of Canal B.

Table 9.3 – Example of Water Management Model Water Accounting.

Time Period	Flow in Stream A	Stream B IFN Req.	Canal B demand	Stream B Delivery. (Priority 1)	Canal B Delivery. (Priority 2)	Change in Storage	Cumulative Storage	Spill
	units	units	units	units	units	units	units	units
1	30	20	30	20	10	0	0	0
2	60	20	30	20	30	10	10	0
3	80	20	30	20	30	30	40	0
4	120	20	40	20	40	50	90	10
5	120	20	50	20	50	0	90	50
6	50	20	60	20	60	-30	60	0
7	20	20	70	20	60	-60	0	0
8	10	20	60	10	0	0	0	0

Table 9.3 shows a typical water accounting model for this simple system. As indicated, in this example the system met priority one demands in seven of the eight periods and failed to meet the priority two demands three of the eight periods. The relative benefit of a potential alternative, such as increasing the size of the storage reservoir, would then be evaluated by imposing the alternative on the model and evaluating its performance relative to the base case.

9.2.2 Water Resources Management – Decision Support System

As noted previously, southern Alberta has developed a significant water management infrastructure and water distribution system over the past 100 years. This system continues to evolve. The evaluation of potential water management strategies for a complex system such as that in southern Alberta requires a sophisticated model to assess the risks and benefits.

The Water Resources Management Model (WRMM) has been used by AENV since 1981 as the principle analysis tool for river basin planning, operations and allocation decisions. Just as the water management infrastructure has increased in size and complexity, so have expectations of the simulation tools. Over the years, the WRMM model has undergone extensive development of its technical capacities to simulate the ever increasing complexities of the river basin components and of the legal constraints.

The current version of the model is written in C++, version 6, and has been compiled under Microsoft Visual studio 2005. The model code is owned by AENV. It is maintained and operated by the Environmental Modeling Team and is known as the Water Resources Model – Decision Support System (WRM-DSS).

The model interfaces with other models such as Alberta Agriculture and Rural Development's (AARD) Irrigation District Model and Irrigation Requirements Model which are equally complex models designed to generate historical irrigation demands. Work is underway to link the model to a water quality model and eventually to a flow prediction model. The model is distributable and users can use the model with MS Windows and MS Office software: no other additional software is required.

Quick Facts

- **The Water Resources Management Model (WRMM) has been used by AENV since 1981 for river basin planning, operations and allocation decisions.**
- **This model can be used to run simulations and do scenario analysis. In the future, it will support water supply forecasting, water quality, ground water and land-use based hydrologic models.**

Data Requirements

As with the simple example provided above, the WRM-DSS model requires four basic sets of data to simulate a river system. These are:

1. Definition of the physical system
2. Assignment of priorities which defines the water allocation operating policies
3. Water supply data
4. Water demand data

Definition of the physical system and its components is critical to modeling the movement of water between system components and any constraints to this movement. The definition of the physical system requires an understanding of the layout of the system components relative to each other as well as an understanding of the physical constraints of the components (i.e. canal capacity, live storage capacity of a reservoir, etc). The components of a physical system that need to be identified include:

- Storage reservoirs
- Irrigation blocks

- Points of water withdrawals
- Hydropower plants
- Local inflows
- Outlet structures
- Natural channels
- Diversion channels
- Return channels
- Apportionment channels
- Canal losses

Figure 9.6 provides an example of how some of the above components and the layout of a physical system are represented within a model schematic.

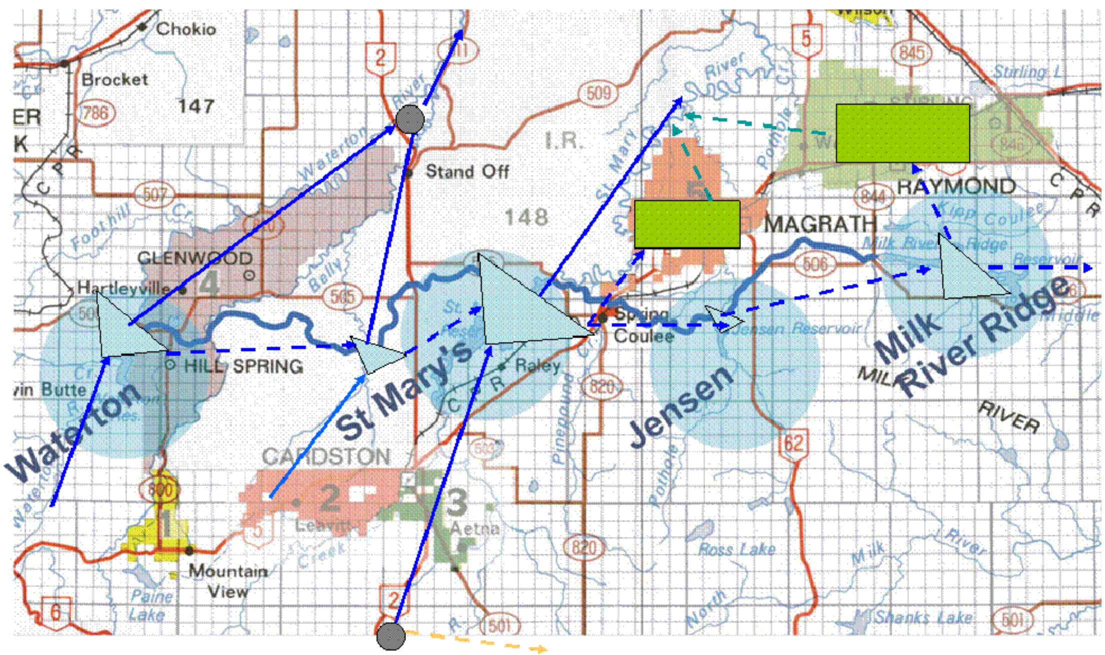

Figure 9.6 – Example of Model Representation of a Physical System.

Operating policies define the ideal operating state for all components. These ideal requirements can represent a specific mode of operation or a water requirement. When there is not enough water to satisfy all requirements, the model will operate the system according to a set of priorities.

For example, in Table 9.3, there is insufficient water to meet both the instream flow needs and diversion demands for time step 7. As such, the model needs some knowledge as to policy in order to determine which of the two demands should receive the limited supply that is available in that time step. Within the WRMM model, policies relating to priorities and/or operations are defined by a penalty point system. For each time step, the model assigns a penalty point cost of not meeting certain requirements. As the model tries to minimize total penalty points, the higher the penalty for not meeting the requirements of a use, the higher the priority of that use.

If a WRMM model were built for the example provided in Figure 9.3, the higher priority of stream B relative to canal B would be represented within the model by assigning a higher penalty point to failing to meet stream B demands. Within the WRMM model, penalty point costs are assigned to not meeting irrigation demands, minimum river flows, reservoir storage targets and electrical and power generation requirements.

Water supply data within the WRMM model consists of initial reservoir storages, natural flows (local inflows), flows diverted into the system, and reservoir precipitation and evaporation data. With the exception of initial reservoir storages, all other water supply data must be defined for each time interval for the entire model simulation period. As indicated previously, Alberta has developed historical weekly natural flows, precipitation and evaporation data covering the entire 1912 to 2001 period for over 100 sites within the South Saskatchewan River Basin, including the St. Mary River, and for about 6 sites within the Milk River Basin. These historical weekly data form the water supply data that is used as input to all St. Mary River and Milk River model simulations.

Water demand data represents municipal and industrial consumption, irrigation requirements, hydropower requirements, diversion or downstream demands such as apportionment flows. Historical weekly water demand must also be defined for each time interval of the simulation period. Water demand files for each irrigation district and some of the private irrigation projects have been generated by AARD using their Irrigation Requirement Model and Irrigation District Model.

Model Output

The model can output simulations results into an access database or in text format. Both formats contain simulation targets and simulation results for each modeled component. A WRMM Viewer enables the user to view the results quickly in graphical and table format. One can also view and compare results from two scenario runs for comparison purposes. Other result analysis and processing can easily be done using spreadsheets linked to the access database.

Model Uses

The WRMM model has been used by AENV since 1981 as the principal analysis tool for river basin planning, operations and water allocations decisions. The major clients have been AENV water planners, approvals and operation managers, AARD, irrigation districts, Trans Alta Utilities, consultants, Saskatchewan Water Corporation and Watershed Planning and Advisory Councils.

Recent model applications include sustainable water management planning, the evaluation of water applications and water transfers. These applications support the evaluation of Environmental Impact Assessments, the analysis of infrastructure system capacities, the feasibility studies of potential water storage sites, the planning and operation during dry periods, the expansion and storage development in irrigation districts and scenario analysis of interprovincial and international apportionment agreements.

Future applications will include the integration of water resources planning and real time water management into a single model capable of water allocation, channel routing and optimization. Work is underway to link the model to other analytical tools such as water supply forecasting, water quality, ground water and land use based hydrologic models.

9.2.3 The Southern Tributaries Model

Quick Facts

- **The Southern Tributaries (Waterton, Belly and St. Mary Rivers) Model is used to support planning for eight irrigation districts and several private licence-holders in this area.**
- **The Milk River Model was created to evaluate water management alternatives in the basin, including on-stream storage scenarios.**

The Southern Tributaries Model represents all aspect of water supply and use in the major southern tributaries to the Oldman River (Waterton, Belly and St Mary Rivers). The model also includes the government-owned and operated headworks system consisting of storage reservoirs, diversions structures and canals and all infrastructure within the irrigation districts (Figure 9.7).

Irrigation represents the largest use of water within the Southern Tributaries. Irrigation is comprised of eight irrigation districts which in 2007 reported a total irrigated acreage of 512,906 acres (207,570 ha) and of private irrigators who hold licences for an additional 42,458 acres. Non-irrigation uses represent a volume of water equal to 15,867 ac-ft.

The Southern Tributaries Model (STRIBS) was assembled to enable the evaluation of potential water management and development strategies in this complex system and to assess the risks and benefits to users that are sharing this common resource.

Water in Alberta is allocated using the "first in time first in right" principle with users having an assigned priority corresponding to the date on their licence. Older licences have priority over ones that are more recent. Reservoir storage and minimum flow requirements may also have priority over other uses depending on the date of their coming into effect. Since the water supply is shared by all, any changes in management and allocation decisions in one area may negatively affect other users. The STRIBS model was designed to assist managers in making water management decisions by evaluating the potential implications of the decision.

Water transfers are now a reality and in many instances the only way for new users to get a water allocation. For transfer to take place, the Director needs to show that the transfer will not adversely affect existing users. This is yet another use for the model.

The STRIBS model is used whenever there is a need to evaluate irrigation expansion in an irrigation district, the granting of new licences on a river reach or the feasibility of building a new or enlarging an existing reservoir. All that is needed is to modify the proper components and compare the results with a base scenario. The model has been used extensively to evaluate several expansion scenarios, the transfer or allocation of licences, the modification of reservoir operating procedures, the enlargement of delivery canals and the modification of major infrastructure.

Recently, a special version of the model which includes the Milk River Basin Model was created to evaluate potential diversions from the Milk River Ridge Reservoir into the Milk River. This was necessary because water diverted to the Milk River would come from the delivery system which supplies districts within the St. Mary Irrigation Project and could possibly adversely affect their performance.

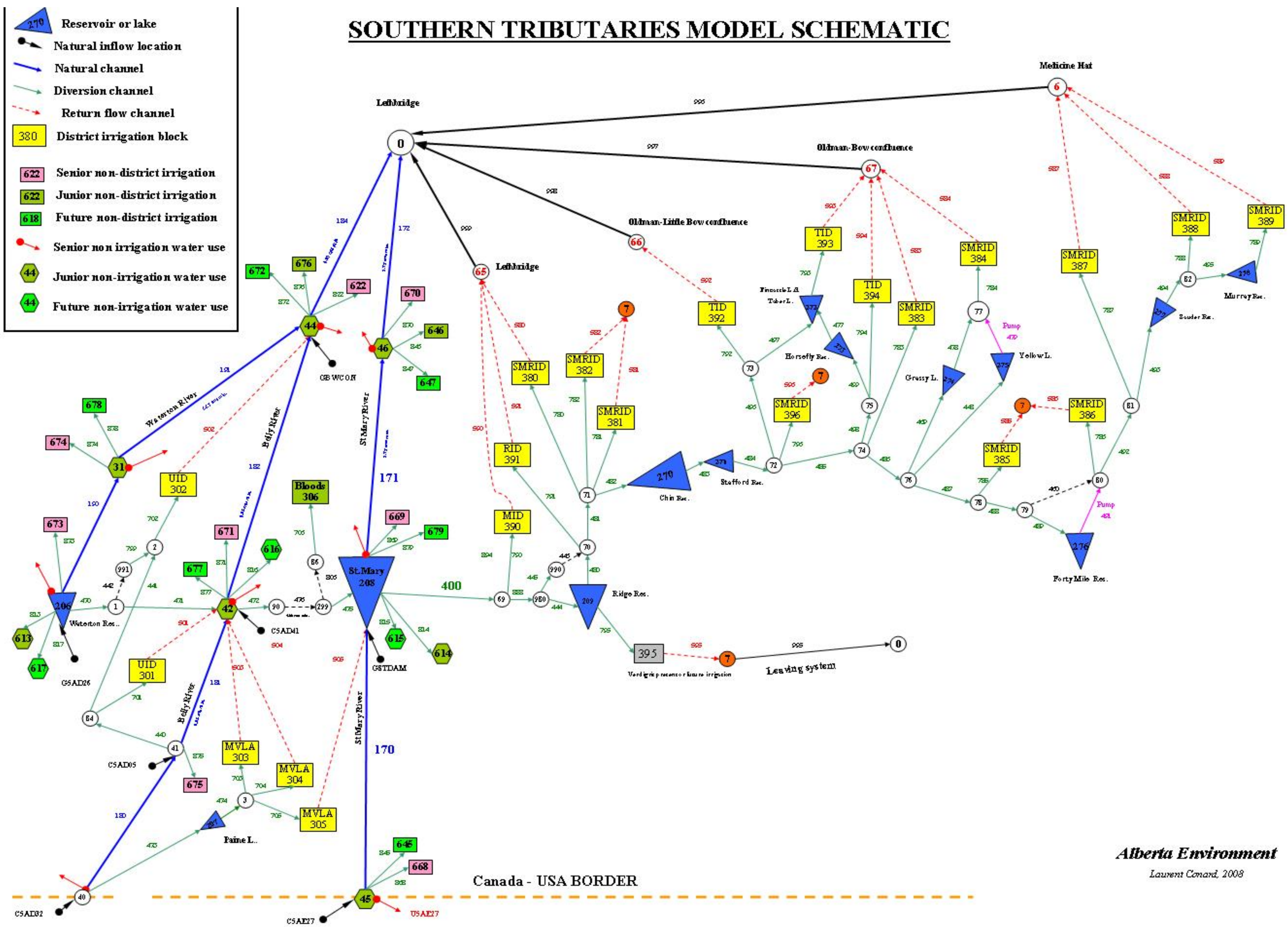

Figure 9.7 – Southern Tributaries Model Schematic

Model Input Requirements

The model water supply is represented by natural inflows at selected locations. Historical natural inflows are reconstructed for the entire 1912 to 2001 period using the "Project Depletion Method"; a process in which historical measured water uses are added to historical observed streamflow to reconstruct what would have been the natural flow in the absence of human activities. The current simulation period is from 1928 to 2001. Years that are more recent will continue to be added as more data becomes available.

In all past and current planning scenarios modeling, Alberta has assumed that the U.S. will divert its full entitlement of the St. Mary River into the Milk River. This is done by removing the U.S. entitlements from the computed natural flow for the St. Mary River at the border; that is by starting all simulations with only Canadian entitlements. Reservoir storage change due to precipitation and evaporation is calculated using nearby weather monitoring station. When there is no nearby station, a more distant station is used with an adjustment factor applied to it.

Within the model, irrigation water demands by private water allocations are spread over the irrigation season and distributed according to a typical demand curve. In some instance, the simulations utilize irrigation demand data supplied by AARD. All other water allocations are distributed evenly over the calendar year. Volume deliveries to all private licences are limited to the actual licensed allocation.

Water demand files for each irrigation district and some of the private irrigation projects were generated by AARD using their Irrigation Requirement Model and Irrigation District Model. For modeling purposes, private irrigation is grouped by the river reach from which they draw water. Irrigators within irrigation district are grouped into areas or blocks served by major canal turnouts. All the significant storage sites within the districts are modeled.

Annual diversions to the irrigation districts are capped to their respective licensed allocations and limited to conditions dictated by their priority of use and infrastructure. Table 9.4 shows the volume allocations for each district.

Table 9.4 – Volume Allocations for Alberta's Irrigation Districts.

Irrigation District	Source of supply	Licensed Volume (Acre Feet)
St. Mary River	Waterton, Belly and St. Mary rivers	722,000
Magrath	Waterton, Belly and St. Mary rivers	34,000
Raymond	Waterton, Belly and St. Mary rivers	81,000
Taber	Waterton, Belly and St. Mary rivers	158,000
Total		**995,000**
United	Waterton and Belly rivers	66,400
Mountain View	Belly River	8,000
Leavitt	Belly River	12,000
Aetna	Belly River	9,000

In 1991, minimum flow requirements were assigned to the lower reaches of the Waterton, Belly and St. Mary Rivers. Meeting these minimum has precedents over junior licensed allocations. Senior licences which were in place prior to 1991 have no such condition of use and have access to all available water. The minimum flows for the Southern Tributaries are as follows:

30 cfs for all reaches of the Belly River downstream of the United Irrigation District diversion
80 cfs for the Waterton River downstream of Waterton Reservoir
97 cfs for the St. Mary River downstream of the St. Mary Reservoir

Available Hydro-climatic Data

Historical weekly natural flows for the following locations have been computed and are utilized in the STRIBS model:

Waterton River at the Waterton Reservoir (*file G5AD26*)
Belly River at the U.S. border (*file C5AD32*)
Belly River at the United Irrigation District diversion *(file C5AD05)*
Belly River at Belly River to St. Mary Reservoir diversion *(file C5AD41)*
Belly River below the Waterton River confluence *(file GBWCON)*
St. Mary River at the U.S. border *(file C5AE27)*
St. Mary River at the St. Mary Reservoir *(file GSTDAM)*

Note the "C" at the beginning of a file name indicates reconstructed, void filled, natural inflows at a flow recording location. The "G" at the front of a file name indicates natural inflows generated for location of interest, which is not and has not been a recording site, using other nearby flow recording stations. The following meteorological files were used to compute storage change due to precipitation and evaporation at all reservoir sites:

EGD LETH	(gross evaporation, deep lake)
EGD MHAT	(gross evaporation, deep lake)
PG LETH	(precipitation)
PG TABR	(precipitation)
PG BEYE	(precipitation)
PG CARDS	(precipitation)

9.2.4 The Milk River Preliminary Feasibility Study (2003)

The Milk River is the major source of water in the southern most part of the province. Historically the basin has experienced severe water shortages and periods when there was zero flow. In recent years, the area experienced a drought in 2001 and very low flows in 2006 and 2007. Water supply is and has been a major concern for residents of the basin.

Discussions regarding the precarious nature of water supply in the Milk River Basin date back to the late 1970s. Since 1986, AENV has maintained a moratorium on issuing new water licences for diversion and use of water from the Milk and North Milk Rivers. The Milk River Model was created to enable the evaluation of water management alternatives in the basin.

In 2003, the Milk River Basin Water Management Committee (MRBWMC), a local group of water users along with representatives from the communities of Milk River, Coutts and Warner, the Counties of Warner, Cardston and Forty Mile, and several water users and irrigators, requested that the Government of Alberta investigate various water supplies alternatives. In response, AENV commissioned the Milk River Basin Preliminary Feasibility Study which was completed in 2003.

The study was assigned to Klohn Crippen Consultants Ltd. in association with Mack, Slack & Associates Inc., AXYS Environmental Consulting Ltd., Marv Anderson and Associates Ltd., and Hart Water Management Consulting. PFRA had identified a preferred storage site known as the Forks Site 2. Another 19 off-stream sites were also identified but only four storage sites were retained for further investigation. They are situated at Shanks Lake, Lonely Valley, Verdigris Lake and MacDonald Creek.

The water management model for each of the alternatives was carried out by AENV. Figure 9.8 shows the Milk River Basin with the current irrigated areas in Canada. Figure 9.9 shows the model schematic.

Model Description

The Milk River is the smallest of Alberta's major river basins with a drainage area of 2,573 sq. mi. Canada's average annual entitlement from the flows of the Milk River is estimated at about 36,500 ac-ft. As Canada has not developed any storage in the Milk River, most of Canada's entitlement flows unused into the U.S. Within Alberta, there is an estimated 95,000 acres of irrigable land within two miles of the Milk River, which could benefit from Canadian Milk River entitlements.

In simulating the potential benefits of storage projects, each storage site was modeled separately and the irrigated area was started at a modest amount and gradually increased to determine the level of irrigation expansion that could be sustained while meeting AARD failure criteria. The modeling period is from 1928 to 1995 (68 years) using weekly time steps.

Quick Facts

- **Canada's average annual entitlement from the flows of the Milk River is estimated at about 36,500 ac-ft.**
- **Within Alberta, there is an estimated 95,000 acres of irrigable land within two miles of the Milk River, which could benefit from Canadian Milk River entitlements.**

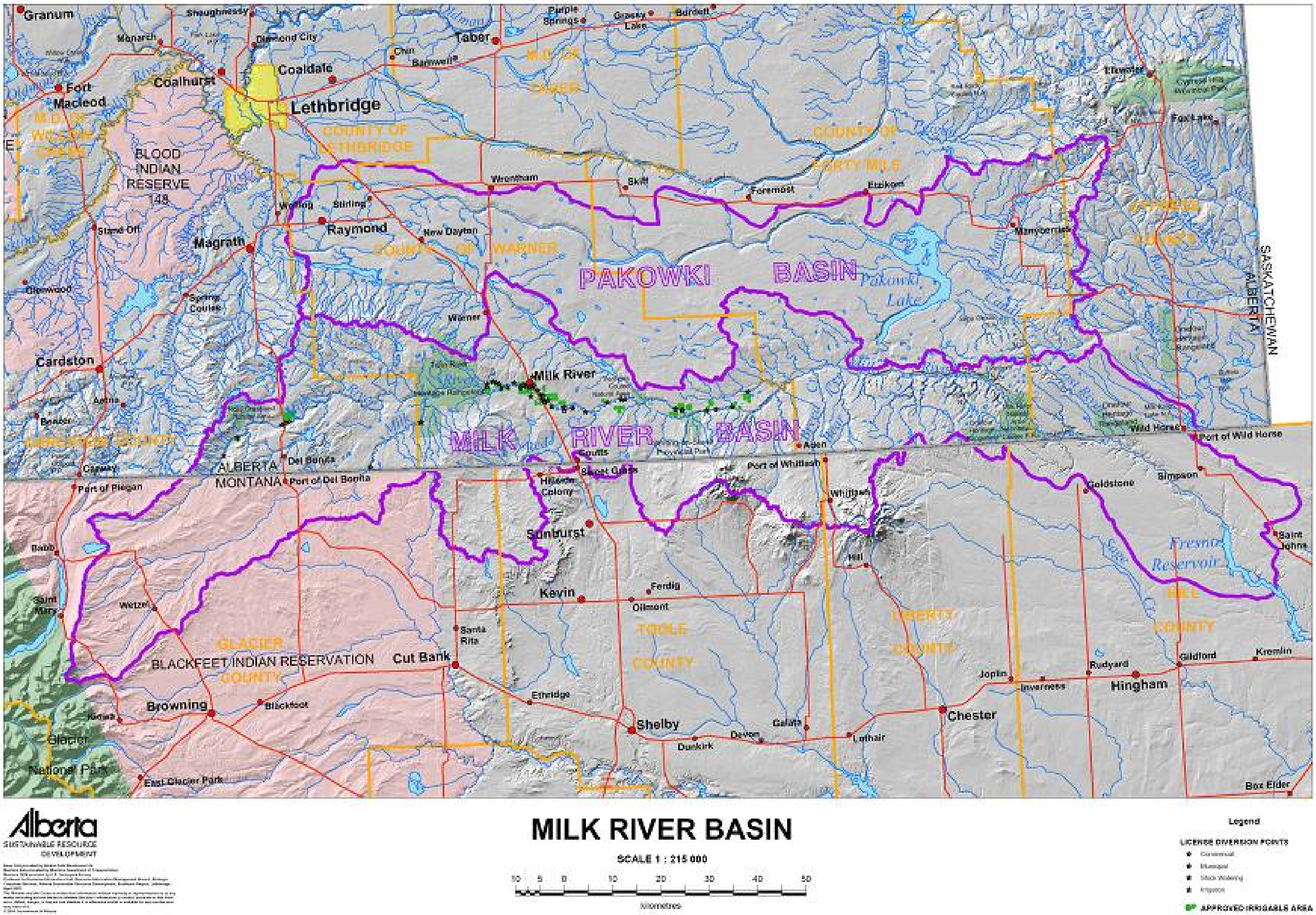

Figure 9.8 – Current irrigated areas of the Milk River Basin.

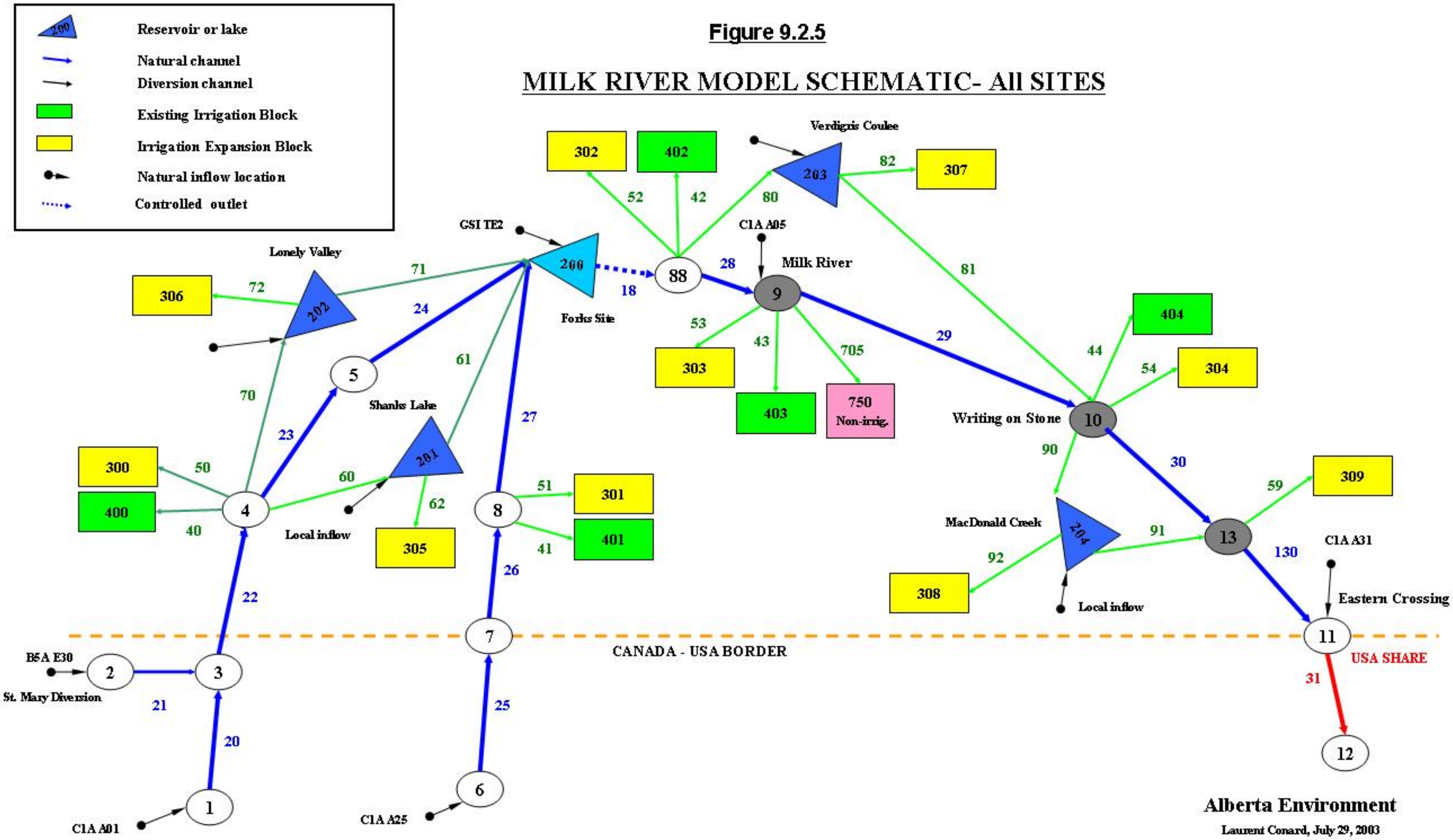

Figure 9.9 – Milk River Model Schematic.

Model Input Requirements

The model water supply is represented by natural inflows at selected locations. Historical natural inflows are reconstructed by adding past water use to past recorded flow data. Additional inflows are the result of the U.S. diversion of some of its St. Mary River entitlement into the North Milk and finally into the Milk River to eventually return to the U.S. at the Eastern Crossing. The total U.S. water entitlement is calculated by adding the U.S. share of the natural flow of the Milk River at the Eastern Crossing to the U.S. St. Mary diversion into the North Milk, minus losses incurred while flowing through Canada.

As the study was primarily focused on the utilization of Canadian Milk River entitlements, all simulations were carried out using historical U.S. St. Mary diversions instead of the U.S. St. Mary River entitlements. It is believed that this will have no noticeable effect on the computations. Reservoir storage change due to precipitation and evaporation is calculated using nearby weather monitoring station. An adjustment factor is applied where there is no station located within close proximity.

All non-irrigation water allocations are distributed evenly over the calendar year. Water diversion to existing private irrigation was not limited to the licensed allocation. For the purpose of this exercise, existing irrigation has precedent over expansion acreage.

AARD used their Irrigation Requirement Model and Irrigation District Model to generate water demand for irrigation. For modeling, private irrigation is grouped by the river reaches where they draw water. While there is no minimum flow requirement assigned for the streams in the basin, a minimum of 10 cfs was chosen for the Milk River at Milk River in order to prevent flows from dropping to zero due to water use.

Available Hydro-climatic Data

The model water supply is represented by natural inflows files which were generated by AENV for the following locations:

North Milk River at the International Boundary *(file C1AA01)*
Milk River at the Western Crossing (*file C1AA25*)
Milk River at the Forks Site *(file GSITE2)*
Milk River at the Town of Milk River *(file C1AA05)*
Milk River at the Eastern Crossing (*file C1AA31*)

Additional water supply input into the model comes from the U.S. diversion from St. Mary River flows into the North Milk River.

Effective St. Mary River diversion to North Milk River *(file B5AE30)*
St. Mary diversion losses while in Canada *(file A31EVPLC)*

File "B5AE30" represents the recorded flow of St. Mary diversion reaching the North Milk River.

The following meteorological files were used to compute storage change due to precipitation and evaporation at all reservoir sites:

GS2 EVP (gross evaporation, deep lake at the Forks Site 2)
GS2 PCP (precipitation at Forks Site 2)

Modeling Results

Amongst all the sites investigated, the on-stream alternatives were the most promising. Development of a major storage reservoir would have significant increased irrigation opportunities in a part of the province where growth is not occurring.

9.2.5 The Milk River Supplemental Water Supply Investigation

Quick Fact

- **Under the Milk River Supplemental Water Supply Investigation, the Southern Tributaries Model and the Milk River Model were combined.**
- **Together, these models will be used to investigate potential options to divert Canadian St. Mary River water from the Milk River Ridge Reservoir to the Milk River.**

The Milk River Watershed Council Canada (MRWCC) was established under the Province of Alberta's *Water for Life* Strategy. The Council includes representatives from government agencies, non-government organizations, community groups, landowners and industry. The Council commissioned the Milk River Supplemental Water Supply Investigation in August 2007 and retained the services of Klohn Crippen Berger Ltd. to investigate the potential options to supply water from the Milk River Ridge Reservoir to the Milk River.

Model Description

Because of the inter-basin nature of the supplemental supply, the Milk River model was joined to the STRIBS model described previously. Figure 9.10 shows the general layout of the Milk River from the North and South Milk Rivers originating in the U.S., the St. Mary River Diversion Canal and the Canadian portion of the Milk River to the Eastern Crossing as the river returns south of the border. The current irrigated areas are shown in yellow and the potential expansion areas in green. The expanded acreage is distributed along the river below the confluence of the South and North Milk Rivers. Non-irrigation demands are represented by green hexagons.

The model runs on weekly time steps for the period of 1928-2001. This period of 74 years contains a wide variety of flow conditions, from extended drought years to years with very high flows. Water supply to the model is in the form of natural inflows and calculated U.S. diversion from the St. Mary River to the North Milk River. Potential supplemental water supply would be diverted from Ridge Reservoir (Figure 9.11).

The scenarios are based on a total irrigated acreage of 18,069 acres consisting of the current 8,069 acres and an additional 10,000 acres. For the purpose of the study, both limited and unlimited supply was modeled. Limited supply is when water is shared with other users in the Southern Tributaries basins. The unlimited supply scenarios use a fictitious large supply source to determine the amount of water needed to meet all Canadian water demands and to determine the maximum diversion flow rate.

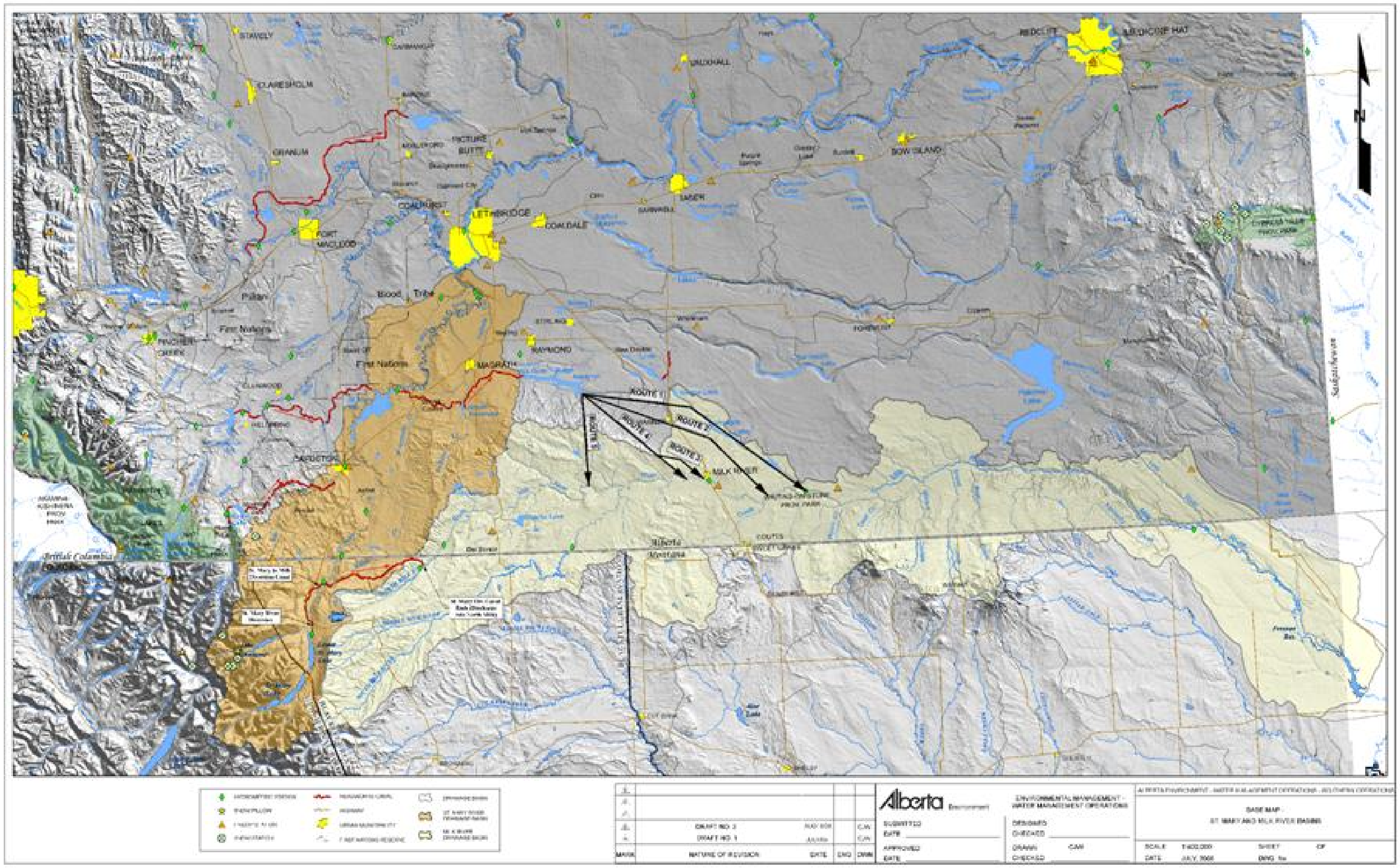

Figure 9.10 – Map of the Milk River Basin showing existing and potential expansion in irrigation.

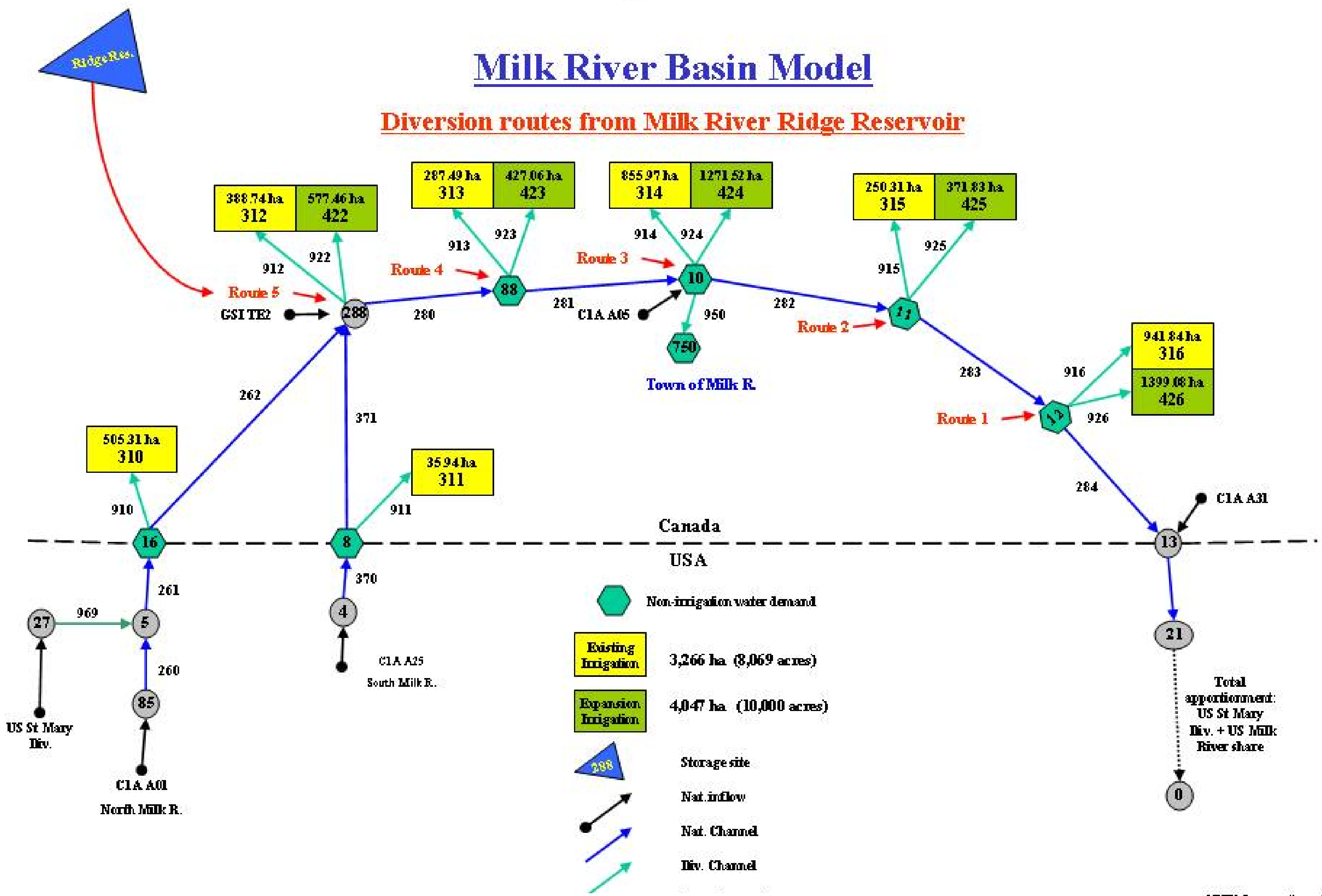

Figure 9.11 – Milk River Basin Model.

The U.S. St. Mary diversions into the North Milk were calculated for the same period using the apportionment formula for the St. Mary River at the U.S. border and by limiting flows to the canal design capacity of 850 cfs. A period of diversion from April 30 till October 7 of each year (weeks 18 to 40 of the Julian calendar) was chosen to reflect historical diversions. Priming, evaporation and seepage losses within the supplemental water supply system were not simulated.

A minimum flow requirement of 10 cfs was imposed on the Canadian North, South and Milk Rivers to prevent flows from dropping to zero due to water demand. Current licences do not have minimum flow conditions requirements but low flows are monitored by AENV and water diversion controlled to prevent flow interruption. A minimum of 30 cfs was also imposed on the Milk River at Milk River during the winter months. Settings minimums and giving them high priorities does not guarantee they will be met at all times, they only limit other uses. Natural flows may fall below minimum desirable flow especially in winter months when no diversion occurs.

Five potential routes were identified by Klohn Crippen Berger and after some initial model runs a range of diversion capacities were retained for further investigation. The effects of a U.S. diversion canal shutdown were also analyzed for each of the routes. Two scenarios were done with unlimited additional supply to Milk River. This resulted in 18 scenarios described in the Table 9.5.

Model Input Requirements

The model water supply is represented by natural inflows at selected locations. Historical natural inflows are reconstructed by adding past water use to past recorded flow data. Additional inflows are the result of the U.S. diversion of some of its St. Mary River entitlement into the North Milk and finally into the Milk River to eventually return to the U.S. at the Eastern Crossing. The total U.S. water entitlement is calculated by adding the U.S. share of the Natural Flow of the Milk River at the Eastern Crossing, to the U.S. St. Mary diversion into the North Milk, minus losses incurred while flowing through Canada.

All non-irrigation water allocations are distributed evenly over the calendar year. Water diversions to existing private irrigation were not limited to the licensed allocation. For the purpose of this exercise, existing irrigation has precedent over expansion acreage.

Table 9.5 – Scenario Description Summary.

Scenario Designation	Diversion Route	U.S. St. Mary Diversion	Diversion from Ridge Reservoir	Diversion Capacity (m^3/sec)
Base case	n/a	Yes	No	n/a
1A	1	Yes	Limited	5.5
1B	1	No	Limited	5.5
2A	2	Yes	Limited	5.5
2B	2	No	Limited	5.5
3A	3	Yes	Limited	5.5
3B	3	Yes	Limited	4.0
3C	3	Yes	Limited	3.0
3D	3	No	Limited	5.5
3E	3	Yes	Unlimited	5.5
4A	4	Yes	Limited	5.5
4B	4	Yes	Limited	4.0
4C	4	Yes	Limited	3.0
4D	4	No	Limited	5.5
4E	4	Yes	Unlimited	5.5
4F	4	Yes	Limited	3.5
5A	5	Yes	Limited	5.5
B	5	No	Limited	5.5

AARD used their Irrigation Requirement Model and Irrigation District Model to generate water demand for irrigation. They used their Irrigation Requirement Model (IRM) to generate irrigation requirements (mm) for the current and expansion areas. The IRM model uses historical meteorological data and various (current and projected) crop mixes to generate weekly moisture deficits which vary in magnitude and distribution from year to year. The crop mix is shown in table 9.6.

Table 9.6 – Irrigated crop mix.

Crop	Current acreage %	Expansion acreage %
Alfalfa 2 cut	21,5	18.2
Barley (silage)	(6.4)	13.1
Canola	7.1	5.1
Dry beans	0.4	1.9
Dry peas	6.6	6.1
Grass hay	21.3	21.5
Grass seed	5.4	6.0
Hard spring wheat	9.4	10.2
Native pasture	9.3	
Oats	1.0	2.9
Tame pasture	7.8	11.6
Timothy hay	3.1	
Triticale	0.7	3.3

A total of 703 ac-ft of water is licensed to municipal, industrial and domestic uses in the basin. These uses were modeled by spreading the diversion of licensed volume over the entire year. These demands and any other water demand in this model are taken out at the upstream end of the reach where they occur. This is done in order to assure that any minimum flow set would be met along the entire river reach.

Available Hydro-climatic Data

The model water supply is represented by natural inflows files which were generated by AENV for the following locations:

North Milk River at the International Boundary *(file C1AA01)*
Milk River at the Western Crossing (*file C1AA25*)
Milk River at the Forks Site *(file GSITE2)*
Milk River at the Town of Milk River *(file C1AA05)*
Milk River at the Eastern Crossing (*file C1AA31*)

Additional water supply input into the model comes from the U.S. diversion from St. Mary River flows into the North Milk River. As mentioned in section 10.2.4, the U.S. diversion was calculated using the apportionment formula and using the diversion canal design capacity *(file USSTM850)*.

Modeling Results

The current Milk River water supply (Base case scenario with current level of development) could not support an irrigation expansion of 10,000 acres. The average irrigation deficit would be over eight inches and exceed the irrigation failure criterion 86% of the time. (The irrigation failure criterion is a deficit of four or more inches allowed to occur in no more than 10% of years or an average of 1 year in 10.)

When the water supply from Ridge Reservoir is limited (water supply is shared with the St. Mary Project districts), the average annual diversion is about 11,350 ac-ft and ranges from zero to 21,235 ac-ft. When water supply is unlimited, the average diversion is approximately 12,300 ac-ft, ranging from zero to a maximum of 27,479 ac-ft and irrigation deficits are eliminated. The maximum diversion rate needed from Ridge Reservoir would never exceed 194 cfs.

The selection of the diversion route has very little impact on the overall irrigation deficit as long as the U.S. St. Mary diversion is in operation. The U.S. diversions combined with the natural flow ensures there is enough flow in the river to supply Alberta's Milk River irrigation, as long as modeled diversions from Ridge Reservoir are sufficient to make up withdrawals in order to meet apportionment requirements at the eastern boundary. The average and magnitude of irrigation deficits are approximately the same for the A scenarios, with diversion capacity of 194 cfs, with the U.S. St. Mary diversions in operation and limited supply from Ridge Reservoir. Reducing the supplemental diversion capacity from 194 cfs to 141 cfs and to 106 cfs would result in slightly higher irrigation deficits as shown in Figure 9.12 when comparing scenarios 3A, 3B, 3C and scenarios 4A, 4B and 4C.

Limitations on water supply from Ridge Reservoir causes a significant limitation to the available supplemental water supply to Milk River. Comparing scenarios 3A versus 3E and scenarios 4A versus 4E, shows that an unlimited supply would eliminate all deficits (Figure 4.12). Limited supply results in irrigation failures in 10% of the years with average deficits in the 0.9 inches range.

The location of the water supply delivery to the Milk River becomes important if the U.S. St. Mary Diversion is not in operation. Scenarios 5A and 5B show that the average deficit would only increase from 0.9 to 1.0 inches, and the frequency of deficits of 4 inches and above would go from 8% to 11%. The most downstream route (Route 1) would result in average deficits increasing from 0.9 to 3.5 inches and the frequency of irrigation failures jump from 8% to 36%.

Figure 9.12 shows that the diversion would operate 60% of the time during the diversion period. Diversion rates of 35 cfs would occur 40% of the time, flows of 70 cfs only 20% and diversion of 105 cfs in less than 10% during the diversion period.

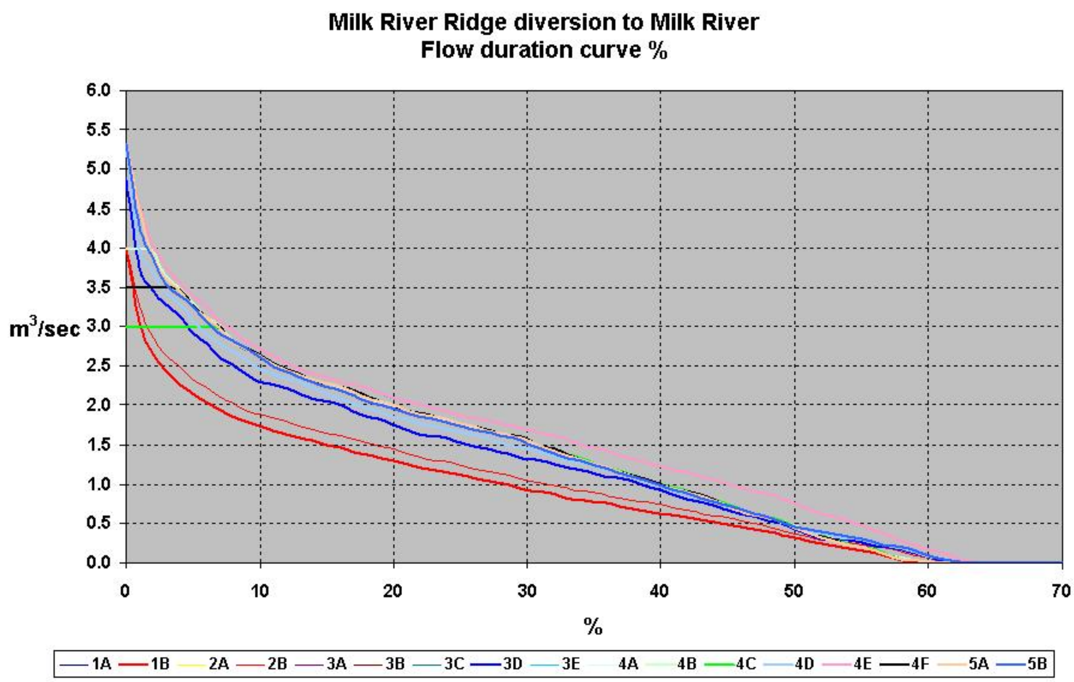

Figure 9.12 – **Milk River Ridge diversion to Milk River flow duration curve percentage.**

9.3 IJC Task Force Hydrologic Simulations

In December 2004, the International Joint Commission (IJC) established the St. Mary/Milk Rivers Administrative Measures Task Force (Task Force). They directed the Task Force to *"examine opportunities to improve the administrative procedures for the apportionment of the St Mary and Milk rivers to ensure more beneficial use and optimal receipt by both Canada and the United States of its apportioned water".*

The Task Force investigated a number of potential modifications to the administrative measures used in apportioning the flows including:

- Improving the procedures used to determine the natural flows,
- Increasing the length of the balancing period, and
- Alterations in the treatment of surplus and deficit deliveries.

The potential impact of improvements in the computational procedures was assessed by evaluating the potential error associated with each of the components used in the computation of natural flows. Based on this review, the Task Force concluded that the natural flow computations could be improved by:

- Monitoring flow at several additional locations,
- Better accounting of consumptive uses, and
- Determining channel conveyance losses for U.S. diversions.

However, these computational improvements would result in only modest increases in the beneficial use and optimal receipt by each country of its apportioned share.

To evaluate the potential impact of changes to the length of the apportionment balancing period and in the accounting of surplus and deficit deliveries, the Task Force developed a series of spreadsheet models. These models assessed the volume of St. Mary entitlements that could be diverted by the U.S. and the volume of Milk River entitlements that could be taken by Canada (for the November 1, 1979 to October 31 2004 period) under various lengths in the apportionment balancing period (weekly, bi-monthly, monthly, seasonal, and annual water-year [Nov 1 to Oct. 31]).

Table 9.7 provides a summary of the model results for the scenarios assessing the quantities of water that could be taken and diverted by the U.S. through a change in the length of the balancing period while maintaining a continuous outflow of 25 cfs from Lake Sherburne. A detailed summary of all scenarios analyzed by the Task Force is presented in Tables 9.8a and 9.8b. The scenarios analyzed by the Task Force assumed St. Mary Canal diversions started on March 15 for all years, even though some years this is not practicable due to snow and ice conditions and other limitations. Diversions continued until October 31.The model estimates what water could potentially be diverted: actual diversions would likely be somewhat less for a variety of factors.

Table 9.7 – Summary of Modeled U.S. St Mary Diversions under Various Balancing Periods.

Type of Year	Historical U.S. Entitlements	Historical U.S. Diversions with bi-monthly Balancing Period	Modelled Diversions (in Ac-ft) for Indicated Balancing Period				
			7-day	bi-monthly 15th & end of month	Monthly	Seasonal (irrigation/ non-irrigation	Water Year (Nov 1 - Oct 31)
Average	246,500	175,300	201,300	202,000	204,200	211,500	226,600
Median	229,600	177500	203,500	201,800	205,800	212,000	229,700
Average 5 wettest years	352,200	155,600	239,200	239,600	242,000	255,000	264,900
Average 5 driest years	166,800	157,000	149,500	149,700	151,000	152,000	166,000

Note 1.Values for the 5 driest years within the above table differ from values within Table 5 of the Task Force report as the latter used the average for the 6 driest years.

Note 2. All balancing period scenarios are based on an assumed 25 cfs release from Sherburne Lake.

As indicated in Table 9.7, while an extension in the balancing period allows the U.S. to divert a greater volume of its entitlements, during dry years the increases are relatively modest for all balancing periods except an annual, water-year (November 1 to October 31) balancing period. The benefit for the water year balancing period is primarily the result of the U.S. being able to accumulate a credit due to winter releases from Lake Sherburne which would otherwise flow into Canada.

Table 9.8a - Summary Of U.S. St. Mary River Diversions Possible For Various Operational And Administrative Alternatives

Water Year	Modelled Nat Flow St. Mary R. @ Int. Boundary	Actual Nat Flow St. Mary R. @ Int. Boundary	Modelled U.S. St. Mary R. entitlement	Actual U.S. St. Mary R. entitlement	Historical U.S. St. Mary Diversions	Potential U.S. Diversion For Indicated Scenario of Canal Capacity, Balance Period and Min Release from L. Sherburme									
						1 650 cfs Canal 7-day bal. 25 cfs min Q	1a 650 cfs Canal 7-day bal. 0 min release	2 650 cfs Canal 15/16day bal. 25 cfs min Q	2a (current) 650 cfs Canal 15/16day bal. 0 cfs min Q	3 650 cfs Canal monthly bal. 25 cfs min Q	3a 650 cfs Canal monthly bal. 0 cfs min Q	4 650 cfs Canal seasonal bal. 25 cfs min Q	4a 650 cfs Canal seasonal bal. 0 cfs min Q	5 650 cfs Canal annual bal. 25 cfs min Q	5a 650 cfs Canal annual bal. 0 cfs min Q
	(ac-ft)	(ac-ft)	(Ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
1979-1980	592,298	587,851	231,771	233,047	199,494	206,483	214,067	211,751	219,175	211,751	219,381	223,114	229,030	234,796	234,796
1980-1981	657,465	655,755	272,404	273,799	231,831	225,050	232,257	225,137	232,428	231,029	237,576	246,980	252,883	257,110	263,013
1981-1982	601,754	602,450	245,627	245,526	99,414	206,511	213,403	206,164	212,872	206,809	213,518	222,057	228,766	226,557	233,266
1982-1983	468,396	468,532	181,681	181,420	178,516	165,191	171,800	165,649	171,979	165,769	172,100	165,830	172,662	181,904	182,053
1983-1984	500,104	500,422	192,606	192,406	164,066	172,753	179,123	172,828	179,148	172,828	179,148	172,828	179,280	192,271	192,287
1984-1985	584,774	584,711	227,065	226,922	215,670	199,010	207,644	198,790	207,474	203,018	210,958	206,742	213,385	223,314	223,314
1985-1986	611,561	611,677	241,789	241,930	135,673	198,343	205,896	198,229	205,881	210,660	217,927	212,028	218,886	244,316	244,465
1986-1987	557,133	557,258	219,910	220,058	177,513	196,456	203,574	197,161	204,039	197,947	204,342	199,221	205,404	220,261	220,291
1987-1988	432,966	433,993	162,984	163,666	177,166	149,940	155,776	149,940	155,776	150,493	156,053	151,143	156,978	162,337	162,386
1988-1989	693,424	694,002	282,568	282,730	277,426	242,272	250,028	243,861	250,910	246,230	254,180	256,129	262,694	262,992	268,268
1989-1990	757,948	758,101	314,344	314,750	206,885	254,540	263,370	260,058	267,875	263,704	270,310	272,006	278,153	287,436	287,436
1990-1991	845,249	845,496	364,529	364,790	218,439	238,074	244,652	238,387	244,966	238,402	244,981	252,110	258,689	279,977	279,976
1991-1992	435,297	435,714	156,950	157,251	137,629	138,445	144,840	138,445	144,840	138,825	146,394	140,114	146,509	156,342	156,441
1992-1993	571,475	571,386	220,966	221,065	188,071	197,620	204,684	197,620	205,136	199,414	206,930	200,367	207,090	221,049	221,178
1993-1994	502,599	497,977	198,713	196,335	162,728	173,634	180,284	174,503	180,998	176,824	183,696	176,824	183,696	198,504	198,652
1994-1995	786,804	786,540	333,545	333,514	85,538	241,869	248,551	241,815	248,547	243,866	250,647	249,821	256,602	250,253	257,034
1995-1996	822,288	823,873	349,293	349,826	149,074	260,691	264,925	261,472	265,971	268,577	268,577	287,375	287,375	287,375	287,375
1996-1997	819,620	819,804	344,287	344,612	172,517	244,700	251,459	245,883	252,625	248,409	254,457	260,061	267,002	269,080	276,020
1997-1998	562,486	562,853	229,589	229,848	214,234	204,777	210,363	205,140	210,726	205,771	213,050	239,409	246,123	249,798	256,540
1998-1999	614,907	615,088	246,747	247,090	179,588	221,899	227,539	222,165	228,356	222,531	228,722	230,962	237,599	245,612	245,981
1999-2000	572,120	572,503	228,846	229,173	178,709	188,486	195,221	190,164	196,868	190,164	197,539	190,852	197,475	229,683	229,457
2000-2001	364,776	365,157	139,714	139,852	131,123	127,674	133,008	127,892	134,155	127,892	134,155	127,892	134,155	139,727	139,826
2001-2002	851,669	851,339	367,946	368,120	152,539	210,514	217,003	210,514	217,003	210,514	217,003	225,245	231,734	237,670	240,853
2002-2003	484,804	489,663	189,521	191,696	160,556	166,276	173,396	166,370	174,096	172,061	178,497	175,835	182,578	189,423	189,522
2003-2004	565,965	568,301	217,758	219,124	188,615	202,454	209,067	201,840	208,453	202,534	209,147	202,534	209,147	217,360	217,360
average	610,315	610,418	246,446	246,742	175,321	201,346	208,077	202,071	208,812	204,241	210,772	211,499	217,756	226,606	228,312
Median	584,774	584,711	229,589	229,848	177,513	202,454	209,067	201,840	208,453	205,771	213,050	212,028	218,886	229,683	233,266

Table 9.8b - Comparison Of Potential U.S. St. Mary River Diversions For Dry, Anerage, and Wet year Under Various Operational And Administrative Alternatives

Water Year	Modelled Nat Flow St. Mary R. @ Int. Boundary	Actual Nat Flow St. Mary R. @ Int. Boundary	Modelled U.S. St. Mary R. entitlement	Actual U.S. St. Mary R. entitlement	Historical U.S. St. Mary Diversions	Potential U.S. Diversion For Indicated Scenario of Canal Capacity, Balance Period and Min Release from L. Sherburme									
						1 650 cfs Canal 7-day bal. 25 cfs min Q	1a 650 cfs Canal 7-day bal. 0 min release	2 650 cfs Canal 15/16day bal. 25 cfs min Q	2a (current) 650 cfs Canal 15/16day bal. 0 cfs min Q	3 650 cfs Canal monthly bal. 25 cfs min Q	3a 650 cfs Canal monthly bal. 0 cfs min Q	4 650 cfs Canal seasonal bal. 25 cfs min Q	4a 650 cfs Canal seasonal bal. 0 cfs min Q	5 650 cfs Canal annual bal. 25 cfs min Q	5a 650 cfs Canal annual bal. 0 cfs min Q
	(ac-ft)	(ac-ft)	(Ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
5 DRIEST YEARS															
2000-2001	364,776	365,157	139,714	139,852	131,123	127,674	133,008	127,892	134,155	127,892	134,155	127,892	134,155	139,727	139,826
1987-1988	432,966	433,993	162,984	163,666	177,166	149,940	155,776	149,940	155,776	150,493	156,053	151,143	156,978	162,337	162,386
1991-1992	435,297	435,714	156,950	157,251	137,629	138,445	144,840	138,445	144,840	138,825	146,394	140,114	146,509	156,342	156,441
1982-1983	468,396	468,532	181,681	181,420	178,516	165,191	171,800	165,649	171,979	165,769	172,100	165,830	172,662	181,904	182,053
2002-2003	484,804	489,663	189,521	191,696	160,556	166,276	173,396	166,370	174,096	172,061	178,497	175,835	182,578	189,423	189,522
average	437,248	438,612	166,170	166,777	156,998	149,505	155,764	149,659	156,169	151,008	157,440	152,163	158,577	165,947	166,046
5 MEDIAN YEARS															
1992-1993	571,475	571,386	220,966	221,065	188,071	197,620	204,684	197,620	205,136	199,414	206,930	200,367	207,090	221,049	221,178
1999-2000	572,120	572,503	228,846	229,173	178,709	188,486	195,221	190,164	196,868	190,164	197,539	190,852	197,475	229,683	229,457
1984-1985	584,774	584,711	227,065	226,922	215,670	199,010	207,644	198,790	207,474	203,018	210,958	206,742	213,385	223,314	223,314
1979-1980	592,298	587,851	231,771	233,047	199,494	206,483	214,067	211,751	219,175	211,751	219,381	223,114	229,030	234,796	234,796
1981-1982	601,754	602,450	245,627	245,526	99,414	206,511	213,403	206,164	212,872	206,809	213,518	222,057	228,766	226,557	233,266
average	584,484	583,780	230,855	231,147	176,272	199,622	207,004	200,898	208,305	202,231	209,665	208,626	215,149	227,080	228,402
5 WETTEST YEARS															
1994-1995	786,804	786,540	333,545	333,514	85,538	241,869	248,551	241,815	248,547	243,866	250,647	249,821	256,602	250,253	257,034
1996-1997	819,620	819,804	344,287	344,612	172,517	244,700	251,459	245,883	252,625	248,409	254,457	260,061	267,002	269,080	276,020
1995-1996	822,288	823,873	349,293	349,826	149,074	260,691	264,925	261,472	265,971	268,577	268,577	287,375	287,375	287,375	287,375
1990-1991	845,249	845,496	364,529	364,790	218,439	238,074	244,652	238,387	244,966	238,402	244,981	252,110	258,689	279,977	279,976
2001-2002	851,669	851,339	367,946	368,120	152,539	210,514	217,003	210,514	217,003	210,514	217,003	225,245	231,734	237,670	240,853
average	825,126	825,410	351,920	352,172	155,621	239,169	245,318	239,614	245,823	241,954	247,133	254,922	260,280	264,871	268,252
overall average	603,295	603,612	243,632	244,024	163,396	193,565	200,188	194,201	200,939	195,836	202,253	202,315	208,456	216,618	218,115

Table 9.9 provides a summary of the model results for the scenarios assessing the quantities of Milk River water entitlements that could be taken and diverted by Canada through a change in the length of the balancing period. It is noted that for all scenarios under "access solely to Milk River Natural Flow", Canada is permitted to divert accumulated surplus deliveries only from the natural flow of the Milk River and not from any diversions. Whereas in the scenario indicated as "Access to all Flows", Canada is allowed to draw surplus deliveries from all flows in the Milk River.

Table 9.9 – Summary of Modeled Canadian Diversion (ac-ft/yr) of Milk River Water under Various Balancing Periods.

Type of Year	Historical Canadian Entitlements[1]	Current Canadian Needs[3]	Modelled Diversions (in Ac-ft) for Indicated Balancing Period with access Limited to Milk River Natural Flow[2]						Access to all Flow in Milk R and Annual Balancing
			7-day	bi-monthly 15th & end of month	bi-monthly 15th/end of month + 4,000 ac-ft LOI	Monthly	Seasonal (irrigation/ non-	Water Year (Nov 1 - Oct 31)	
Average	36,500	10,600	4,400	4,700	8,721	5,100	7,300	7,600	10,300
Median	34,100	10,800	4,800	4,500	9,124	4,600	6,000	6,000	10,800
Average 5 wettest years	69,500	9,500	5,400	5,900	10,500	6,300	8,100	8,100	9,500
Average 5 driest years	13,500	13,500	2,500	2,700	6,463	3,100	5,000	5,800	12,000

Note 1. Based on Montana computation of (Nov. 1, 1979-Oct. 31, 2004) natural flows and diversions.
2. Subject to availability of accumulated surplus deliveries
3. Based on current irrigation (8,100 acres)

As indicated in table 9.9, while an extension in the balancing period allows Canada to divert a greater volume of its Milk River entitlements, the increases are relatively modest and insufficient to meet even current irrigation requirements unless Canada is allowed to draw its accumulated surplus deliveries from all flows in the Milk River. It is also noted that the additional benefits to Canada from the 2001 Letter of Intent exceeds that which would be realized under an extended balancing period with only access to Milk River natural flows.

9.4 Proposed St. Mary – Milk River Models

9.4.1 Proposed Model

After assessing all previously developed models and existing data sets, the model proposed and being developed by the Joint Technical Team for the assessment of water management alternatives within the St. Mary and Milk Rivers is based on the Water Resources Management Model (WRMM). This model was developed for the Canadian portions of the Milk River Basin and St. Mary River headworks system. The model is being extended to include the entire St. Mary and Milk River Basins from the headwater to the mouth and will run using a bi-weekly time step.

A single model will facilitate the evaluation of water management scenarios. Development of separate models in the U.S. and Canada would have meant running a U.S. model, feeding the output into a Canadian model and again feeding the output back into yet another U.S. model. A preliminary model schematic is show below in Figures 9.13a, b and c, although these will likely be modified as a better understanding of the system is developed.

The input model water supply is in the form of historical natural flow data. All aspects of existing and future water demands are represented. Theoretical irrigation water demands are being developed using current crops and irrigation systems and historical meteorological data.

The WRMM is a water accounting model. The water supply is identified through a series of historical natural flows for tributaries and main stem reaches for a given time step (generally one bi-weekly). Water demands are identified through a series of historical (for historical simulations) or projected (for future planning scenario evaluation) water demand tables for the same time-step used for water supplies.

The model then allocates the available water supply to the water demands according to a set of rules. These rules represent water allocation priorities, operating policies and apportionment agreements of the St. Mary and Milk Rivers between Canada and the U.S. The model delivers water through the existing water management infrastructure such as storage reservoirs, irrigation canals and diversion structures. It enables the users to study the effect of added storage, irrigation expansion, crop changes, apportionment periods, reservoir operating procedure, changes in canal capacities, etc.

Quick Facts

- **The Technical Team proposes that a single model of the St. Mary – Milk River system be built to analyze water management scenarios.**
- **AENV's *WRM* model is being extended to include the entire St. Mary and Milk River Basins .**
- **Concurrently, Montana DNRC is developing a model that simulates the upper St. Mary and Milk River systems using the *CADWES RiverWare* software. This model will be used to verify the Canadian model, for the upper part of the basins.**

As outlined in Section 9.1, Montana DNRC is currently developing a model that simulates the upper St. Mary and Milk River systems using the *CADWES RiverWare* software. This model simulates operations of the upper St. Mary River system on a daily time-step. The goal is to maximize diversions down the St. Mary Canal while meeting international apportionment requirements. The model links the St. Mary Canal with the Milk River system. It includes all of the major reservoirs and canals in the U.S. portion of the St. Mary and Milk River system.

As Montana does not have experience with the WRMM model, the DNRC model will be run concurrently with the Alberta model to verify the Alberta model performance and results for the Upper St. Mary River and Milk River systems. Montana does not propose extending the Montana model to include the Alberta St. Mary River watershed and irrigation system at this time.

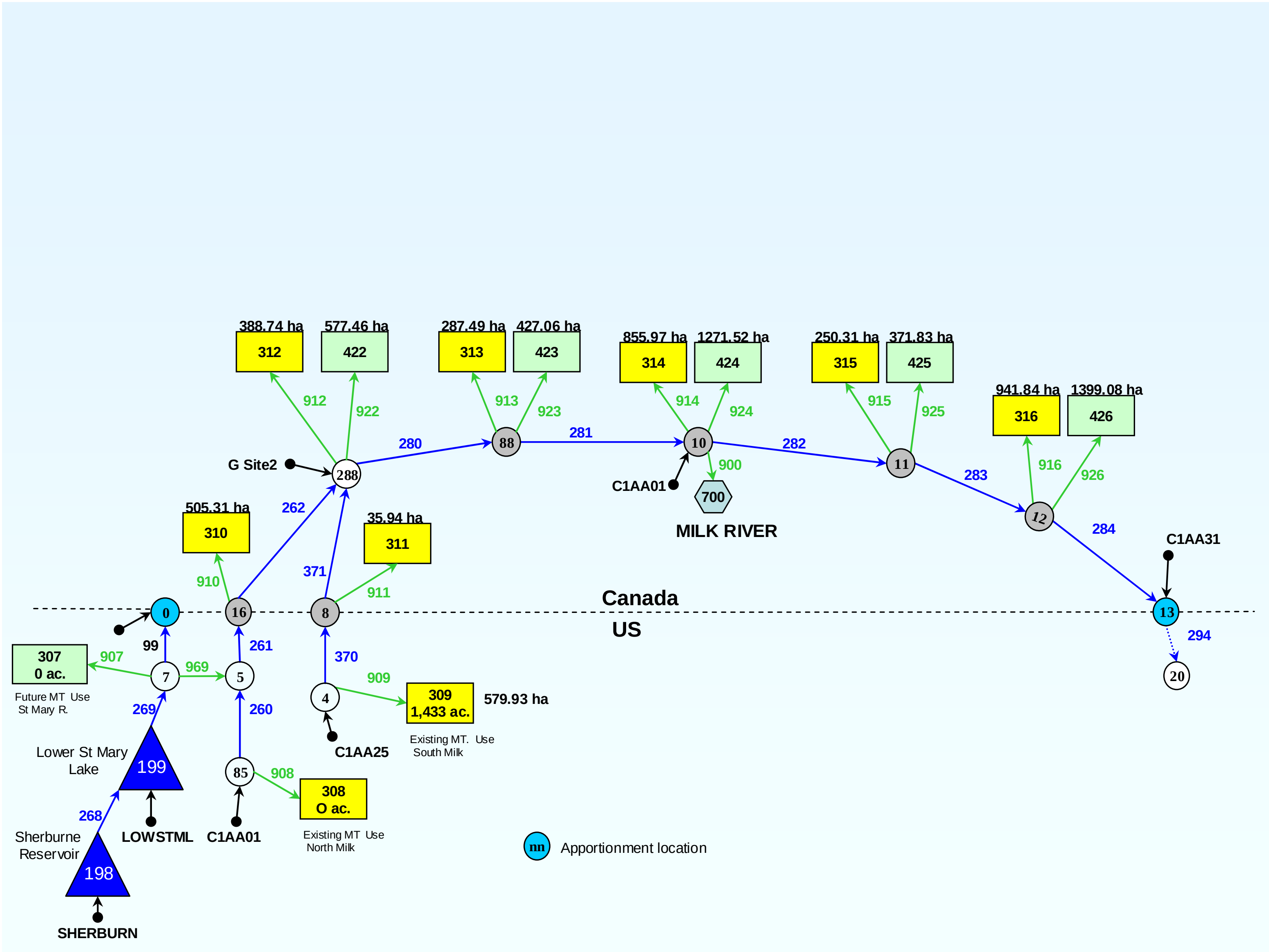

Figure 9.13a – Schematic of Proposed WRMM Model for the St. Mary-Milk River Headwaters to the AB-MT Boundary.

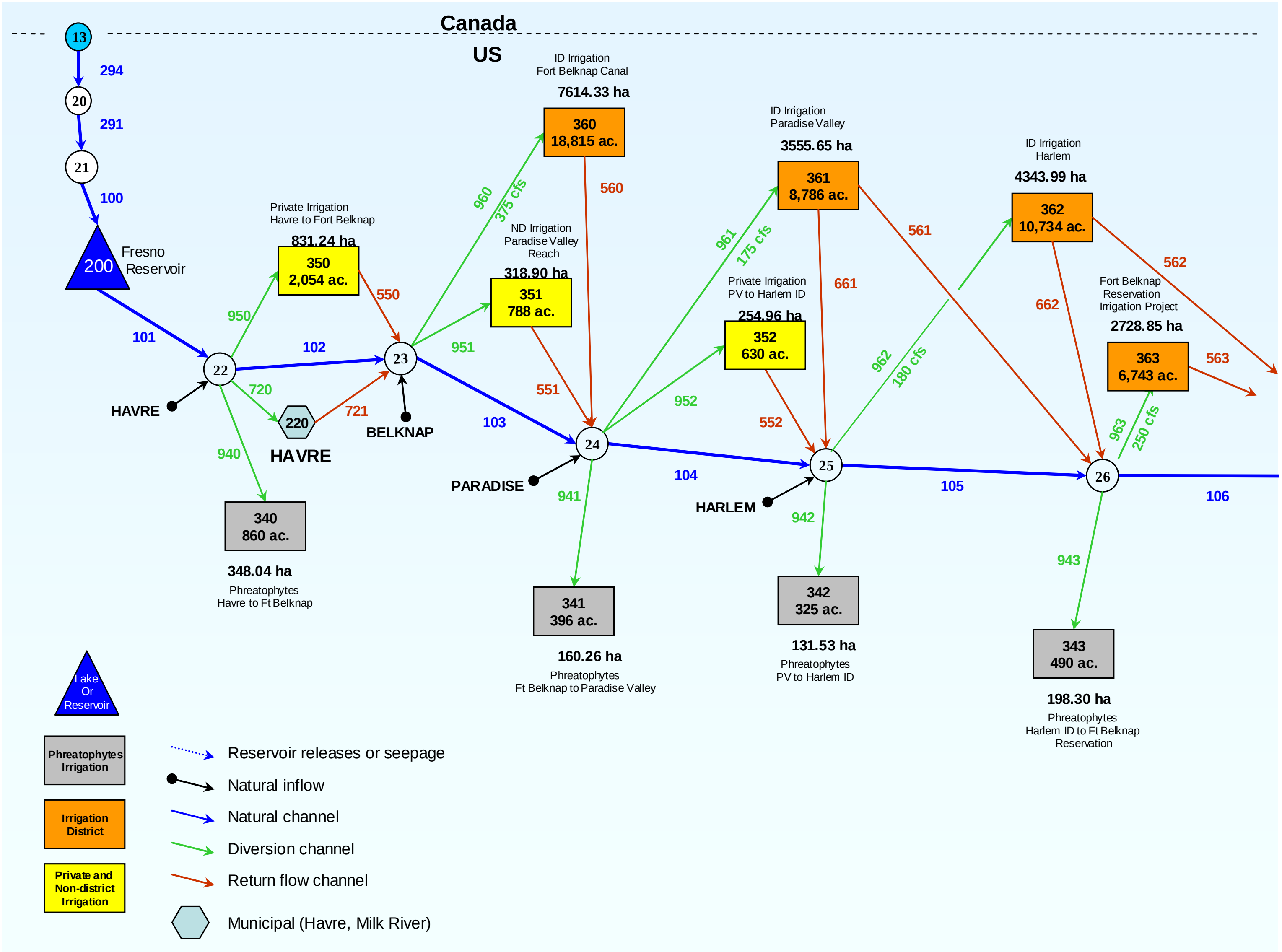

Figure 9.13b – Schematic of Proposed WRMM Model for Milk River at the Eastern Crossing to Harlem.

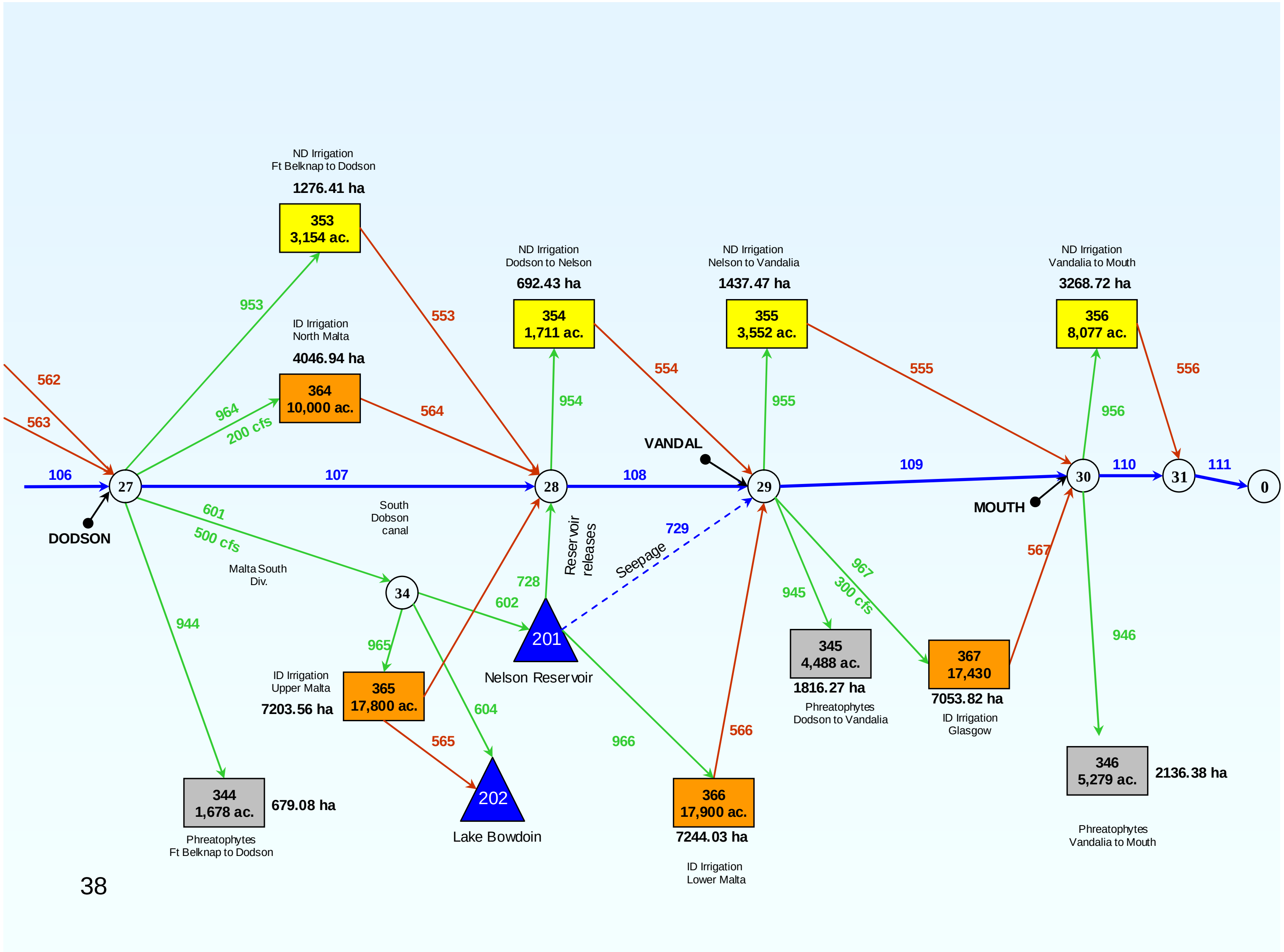

Figure 9.13c – Schematic of Proposed WRMM Model for Milk River at the Harlem to Missouri Confluence.

9.4.2 Proposed Model Period

As indicated previously in section 9.2, to support its planning and evaluations modeling, AENV has developed a set of weekly historical natural flows for the 1912 to 2001 period at over 100 sites within the South Saskatchewan River Basin. These include the St. Mary River Basin and six sites in the Milk River Basin as well as historical weekly precipitation and evaporation estimates for various location across the basins. However, as the 1912 to 1927 period generally represents a relatively wet period within southern Alberta, and as the data is of a lower level of accuracy for this period, Alberta water management models are generally set up to simulate system performance solely for the 1928-2001period.

As outlined in Section 9.1, to support the *CADWES RiverWare* modeling of the St. Mary-Milk System within Montana, DNRC has developed daily naturalized flows for various local areas within the St. Mary River upstream of the International Boundary and tributary inflows and reach gains for the Milk River Basin downstream of the Montana-Alberta border. These data, as well as estimated irrigation demand data, have been developed for the 1959-2003 period.

Quick Facts

- **As the 1959-2003 period has readily available historical natural flow data, and contains a representative mixture of wet, dry and average years and cycles, the technical team recommended that it be used to evaluate water management alternatives.**

After considering all factors, the Technical Team proposed that model simulations be carried out based on the 1959 to 2003 period. Data that are more recent can be incorporated into the model if, and when, it becomes available. This period was selected because:

- Naturalized daily stream flow data for tributaries within Montana is already available for this period and can be easily modified to a bi-weekly data set,
- Due to the scarcity of data prior to 1959, it would be very difficult to generate reliable natural flow data for Montana tributaries for earlier periods,
- Naturalized stream flow data for local areas within Alberta can be readily extended (by April 20, 2009) to incorporate the 2002 and 2003 period,
- Extension of natural flow data to 2008 within Alberta cannot be achieved prior to mid-2010, and above all,
- The 1959-2003 period contains a representative mixture of wet, dry and average years as well as reasonably representative wet and dry cycles (Figures 9.14 and 9.15).

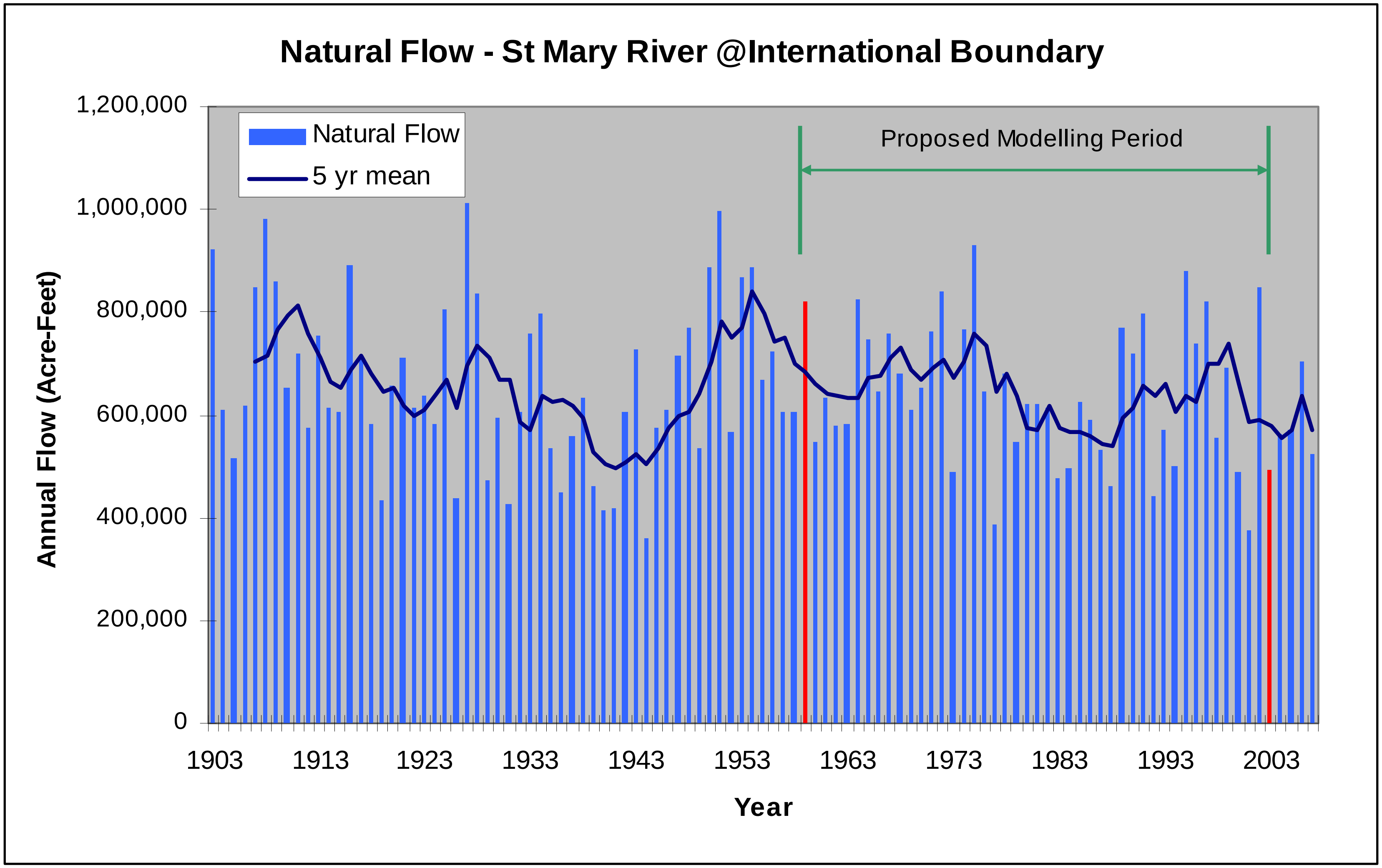

Figure 9.14 –.Historical Natural Flows: St. Mary River at the International Boundary.

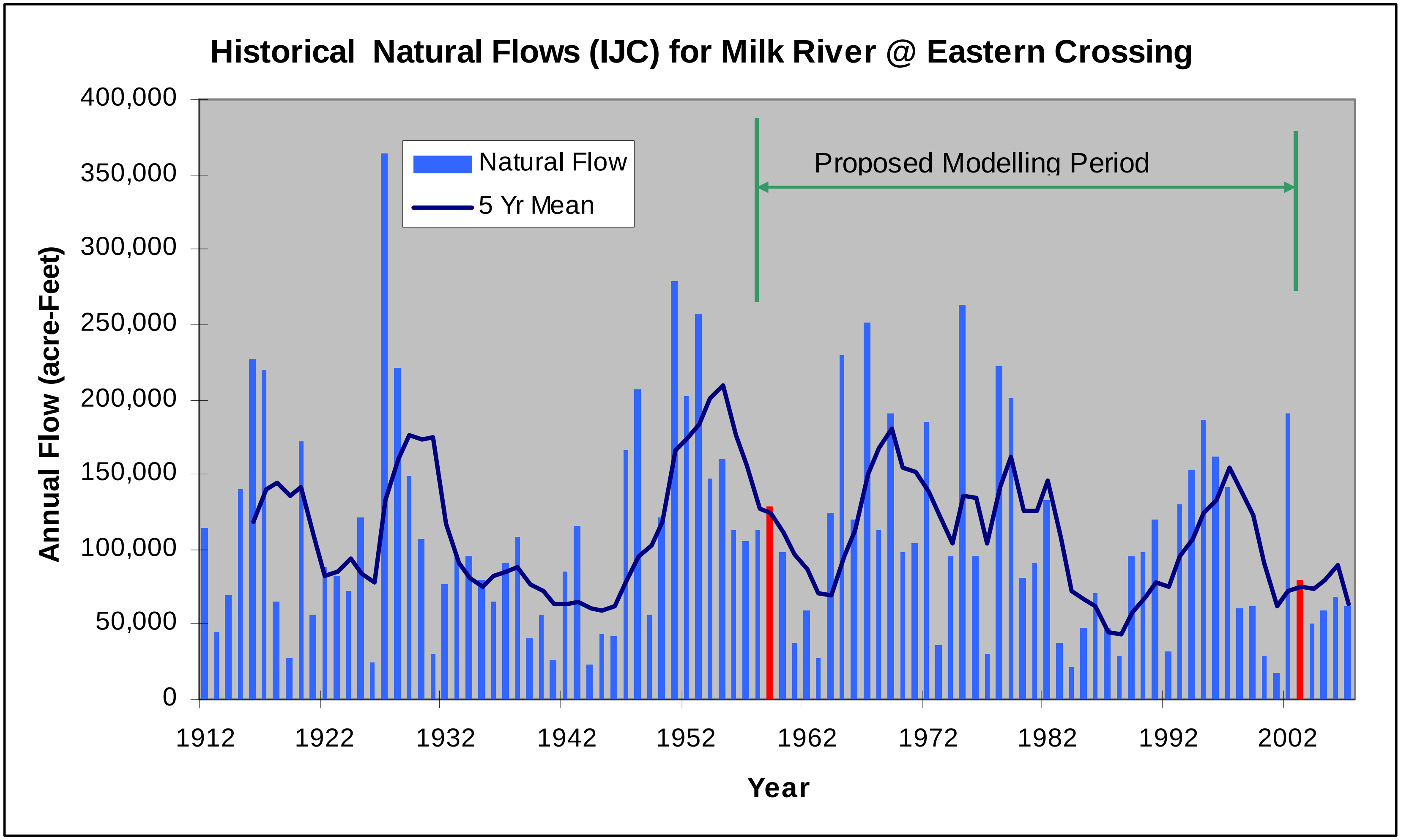

Figure 9.15 – Historical Natural Flows: Milk River at the Eastern Crossing of the International Boundary.

10.0 Past and Ongoing Structural and Water Management Investigations

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This section provides a general description of past water management and infrastructure options that were evaluated by both Montana and Alberta, as well as other United States (U.S.) or Canadian agencies (storage, diversion), including why they were looked at, and the result of the investigation. This information is intended to provide insight to the project team in order to prioritize projects/options that it may wish to undertake in the future.

10.1 Montana Past and Ongoing Structural and Water Management Investigations

10.1.1 Montana U.S. St. Mary Canal Rehabilitation

Quick Facts

- **The Montana U.S. St. Mary Canal is nearly a century old and is beginning to show its age. The failure of any of its numerous components (siphons, drops, etc.) could leave many Montana Milk River irrigators with little water and cause considerable damage.**
- **A working group initiated in 2003 has been working towards making a complete rehabilitation of the Montana U.S. St. Mary Canal a reality.**

The Montana U.S. St. Mary Canal was first constructed and put into use nearly 100 years ago (first used in 1917). The history of the project is summarized in Figure 10.1 below and in Chapter 8. Given their age, the numerous structures (diversion dam, siphons, drops, etc.) have outlived their original design life, perhaps by a factor of two. The failure of major components of the infrastructure, such as the St. Mary siphon or one of the drop structures, would cause considerable environmental damage potentially in the Blackfeet Indian Reservation and Alberta. The single-bank, contour canal (built with teams and fresnos) is inefficient. The need to rehabilitate the Project has been discussed and studied for many years.

In October 2004, the U.S. Bureau of Reclamation (USBR), Montana Area Office, released the *Regional Feasibility Report, North Central Montana*. This study looked at numerous alternatives, with six looking promising, for firming up the water supply in Montana's Milk River Basin. The study findings are as follows:

"As shown in Table S.1, St. Mary Canal System Enhancements is the only alternative that would significantly address the water supply and related issues of north central Montana and that would produce positive economic benefits. The other 5 promising alternatives would contribute to the water supply on a much smaller scale and wouldn't produce net economic benefits when only agriculture was (sic) considered."

Figure 10.1 – History of the Milk River Project.

During the fall of 2003, while the north central report was being finalized, then Lt. Governor Karl Ohs convened the first meeting that would lead to the formation of the St. Mary Canal Rehabilitation Working Group. This group of volunteers has been working ever since toward making a complete rehabilitation of the Montana U.S. St. Mary Canal a reality.

In November 2004, after consultation with the Working Group, DNRC hired TD&H Engineering to pursue further engineering studies related to the potential rehabilitation of the Montana U.S. St. Mary Canal. Phase I of that contract was to review existing information, including the North Central Report; perform field reconnaissance and analysis of existing infrastructure; and provide a report detailing the findings and recommending a course of action. The resultant report, *St. Mary Diversion Works Data Review, Preliminary Cost Estimate and Proposed Rehabilitation Plan* set the stage to continue with Phase II of the rehabilitation planning.

Since their first report, TD&H has submitted to DNRC: *Feasibility and Preliminary Engineering Report*, *Preliminary Economic Analysis Impacts and Benefit-Cost Analysis*, *Hydrologic and Hydraulic Design Considerations*, *Geotechnical Studies for both the St. Mary Siphon Crossing and Hall Coulee Siphon Crossing*, *Existing Topography, Geotechnical Report for Canal Bank Instabilities*, *Structural Evaluation of Canal Bridges*, and *Borrow Resources Study Phase I*. TD&H is still under contract to DNRC to monitor slope movements at the St. Mary River and Hall Coulee siphons and has submitted a scope and budget to perform a preliminary geotechnical study of the proposed new alignment of the St. Mary River Siphon. Using TD&H and DNRC survey data, DNRC is pursuing a preliminary alignment and grade study in-house. Canal capacities from 700 to 1,100 cfs are being considered. A capacity of 1,100 cfs would account for the original canal capacity of 850 cfs plus as much as 250 cfs to transport additional U.S. water.

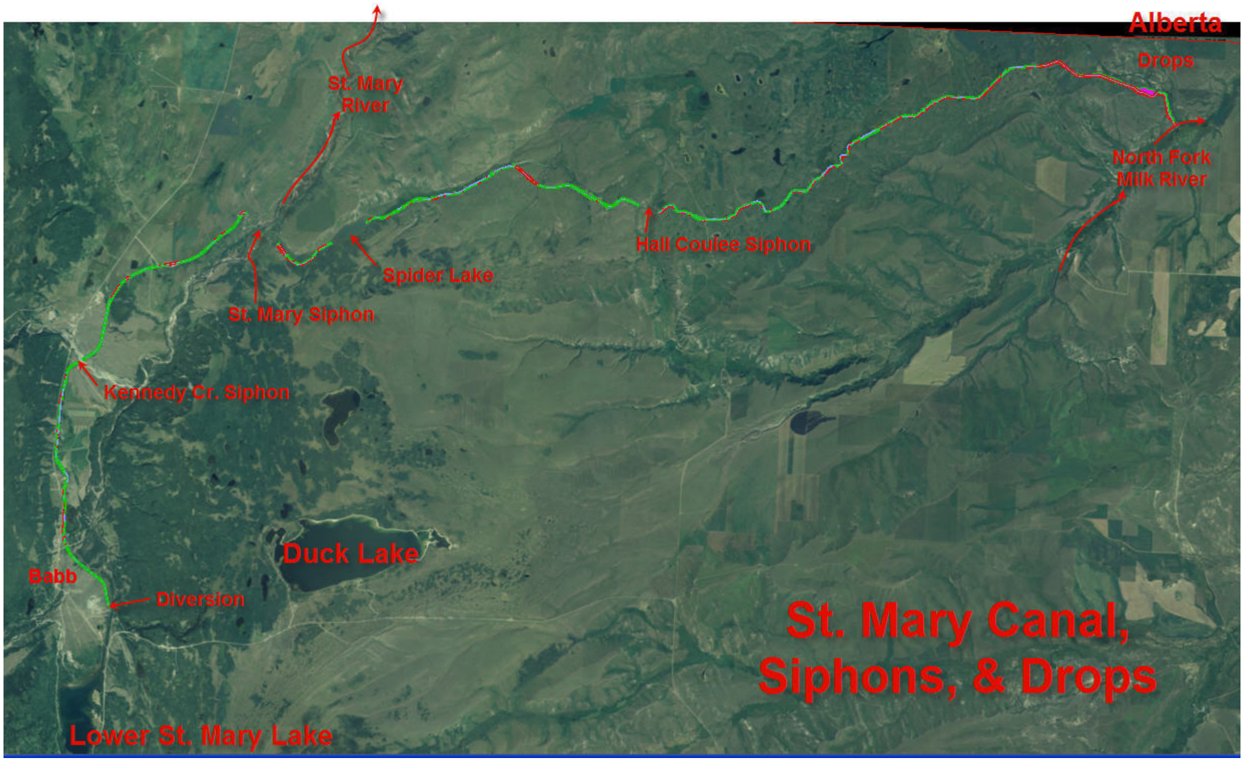

Figure 10.2 – U.S. St. Mary Canal major structures and canal alignment.

Quick Facts

- **The Montana U.S. St. Mary Canal rehabilitation work is estimated at a cost of $153 million and could take up to ten years to complete**
- **This work would improve the reliability and efficiency of the system, as well as improving conditions for the endangered bulltrout and other instream conditions.**

Figure 10.2 shows the major structures and alignment of the U.S. St. Mary Canal superimposed over an aerial photo. The following photos (photos 10. 1 through 10. 3) show deterioration of the infrastructure supporting the case for a total, end-to-end rehabilitation of the project. In addition to the obvious structural reasons for rehabilitation, overall efficiency and capacity of the system can be enhanced.

The sinuous, contour canal can be straightened. A two-bank canal would be more efficient where it traverses coulees. Canal bank instabilities have led to a reduction in the safe canal capacity from the original design capacity. Even at a reduced capacity, there are stretches of the canal that operate with little or no freeboard necessitating constant vigilance. These problems can be alleviated while potentially increasing the total capacity even beyond the original design to accommodate movement of water reserved to the Blackfeet Nation, or potentially to move water into the Milk River for Alberta irrigators. In addition, the diversion dam needs to be modified and or replaced to provide fish passage in the river for endangered Bull Trout spawning and to keep fish from entering the canal.

Using information from the latest TD&H studies, the State of Montana has approached the U.S. Congress twice to seek authorization and funding of the Project. Authorization was recently acquired through the U.S. Army Corps of Engineers *Water Resources Act*. Getting a federal project funded and built is a multi-step process. The Project was authorized for $153 million (USD), but no funding has yet been appropriated. Montana will again approach Congress with an appropriation request for the 2010 Federal Fiscal Year. As currently authorized, the funding share breakdown is show in Figure 10.3.

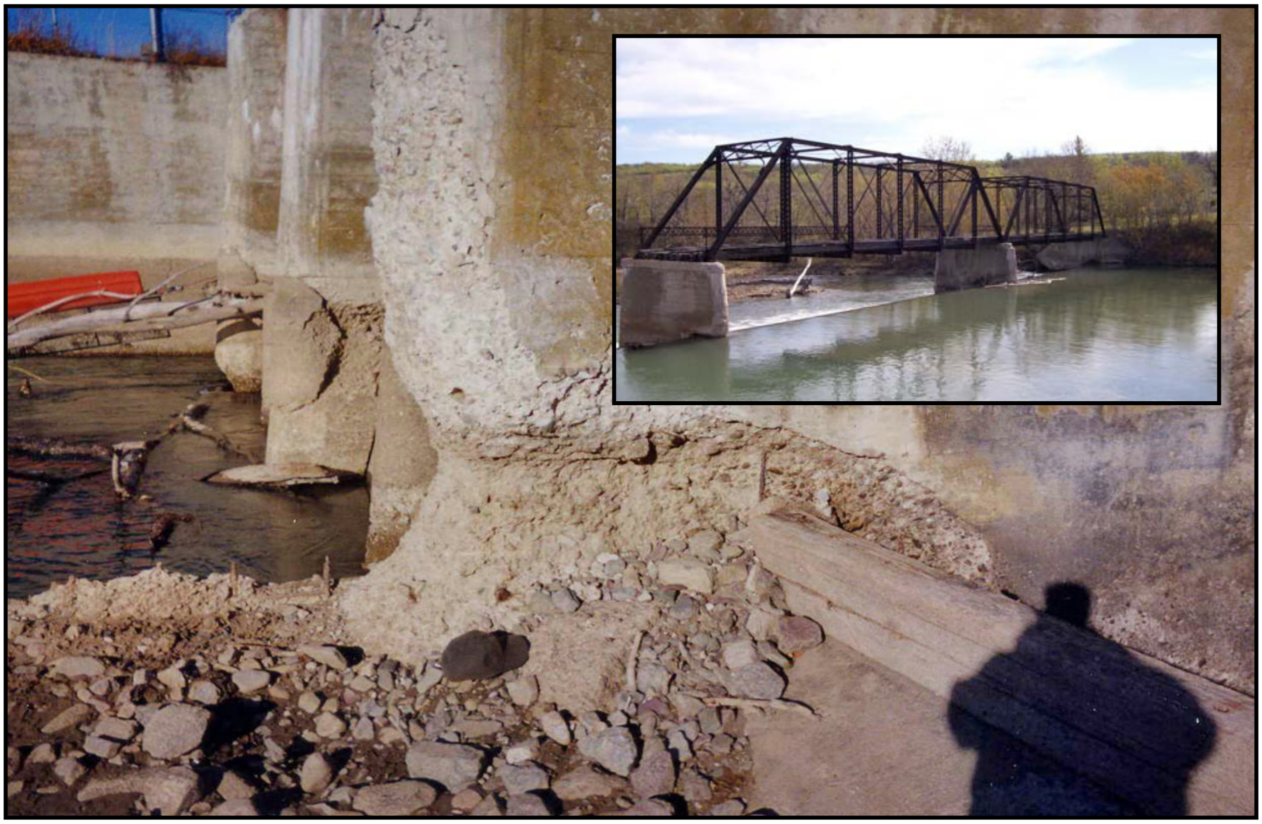

Photo 10.1 – Showing infrastructure deterioration at the diversion dam. Photo: John Sanders

Photo 10.2 – Showing infrastructure deterioration at the canal siphon. Photo: John Sanders

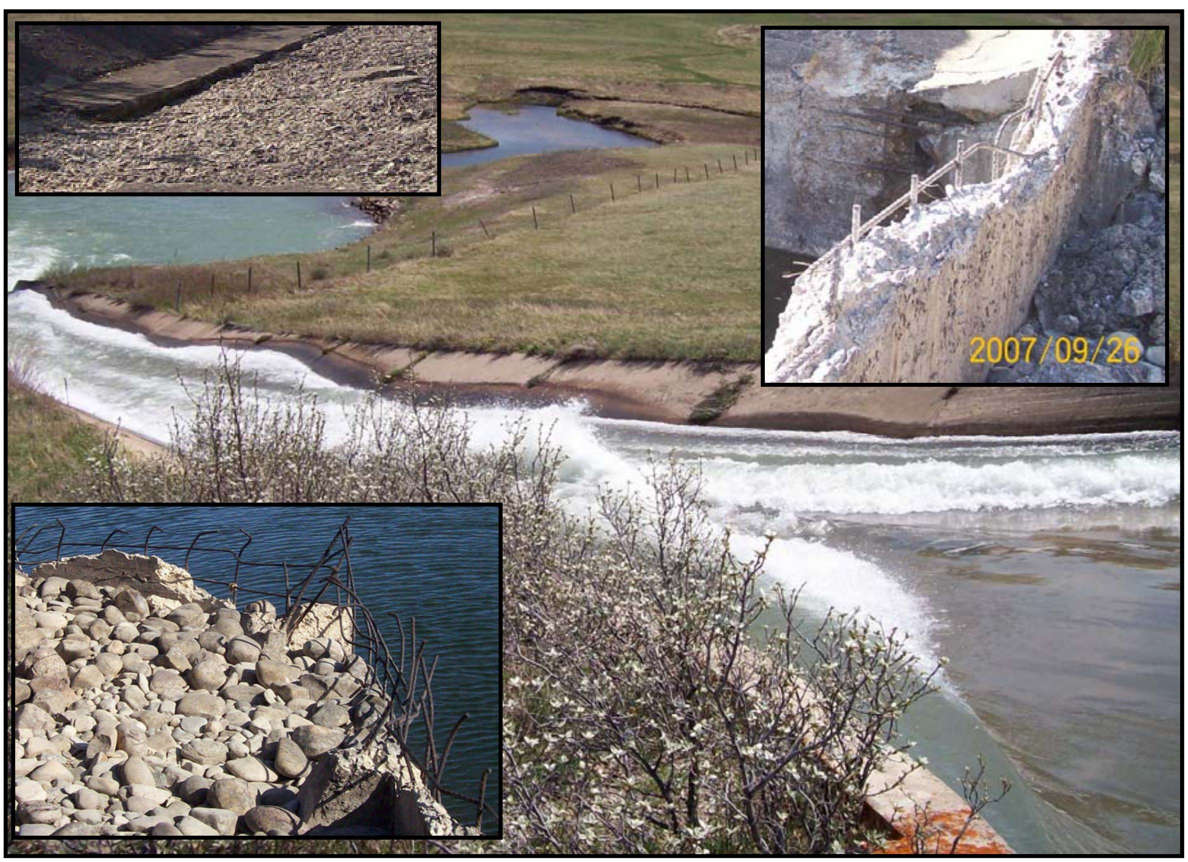

Photo 10.3 – Showing infrastructure deterioration at a drop structure. Photo: John Sanders

TOTAL COST SHARE RESPONSIBILITIES

Federal Responsibility	$114,750,000	75%
Non-Federal Responsibility	$38,250,000	25%
Total Authorization	**$153,000,000**	**100%**

NON-FEDERAL COST SHARE BREAKDOWN

State of Montana	$10,000,000	26%
Unresolved Non-federal Portion	$28,250,000	74%
Total Non-federal	**$38,250,000**	**100%**

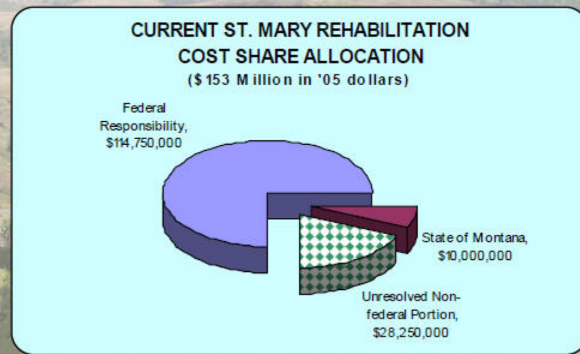

Figure 10.3 – St. Mary Canal rehabilitation funding share breakdown.

Many steps remain to be undertaken before construction can start. Congress must actually appropriate at least some seed money in order for the Corps of Engineers to begin the environmental review and project design processes. Cost share agreements must be negotiated for payment of the non-federal share. There may possibly be two such agreements: one with the State of Montana as the non-federal partner for the purposes of the *National Environmental Policy Act* (NEPA) and design, and one with the water users (and possibly Alberta) as the non-federal partner(s) for actual construction.

Following completion of NEPA and final design, construction could start from three to five years after receiving the first federal appropriation. Depending on timing, staging and season(s) of construction, total rehabilitation could take as much as 10 years. In areas where shifts in alignment and construction of “parallel” structures won’t interfere with water deliveries, work will be scheduled during the summer. Where it can’t be avoided, winter scheduling and construction methods will be utilized to avoid canal shutdowns. Some temporary interruptions of service may be necessary for “tie-ins”, etc.

Given the total length of time that could slip away prior to completion of a total rehabilitation of the Project, Montana has concerns that a major structure could fail catastrophically before it can be replaced. With this in mind and in addition to work mentioned above, TD&H is also under contract to DNRC to present a working document on contingency planning for a catastrophic failure. The Working Group has named a committee to work with DNRC and TD&H on this planning. A potential failure severity matrix has been drafted and discussed with the committee. TD&H conducted a two-day, end-to-end walkthrough of the facilities with many of the stakeholders and is scheduled to complete a draft report this spring (2009). This document could also be used to help the USBR plan and schedule operations and maintenance activities.

10.1.2 Other Investigations

> ***Quick Facts***
>
> - **Several studies have been undertaken to examine options for supplementing water into the lower Milk River to address water shortages in eastern Montana.**
> - **These include a number of structural improvements (enlarging dams, adding canals, etc) as well as improvements to on-farm conservation and improved efficiencies.**

There have been numerous investigations, dating back to the late 1970s, to address Montana Milk River water supply shortages. These include investigations into both structural and non-structural measures that could be used to ease water shortages. The first significant investigation to supplement the Milk River water supply was an evaluation of options to divert water from the Missouri River Basin. This investigation titled *Supplemental Water for the Milk River* was performed by DNRC in 1977 by legislative fiat. The investigation did not address water management or conservation.

In 1990, an investigation titled *Special Report: Summarizing the Milk River Water Supply Study* was issued. This report was a cooperative investigation between the Milk River Project irrigators, the Montana DNRC and the USBR, which in addition to offering recommendations, also offered a three-phased plan with preconditions that must be met before the next phase could commence. The essence of the three-phased plan is still valid. Phase 1 required formation of the Joint Board of Control to consolidate and coordinate basin-wide irrigation operations for more efficient and effective use of water, equipment and personnel. The Joint Board of Control was formed in 1998. Phase 1 also called for restoring the U.S. St. Mary Canal to its original design capacity of 850 cfs, estimated to reduce irrigation shortages by 16,000 ac-ft, which is currently being addressed in the ongoing St. Mary rehabilitation effort.

Phase 2 called for irrigation districts and contract pumpers to reduce demands at the headgates by improving conveyance and on-farm efficiencies. The goal was to increase the overall irrigation efficiency by 15 percent. Phase 2 has not materialized. Phase 3 called for augmentation of the Milk River water supply from the Missouri River if needed after Phases 1 and 2 were completed; all Tribal water rights were quantified; and the basin adjudication was complete.

The Montana Reserved Water Rights Compact Commission (RWRCC) sponsored several investigations to evaluate structural and non-structural mitigation measures to counteract impacts on the Milk River Irrigation Project associated with Tribal water resource development under the Fort Belknap Compact. The RWRCC issued a report in January 2000 titled *Milk River On-Farm Irrigation Study,* which attempted to quantify existing on-farm irrigation efficiencies, and determine the incremental cost per acre per percent increase in on-farm efficiency. A second report was issued by the RWRCC in June 2003 called *Milk River Mitigation Measures Study,* which evaluated an array of structural alternatives to mitigate future Tribal water resource development impacts on Milk River irrigators.

10.1.2.1 Structural Investigations

The best summary of structural alternatives to address water supply problems on the Milk River can be found in the *Regional Feasibility Report: North Central Montana* (USBR 2004). This investigation identified present and potential water supplies, uses and management, water related issues, as well as opportunities to resolve the issues in the Milk, St. Mary and Marias Rivers. The following is a brief synopsis of each structural alternative, besides the U.S. St. Mary Canal rehabilitation which had the highest benefits of all the projects examined, and is the number 1 priority of the State of Montana for improving Milk River water supplies. After the canal rehabilitation is complete, Montana might want to pursue some of these other projects.

a) Virgelle-Milk River Canal: This alternative would convey water from the Missouri River just south of Havre at Virgelle to the Milk River. The water would be pumped out of the Missouri River at a rate of 175 to 230 cfs. The pumps would draw water from the river via an infiltration gallery in the channel bottom. The lift would be about 200 feet. The water would then flow to the Milk River in a 46-mile long canal. The project might supply an additional 50,000 to 70,000 ac-ft of water to the Milk River each year. The 2003 estimated costs for this project were from $66,000,000 to $78,000,000.

b) Duck Creek-Vandalia Canal: The other option to deliver water from the Missouri River to the Milk River would be to convey water from Fort Peck Reservoir at the Duck Creek Arm to Vandalia near the lower end of the Milk River. This proposal would include a 31-mile long 100 cfs canal. The water could flow by gravity when reservoir elevations were high; during other times, a pumping plant would be needed to deliver water from the reservoir to the canal. The project might deliver about 15,000 to 20,000 ac-ft of water per year to the lower Milk River. The 2003 estimated costs for this project were $17,500,000.

c) Tiber-Fresno Reservoir Pipeline: This alternative would deliver water from Tiber Reservoir on the Marias River to Fresno Reservoir on the Milk River. Pumps would lift water about 60 feet from Tiber Reservoir. From there, the water would be conveyed to just east of Chester, Montana. A booster pumping plant would then pump the water over a 200-foot high ridge. From there, a 54-inch diameter pipeline would parallel U.S. Highway 2 for about 59 miles. The water would empty into Fresno Reservoir at Grand Coulee. The capacity of the pipeline would be 50 cfs. The pipeline would supply about 25,000 ac-ft per year to the Milk River. The 2003 estimated costs for this project were about $120,000,000.

d) Babb Dam on St. Mary River: This alternative was for a dam on the St. Mary River near Babb. It would be about 220 feet high and 3,600 feet long and located about 2,000 feet downstream of the St. Mary River Siphon. The reservoir behind the dam would store about 297,000 ac-ft. The reservoir might allow the U.S. to divert about 40,000 ac-ft per year more water of its St. Mary share to the U.S. annually. The 2003 estimated costs for the reservoir were about $229,000,000.

e) Enlarge Fresno Reservoir: The active storage in Fresno Reservoir could be increased from the present capacity of 93,000 ac-ft by modifying or replacing the concrete-crest overflow spillway to include gates. Raising the storable crest 5 feet would increase storage to 95,400 ac-ft; raising it by 10 feet would increase storage to 129,200 ac-ft; raising it 20 feet would increase storage to 217,400 ac-ft. Raising the spillway crest might require other spillway modifications to handle floods safely. Few modifications to the dam, other than to the spillway, would be required. Average annual water deliveries to irrigators by increasing Fresno storage might range from about 4,000 to 10,000 ac-ft. The 2003 estimated costs for enlarging the reservoir were from about $5,000,000 to 43,000,000.

f) Enlarge Nelson Reservoir: This alternative would provide about 16,000 ac-ft of additional storage in Nelson Reservoir by adding a dike at the upper end of the reservoir. The average water supply increase would be less than the 16,000 ac-ft expansion. The 2003 estimated costs for enlarging the reservoir were about $18,000,000.

g) Dams on Milk River tributaries: Potential reservoir sites on Peoples Creek, 30 Mile Creek and lower Beaver Creek have been investigated. Any of these reservoirs would contribute only modestly to water supplies in the Milk River Basin.

h) Nelson Reservoir Pumping Plant: Because the Dodson South Canal is used to deliver water to both irrigated fields and Nelson Reservoir, water can generally only be delivered to the reservoir in the spring and fall. During the peak of the irrigation season, the canal capacity is used to supply irrigation demands. The water supply to Nelson Reservoir could be augmented by pumping water up 70 feet from the Milk River at Cree Crossing. This project would include pumps ranging from six to 150 cfs and a 3,300 foot pipeline. The project might result in an average of up to an additional 12,000 ac-ft per year for Milk River irrigators by allowing for more flexibility in operations. The 2003 estimated costs for the pumping plant and pipeline were from about $3,000,000 to $9,500,000.

i) Dodson South Canal Rehabilitation and Enlargement: Increasing the capacity of the Dodson South Canal from its current capacity of 500 cfs to 600 cfs, 700 cfs and 800 cfs has been examined. Expanding the canal would allow more water to be transferred in the spring, and water to be transferred during the irrigation season. This might make an additional 3,500 to 7,000 ac-ft of water available for Milk River irrigators. It might also provide water more consistently to Lake Bowdoin. The 2003 estimated costs for the canal enlargement were from about $5,000,000 to $17,000,000.

j) Glasgow Irrigation District Re-Regulation Reservoir: Water supplied to the Vandalia Canal is sometimes insufficient. A re-regulation reservoir was examined as a way to capture surplus flows from the canal, to be released later when needed. The reservoir would be located about three miles south of Glasgow, by building an embankment about 1,450 feet long and modifying the present canal banks. The reservoir would store about 130 ac-ft. A pumping plant would be required. By allowing better regulation of flows, it would modestly increase the water supply for water users in the Glasgow Irrigation District. The 2003 estimated cost for the project was about $1,400,000.

10.1.2.2 Water Management and Conservation Investigations and Efforts

Since 1977, the USBR and the Montana DNRC have sustained an on going cooperative effort to improve water conservation and management in the Milk River Basin. The nature of the agreement has evolved over time. The initial focus was to assist irrigation districts with developing and implementing water conservation plans. Most irrigation districts that receive USBR project water are required by federal law to have water conservation plans. The USBR adopted an incentive-based (as opposed to enforcement) policy to encourage irrigation districts to adopt water conservation plans.

Because there was very little data available, the conservation plans mostly focused on increasing water measurement, data collection and accounting. The DNRC took the lead in developing water conservation plans and provided the technical assistance to implement them. However, since implementation was not compulsory, the results (with a few notable exceptions), were minimal.
The cooperative effort took another tack that focused on improving water measurement and telemetry at major diversions through equipment upgrades on the Hydromet sites (Photo 10.4). This effort was considerably more successful, though work on fixing a few glitches is ongoing.

The cooperative effort has been extended through 2009 to execute a pilot project to install water measurement and telemetry on individual Milk River Project pump contract holders on a voluntary basis. DNRC continues to work on improving water measurement, conservation and management improvements with Milk River Basin irrigators.

Photo 10.4 - Hydromet flow monitoring Station on the Dodson South Canal.
Photo: Larry Dolan

10.1.2.3 Other Hydrologic Investigations

The Montana DNRC, in cooperation with the Blackfeet Tribe, is conducting a study of the hydrology and water use in the upper Milk River watershed. The project focuses on the South and North Fork of the Milk River and tributaries. Five temporary stream gauging stations were installed in 2006, and measuring devices have been placed on eight irrigation diversions. Figure 10.4 is a map of the stream gauging station locations. The purpose of the project is to characterize the flows in the upper Milk River watershed and to determine the amount of water that is being used for irrigation, and what effects irrigation is having on streamflows. The stream gauging stations might be operated for one more season. Data for irrigation diversions will continue to be collected, for possible use in the apportionment of Milk River natural flows. A report on the findings of the study should be available in 2010.

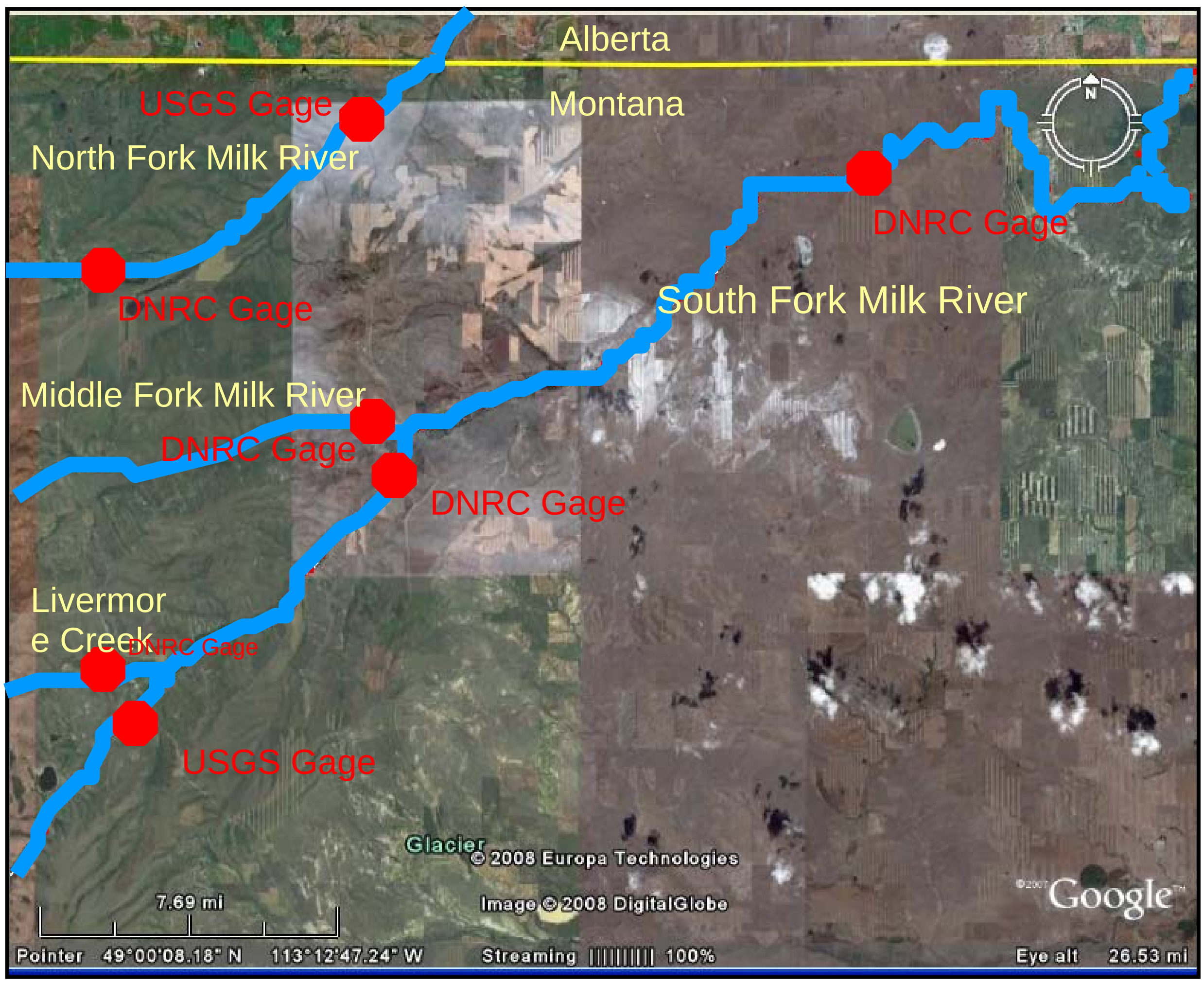

Figure 10.4 – Upper Milk River watershed stream gauging stations.

10.2 Past and Ongoing Structural Water Management Investigations within Alberta

10.2.1 Milk River Ridge Reservoir Study

A study of potential options to supply water from the Milk River Ridge Reservoir to irrigators within the Milk River Basin was undertaken by the Milk River Watershed Council Canada (MRWCC) in May 2008. The object was to identify a solution that would provide a secure water supply for the Milk River Basin in years of drought and would increase water supply to support irrigation expansion, agricultural, municipal and industrial use and thereby improve the economic viability of the watershed.

> ***Quick Fact***
>
> - **A study of the potential options to supply water from the Milk River Ridge Reservoir to irrigators within the Milk River Basin was undertaken by the Milk River Watershed Council Canada in May 2008.**

Pipeline and canal options to supply water from Ridge Reservoir to the Milk River were assessed for five routes. The water supply system was designed for a capacity of 125 cfs and was intended to support 8,200 acres of existing irrigation as well as 10,000 acres of future irrigation expansion. With the canal capacity limited to 125 cfs, the average annual diversion is about 11,350 ac-ft and ranges from zero to 21,235 ac-ft. Although the 125 cfs canal system would significantly reduce Canadian irrigation deficits along the Milk River, deficits would still occur in some years due to the limited supply of water delivered by the 125 cfs canal.

Conceptual designs were conducted for the options with capital costs ranging from $68 million to $98 million in 2008 dollars. The preferred option (option C) consists of a pump station and 1.2 mile pipeline to convey water from the reservoir to a location on the Milk River Ridge and a 27.2 mile-canal following the contour along the Ridge to the Milk River. The capital cost of the system was estimated to be $68 million in 2008 dollars with an annual operation, maintenance and energy cost of approximately $1 million.

10.2.2 Milk River Storage Options

Historically, the Milk River Basin has experienced numerous water supply shortages including periods of drought when the river has run dry. Since 1986, Alberta Environment (AENV) has maintained a moratorium on issuing new water licences for diversion from the Milk River Basin. A local group of water users and representatives of the local communities requested that the Government of Alberta (GOA) evaluate various water storage alternatives to alleviate these shortages.

> ***Quick Facts***
>
> - **Alberta has undertaken several studies on how to provide a secure water supply for existing irrigators within the Milk River Basin and to support expansion.**
> - **A number of sites have been evaluated for on-stream or off-stream water storage in the Milk River Basin to alleviate chronic water shortages.**

In 2003, AENV retained Klohn Crippen Consultants Ltd. to do a Preliminary Feasibility Study, investigating both on-stream and off-stream storage alternatives in the Milk River Basin. This study was an update of a previous study done by the Prairie Farms Rehabilitation Administration (PFRA) in 1986. The PFRA report identified a preferred on-stream storage site called the Forks Sites, located on the Milk River approximately 12 miles upstream of the Town of Milk River. The 2003 updated report considered this as well as other storage sites. The report did not make any conclusions or recommendations but was intended to be a factual assessment of available information to assist the GOA in determining whether further investigations were warranted. The sites investigated in this report are identified in Figure 10.5 and are discussed below.

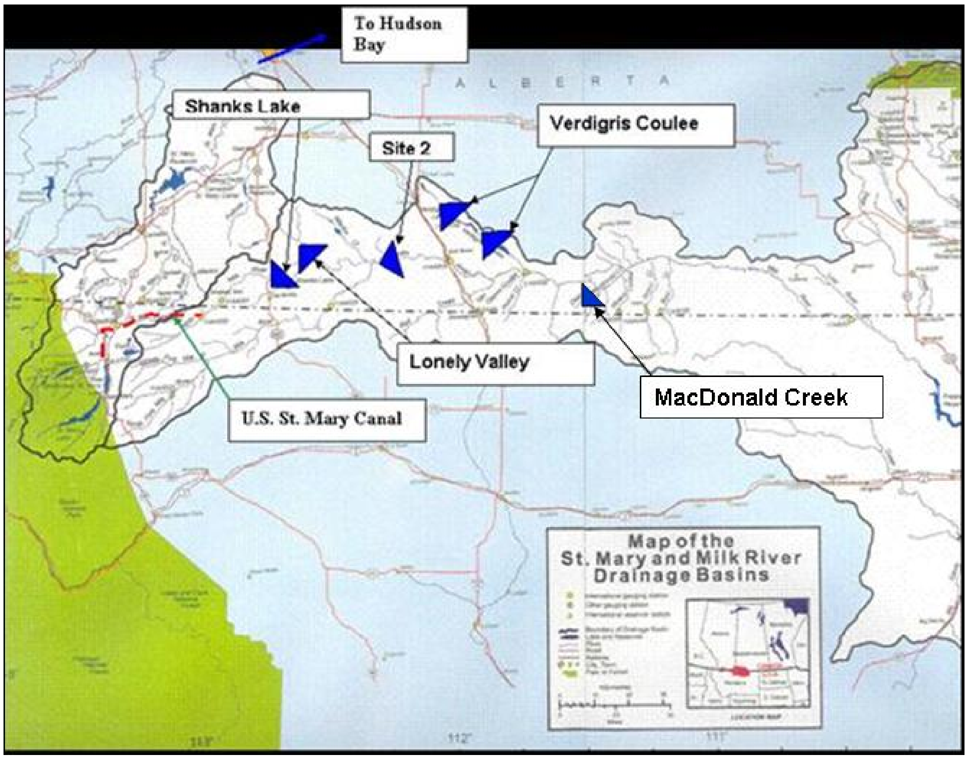

Figure 10.5 – Location of Milk River Storage Sites investigated in 2003.

a) Milk River Site 2 Dam: For the Fork Site or Site 2 Dam, three alternative reservoir levels were identified by PFRA and evaluated in the study. All three alternatives included various configurations of an earth fill dam, a diversion/low level outlet structure, a service spillway structure and an auxiliary spillway channel. Estimated capacities of the three alternatives ranged from 127,975 ac-ft to 243,220 ac-ft. Estimated costs for the three alternatives, not including on-farm costs for development, ranged from $106 million to $123.4 million in 2003 dollars. Ongoing annual operations and maintenance costs ranged from $352,000 to $411,000.

The study identified 19 potential off-stream storage sites within the basin. Preliminary evaluations were carried out for four sites: Shanks Lake, Lonely Valley, Verdigris Lake and MacDonald Creek. Two dam sites locations were studied for the Lonely Valley Alternative. Site Investigations and engineering studies on the four off-stream sites were not available therefore the preliminary feasibility designs are based on limited data and involve a number of design assumptions.

b) Shanks Lake: Shanks Lake is an existing lake that is formed by a small containment dike and control structure and is located near Del Bonita Alberta. The study considered constructing a dam, containment dikes and a combined low level outlet and drop inlet structure. The proposal considered raising the lake by 26 feet and would provide approximately 27,980 acre-ft of additional storage. In 2003 dollars, the estimated cost of the project was $35.9 million with an annual operations and maintenance cost of $646,000.

c) Lonely Valley: Lonely Valley is a glacial melt water channel that is drained by a small creek that flows into the North Milk River approximately 29 miles upstream of the Town of Milk River. Two potential dam locations were evaluated. Alternatives A and B would provide approximately 87,590 acre ft and 85,979 ac-ft of storage respectively. In 2003 dollars, the estimated cost of Alternatives A and B was $88.7 million and $77.5 million with an annual operations and maintenance cost of $296,000 and $249,000, respectively. There are uncertainties of the geological mapping in the area which would have to be resolved before selection of the preferred alternative. However, alternative B was identified as being more economical.

d) Verdigris Lake: Verdigris Lake was previously developed as a small scale reservoir project to supply local irrigation users. Supplemental water was diverted into the lake from Ridge Reservoir which supplied water from the St. Mary River. Due to poor water quality issues the project was abandoned in 1994 and the affected irrigators were compensated for damages.

The proposal for expansion of this storage site would include the construction of two dams, various containment dykes, a low level outlet and an auxiliary spillway. The proposal is to raise the lake level by approximately 56 feet to provide 104,619 ac-ft of additional storage. In 2003 dollars, the estimated cost of the project was $64.9 million with an annual operations and maintenance cost of $214,000. Although much greater volumes of water would be diverted and stored within the reservoir than under the previous project, the implications on water quality in the reservoir from existing salt content in the lake sediments and surface runoff is a significant issue that would need to be resolved.

e) MacDonald Creek: MacDonald Creek is a glacial melt water channel consisting of a small tributary creek that flows into the Milk River approximately 37 miles downstream of the Town of Milk River. The project considered consisted of a low level outlet structure, a service spillway structure and an auxiliary spillway. The site would provide approximately 44,600 ac-ft of storage. In 2003 dollars, the estimated cost of the project was $60.1 million with an annual operations and maintenance cost of $353,000.

Water quality may be an issue at this site as saline areas have been observed. The downstream location of this site would not likely improve the reliability of water supply to many of the existing licenses including the upstream municipalities. The Preliminary Feasibility Study also provided an assessment of environmental and historical resources in the area; an economic analysis of the on-stream and off stream alternatives; as well as an assessment of regional impacts. The details of these assessments are available in the report.

10.2.3 Hydrologic Investigations: Milk River Erosion and Sedimentation Study

In November 2007, the Milk River Watershed Council Canada retained a consultant, AMEC Earth and Environmental, to undertake a study to review Milk River erosion and sedimentation that may result from a potential further increase in St. Mary River diversion flows in to the Milk River. The existing diversion commenced in 1917 and the effects of the diversion of channel morphology have previously been examined. The current study attempted to update the original work conducted in the 1980s and to examine the impact of increase diversion discharges on river morphological processes

Quick Fact

- **The MRWCC has worked with AENV to study potential impacts of proposals to increase St. Mary diversion flows into the Milk River.**

(erosion and sedimentation) and the resulting effects on ice processes, riparian vegetation water quality and fisheries.

Although the design capacity of the St. Mary diversion to the north Fork of the Milk River in Montana was 850 cfs the diversion works have deteriorated over time and the capacity is less than design capacity. Plan for rehabilitation and possible enlargement of the diversion works have been undertaken. The study looked at future scenarios and the impact on the Milk River with diversion capacities ranging from the current 650, 850, 1000 and 1200 cfs.

For the study, modeling was done by Alberta Environment and the hydrological assessment concluded seasonal and peak flood discharges will increase. The impact of the existing diversion and potential future diversions on the morphology of the Milk River were assessed by comparing historical surveys and air photographs as well as utilizing available hydrologic and suspended sediment data to undertake sediment budget and regime analyses. The study found that depending on the reach of river, increased flows are predicted to increase the channel width between 10 to 30%. Generally, a significant change in the channel depth or channel slope is not anticipated. The potential changes are expected to be incrementally small in relation to the changes that have already occurred because of the historical diversion.

The study predicted that the channel will continuously and gradually adjust towards a new dynamic equilibrium. In-channel sediment will continue to move downstream and sediment deposited above bank-full level will be liberated when bank erosion occurs or cut-off channels are created.

The study stated that an increased diversion is expected to result in the river channel widening by erosion. This could result in riparian vegetation losses of up to 10% from existing values. The potential increase diversion could also cause increased flooding; which could favor plains cottonwood regeneration.

A review and brief analysis of available water quality data indicated that increase flows would likely decrease concentrations of nitrogen and salts and increase concentrations of phosphorus. Increased discharges will also result in greater total suspended solids particularly in the upper reaches of the river.

Similar to channel stability, fisheries resources and aquatic habitat in the Milk River will also undergo a period of change following increase diversion flows until channel equilibrium is reached. Increased sediment concentrations are expected to impact negatively fish populations. Conversely, channel width increase will result in additional opportunities for fish habitat to be increased.

While there was insufficient information available to provide estimates on erosion rates due to ice jams and ice action on the channel, the study found in general the Milk River is a dynamic system that is in constant flux. Increases in diversion flows will accelerate river migration, erosion and sedimentation processes.

10.2.4 Water Management and Conservation Investigations - Milk River Metering Pilot Project

Under the *Water for Life* strategy, Alberta Environment in partnership with Alberta Agriculture and Rural Development established a pilot project on the Milk River (main stem) to investigate the viability of monitoring water use for private irrigation projects. Part of the investigation included installing and testing the ability of a variety of meters and telemetry (transmission) devices to collect and transmit reliable and timely water use information. Several commercially available flow meters and transmission devices existed at the time of the project initiation. However, a combination flow meter and telemetry device was not available. Nor had any of these devices been field tested under the extreme conditions often associated with water use projects, thus creating the need for innovation and testing of various combinations to assess accuracy, reliability and cost. This information is also required to ensure effective and timely water management decisions are made for this basin.

> ***Quick Fact***
>
> - **Since 2005, the Milk River Water Metering Pilot Project has provided an increased understanding of water demand and water use patterns in the Milk River.**

Since initiating the project in 2005, four types of meters and three types of telemetry devices were tested at 33 field sites during the irrigation season (April to September). In 2005 and 2006, assessment of the monitoring sites was completed and equipment installed to establish fully functioning systems. By the beginning of August 2007, more than 95 % of the combinations of flow meters and telemetry devices being tested were reporting data. The very dry period in late summer and subsequent low river flows resulted in a relatively early end of the irrigation season, thus providing only one month of continuous results from the pilot project. As such, there was insufficient data upon which to draw conclusions regarding accuracy and reliability and upon which to provide a set of specifications for flow metering and telemetry for broader water use monitoring implementation in the province. It was, therefore, proposed that the pilot project be extended for one to two more years beyond 2007.

The pilot project provided increased understanding on water demand and water use patterns in the Milk River. During August 2007, the near-real time water use information transmitted from the pilot project was used in combination with a temporary website application to allow for better water management decisions along the Milk River. The project provides the means to monitor water use by irrigators, facilitating better resource management and ensure compliance with the apportionment agreement with Montana. The newly developed website is operational and testing of the website continued during the 2008 and 2009 irrigation season.

10.3 Joint Investigations of the Milk River Natural Flow Technical Working Group

The Milk River Natural Flow Technical Working Group (MRTWG) was formed during the 2003 International Records Meeting under a Terms of Reference written by the Canadian Field Representative to the International Joint Commission (IJC). The overall goal of the MRTWG is to improve the accuracy and timeliness of the computation of the natural flow of the Milk River, specifically at the Eastern Crossing where apportionment computations are made. The following is a short summary of assigned tasks and progress that has been made on these tasks:

> ***Quick Fact***
>
> - **The Milk River Natural Flow Technical Working Group is working to improve the accuracy and timeliness of the computation of the natural flow of the Milk River, specifically at the Eastern Crossing where apportionment computations are made.**

a) Evaluation of Consumptive Use upstream of the Eastern Crossing: The current procedures for estimating consumptive uses in the upper Milk River watershed are dated, and are not in-step with the current irrigation practices. Alternative procedures for evaluating consumptive use using surveys, satellite imagery or drought indexes were examined. However, advances in metering led the MRTWG to recommend that a direct measurement approach be used to determine consumptive uses for the Milk River natural flow computations. Alberta and Montana are implementing metering programs in their respective portions of the basin. In this transition period, metered water uses are being compared to estimated irrigation depletions using the existing IJC procedures. It is anticipated that the metered water usage will eventually be used in place of computing irrigation consumptive use upstream of the Eastern Crossing, although some estimation for tributary flood irrigation use might still be required.

b) Evaluation of Milk River Evaporation and Evapotranspiration (ET): One of the components of the determination of natural flow is the increased or "incremental" evaporation from the Milk River channel that results due to the conveyance of St. Mary River water in the Milk River channel. The increased transpiration of water by riparian vegetation along the Milk River due to the higher than natural flows in the channel also is a component of this computation. There has been some work done by group members on updating surface area changes to the active Milk River channel, but this work has not been finalized or incorporated into the apportionment procedures.

c) Alternate Methods for Determining Evaporation Components on a Daily or Real-Time Basis: The objectives of this task were to make the data that are needed to compute evaporation available on a real-time basis. It is difficult to get accurate pan evaporation data on a near real-time basis. Having this data would improve the accuracy of the interim natural flow computations that are used during the irrigation season. The MRTWG had instrumentation added to the weather monitoring station at the Town of Milk River in Alberta, which can be used to estimate evaporation near real-time. Currently, the evaporation estimates made using the Milk River weather station data are being compared to measured pan evaporation to verify their reliability before they are actually used in the interim natural flow computations.

d) Alternatives to Zeroing Negative Natural Flows: Natural flows for the Milk River at the Eastern Crossing are sometimes computed as negative, even when there are measured flows in the South Fork of the Milk River and the North Fork upstream of the St. Mary Canal. The computation of negative natural flows implies that natural flows are not being correctly computed, or that not all potential losses are being taken into account. Computed negative natural flows could be due to measurement errors, incorrect computation of consumptive uses, evaporation or travel time, or it could be due to other unaccounted for losses, or a combination of several of these factors. When negative natural flows are calculated, the established procedure is to set the negative values to zero. This can cause a deviation from mass-balance, which is needed for accurate water accounting. The MRTWG has decided to wait until the accuracy of the various components of the Milk River natural computation procedures are improved before addressing the question of what to do when negative natural flows are computed. If, after that time, computations of zero natural flows are still regularly occurring, alternatives to zeroing will be investigated.

e) Development of a Field Plan for the Determination of Travel Times: Prior the MRTWG investigations, a four-day lag time was used in making the natural flow computations, to account for the time it takes water to flow from the Western to the Eastern Crossing of the International Boundary. After a thorough review of streamflow records, it was found that a five-day lag time would be more appropriate and would result in fewer negative natural flow computations. The five-day travel time has been implemented in the apportionment procedures.

f) Review the Algorithm that is used to compute the Natural Flow of the Milk River: The current procedure to estimate the natural flow of the Milk River came from an equation described in the 1986 report *Natural Flow and Water Consumption in the Milk River Basin, Montana and Alberta* by the USGS and Environment Canada. The MRTWG reviewed the equation and found it to be correct, although it was agreed to remove a component of the equation that accounted for flows from Verdigris Coulee because Alberta is no longer importing water into the Milk River through this channel. The accuracy of the computations would also be improved by measuring St. Mary Canal discharges into the North Fork of the Milk River directly. The current procedure is to compute the canal inflows as the flow of the North Fork of the Milk River below the canal discharge point minus the flow of the North Fork upstream of the canal.

g) Determination of Channel Losses and Streamflow Measurement: There are other channel losses, such as seepage losses, that could be occurring which are not accounted for in the Milk River natural flow computations (Photo 10.5). Channel loss investigations were conducted by the MRTWG to investigate where the river might be losing or gaining water, and by how much. During August, 2007 and again in early October, 2007, crews composed of hydrologist and hydrologic technicians from Environment Canada, the USGS, AENV, and the Montana DNRC comprehensively measured flows along the Milk River in Alberta at about 30 locations over a four-day period. The flow measurement data are compiled and Environment Canada took the lead on analyzing it. As of the date of this report, the analysis has not been completed yet.

Photo 10.5 – Milk River channel loss analysis measurements.
Photo: Montana DNRC

11.0 Additional Information Requested by the Joint Initiative Project Team

Larry Dolan, Hydrologist, Montana Department of Natural Resources and Conservation
Sal Figliuzzi, P.Eng. Section Head, Transboundary Water Policy Branch, Alberta Environment

Throughout its discussions, the Joint Initiative Team members have raised a number of additional questions about water entitlements, losses and various management options and issues. The technical team addresses these outstanding questions in the following section.

11.1 Water Losses along Reaches of the United States St. Mary Canal

Quick Facts

- **Seepage losses from the U.S. St. Mary Canal have only a small effect on water deliveries.**

At the December 12-13, 2008 meeting, the Joint Initiative Team requested that the Technical Team provide estimates as to the quantities of water that are lost from the United States (U.S.) St. Mary Canal. Over the years, stream flow records for the U.S. St. Mary Canal have been collected at three locations:

- U.S. St. Mary Canal at Intake near Babb (USGS Station # 05018000, WSC Station #05AE028),
- U.S. St. Mary Canal at St. Mary Crossing near Babb (USGS Station # 05018500, WSC Station #05AE029), and
- U.S. St. Mary Canal at Hudson Bay Divide near Browning (USGS Station # 05019000, WSC Station #05AE030).

The determination of median annual canal losses for reaches between the historical gauging sites was carried out by subtracting the recorded annual flow at the downstream station from the recorded annual flow at the upstream station for years when flow was measured at both sites. The results for the most recent data (1997-2001 for Babb to St. Mary Crossing and 1951-1966 for St. Mary Crossing to Hudson Bay Divide) are summarized in Figure 11.1. Table 11.1 provides a summary for the entire period of record as well as for the more recent period.

As indicated, the median annual losses are as follows:

- Reach 1 – From St. Mary Canal Intake to St. Mary River Crossing
  - Median Annual Losses (all data) = 19,400 ac-ft.
  - Median annual Losses (1997-2002) = 18,800 ac-ft
- Reach 2 – From St. Mary River Crossing to Hudson Bay Divide
  - Median Annual Losses (all data) = 2,200 ac-ft
  - Median Annual Losses (1951 – 1966) = 4,250 ac-ft

Synoptic measurement made by a Montana Department of Natural Resources and Conservation (DNRC) contractor and the Blackfeet Tribe during mid-August 2008, when the canal was running at about 600 cfs, measured the rate of loss of the canal at about 12 cfs in the upper portions of the canal and 8 cfs beyond the St. Mary River Siphon. DNRC hopes to collect additional information on canal losses in the upcoming field season.

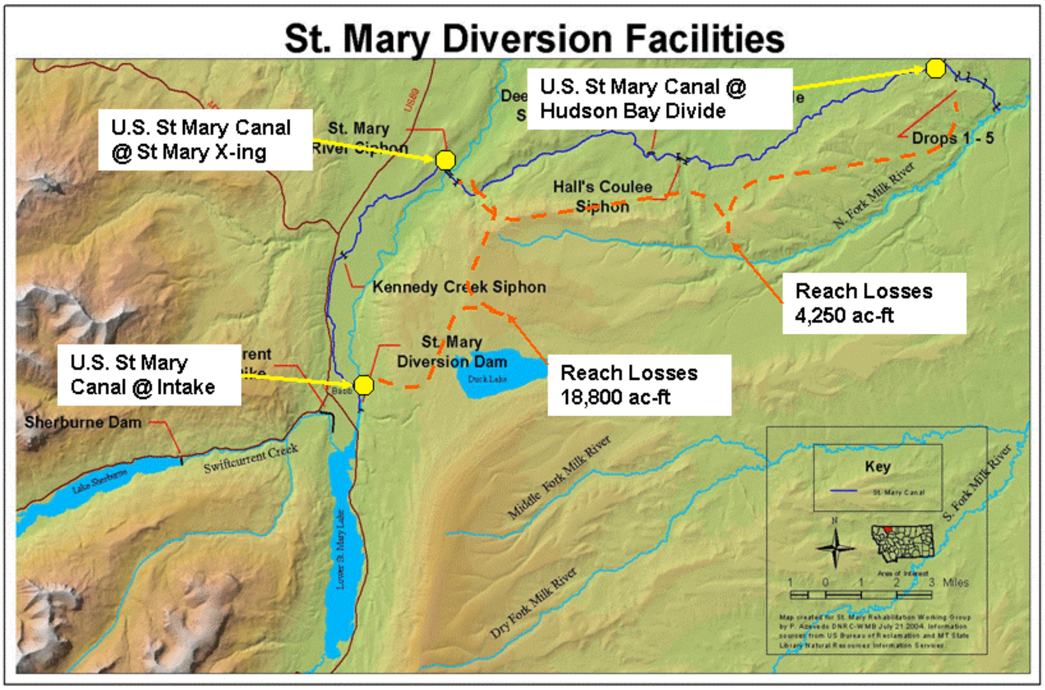

Figure 11.1 – Median Annual Channel Losses for Reaches of U.S. St. Mary Canal.

Table 11.1 – Water Conveyance Losses along U.S. St Mary Canal

Year	St. #05018000 St Mary Canal Intake near Babb	St. #05018500 St Mary Canal at St Mary X-ing near Babb	St. #05019000 St Mary Canal at Hudson Bay Divide near Browning	Canal Losses (Babb to St. Mary Xing)	loss/Gain(-) St. Mary X-ing to HB Divide
	Annual Total (ac-ft)	Annual Total (dam^3)	Annual Total (dam^3)	Annual Total (dam^3)	Annual Total (dam^3)
1917			33715		
1918	86809		57470		
1919	144105	110837	108507	33268	2330
1920	94561	71164	71996	23397	-832
1921	66322	55054	54861	11268	193
1922	81113	67879	66102	13234	1777
1923	94442	82542	82823	11899	-281
1924	110978	91420	93411	19557	-1991
1925	167763	140371	142058	27392	-1687
1926	115167	100164	96556	15003	3608
1927			53218		
1928	82838	72217	69964	10622	2253
1929	118866	102248	101405	16618	843
1930	109425	89568	85885	19857	3683
1931	156155	135239	131680	20916	3559
1932	183760	157029	155566	26731	1463
1933	174622	150625	147316	23998	3308
1934	190059	164630	163091	25429	1539
1935	180172	158939	154711	21233	4228
1936	177708	154081	149877	23626	4204
1937	165684	141569	142244	24115	-675
1938	187196	167871	165736	19325	2135
1939	190247	169372	156068	20875	13304
1940	161016	134081	133024	26935	1058
1941	147409	128147	128786	19263	-640
1942	189196	167359	170272	21837	-2913
1943	133583	118249	118612	15334	-363
1944	126001	110950	109823	15051	1127
1945	203516	177518	174897	25998	2621
1946	217074	193840	191682	23234	2158
1947	153515	138936	138463	14579	472
1948	126430	115071	116860	11359	-1789
1949	170227	152758	150597	17469	2160
1950	168961	154032	152128	14930	1904
1951		84100	83414		686
1952		107211	103807		3404
1953		116480	115666		814
1954		106963	103263		3700
1955		111946	109326		2621
1956		195063	191491		3571
1957		172388	165478		6911
1958		172575	167460		5115
1959		221291	216150		5141
1960		174296	171663		2633

SUMMARY - All Data				Losses Babb to St Mary X-ing	loss/Gain(-) St Mary Xing to HB Divide
				(ac-ft)	(ac-ft)
Median				19441	2206
Maximum				33268	13304
Minimum				10622	-2913

Year	St. #05018000 St Mary Canal Intake near Babb	St. #05018500 St Mary Canal at St Mary X-ing near Babb	St. #05019000 St Mary Canal at Hudson Bay Divide near Browning	Canal Losses (Babb to St. Mary Xing)	loss/Gain(-) St. Mary X-ing to HB Divide
	Annual Total (ac-ft)	Annual Total (dam^3)	Annual Total (dam^3)	Annual Total (dam^3)	Annual Total (dam^3)
1961		205050	197382		7668
1962		189806	183167		6639
1963		224210	219181		5028
1964		173136	168889		4247
1965			130138		
1966		185298	181006		4292
1967		129160			
1968		216021			
1969		167592			
1970		165684			
1971		165030			
1972		201947			
1973		152795			
1974		206074			
1975		99191			
1976		207222			
1977		101951			
1978		101320			
1979		129083			
1980		199468			
1981		231835			
1982		99411			
1983		178524			
1984		164063			
1985		215658			
1986		135679			
1987		177517			
1988		177153			
1989		277452			
1990		206868			
1991		218415			
1992		137617			
1993		188073			
1994		162709			
1995		85535			
1996		149082			
1997	185157	172506		12652	
1998	239644	214210		25434	
1999	198714	179577		19137	
2000	193715	178700		15016	
2001	149925	131122		18803	
2002	175492				

SUMMARY - 1997-2001 for Babb to St Mary Crossing and 1951-1966 for St. Mary X-ing to HB divide				Losses Babb to St Mary X-ing	loss/Gain(-) St Mary Xing to HB Divide
				(ac-ft)	(ac-ft)
Median				18803	4247
Maximum				25434	7668
Minimum				12652	686

11.2 Annual U.S. St. Mary Entitlements not Captured and Diverted by the U.S.

At the December 12-13, 2008 meeting, the Joint Project Team requested that the Technical Team provide estimates as to the annual quantities of U.S. St. Mary entitlements that are not diverted by the U.S. The analysis utilized published values within the International Joint Commission's (IJC) "*Division of the Waters of the St. Mary and Milk Rivers – 2002*" report (Appendix A and B of the *Report to the International Joint Commission on the Division of Waters of the St. Mary and Milk Rivers for the year 2002* - Table 7: *Historical Summary of Computed Natural Flow St. Mary River*). Values were used to determine the irrigation and non-irrigation season (November 1 to October 31) natural flows and U.S. St. Mary entitlements.

U.S. diversions were computed based on recorded data for the U.S. St. Mary Canal, at St. Mary Crossing near Babb (USGS Station # 05018500, WSC Station #05AE029). U.S. St. Mary entitlements that are not taken and diverted by the U.S. were subsequently computed by subtracting the recorded U.S. diversions from the computed U.S. St. Mary River entitlements. The results are presented in Table 11.2 and in the Summary Statistics at the bottom of the table. As indicated for the 1919 to 2002 period:

Quick Fact

- **The U.S. has not been able to capture and divert its full entitlement from the St. Mary River although U.S. diversions have improved 54% of entitlements during the 1919-1960 period to 70% of entitlement during the 1961-2002 period.**

- The St. Mary River at the International Boundary had a median non-irrigation season (Nov 1 – Mar 31) flow of 64,978 ac-ft and a median irrigation season (Apr 1 – Oct 31) flow of 553,709 ac-ft.
- The median annual U.S. entitlements were about 251,439 ac-ft, with upper and lower quartiles (highest [blue highlighted area of Table 11.2] and lowest [brown highlighted] 25% of years) of 313,660 ac-ft and 220,200 ac-ft.
- The median annual U.S. diversions were about 155,555 ac-ft.

A comparison of early period records (1919-1960) versus current period (1961-2002) records indicates:

- The median annual U.S. St. Mary River entitlements (column 6 of Table 11.2) are comparable for the two periods – 250,993 ac-ft for the 1919-1960 period versus 251,885 ac-ft for the 1961-2002 period.
- The median annual U.S. diversions (column 7) have increased significantly over the two periods – from 135,239 ac-ft in the 1919-1960 period to 177,153 ac-ft in the 1961-2002 period.
- While the quantity diverted has increased significantly over the two periods, in the wettest 25% of years the U.S. continues to have significant quantities of waters that it does not capture and use (column 8): more than 187,170 ac-ft in the 1919-1960 period and more than 146,400 ac-ft in the 1961-2002 period.
- The quantities of its share that the U.S. did not capture and use during the driest 25% of years (column 8) is much smaller than for the wetter periods both as a percentage and as an absolute amount at less than 56,690 ac-ft for the 1919-1960 period versus less than 27,750 ac-ft for the more recent 1961-2002 period.

The quantities of its share that the U.S. did not capture and divert for the entire period are summarized in Table 11.3.

Table 11.2 -- St Mary River at International Boundary - Summary Historical Natural Flows, U.S. Entitlements, Diversions and Uncaptured Flows

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
	Computed Natural Flow		**U.S Entitlements**			**U.S. Diversions**	**Uncaptured**
Source	IJ	IJ	IJ	50%		USGS and WSC	**U.S. Annual**
Water Year (Starting Nov.1)	Non-Irrigation Season (Nov to Mar)	Irrigation Season (Apr to Oct)	Irrigation Season	Non-Irrigation Season	Total	USGS St.# 05018500, WSC St. # 05AE029	**Entitlements (Col. 6 - Col.7)**
	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
1918-1919	49,696	386,704	142,683	24,848	167,531	110837	56,695
1919-1920	61,046	579,651	227,807	30,523	258,330	71164	187,166
1920-1921	72,152	636,400	255,371	36,076	291,447	55054	236,393
1921-1922	64,694	565,869	228,618	32,347	260,965	67879	193,085
1922-1923	47,183	582,894	229,428	23,591	253,020	82542	170,478
1923-1924	51,398	520,470	203,486	25,699	229,185	91420	137,765
1924-1925	78,638	720,713	295,906	39,319	335,225	140371	194,854
1925-1926	49,210	372,112	124,037	24,605	148,642	100164	48,478
1926-1927	74,828	932,306	401,297	37,414			
1927-1928	111,877	734,495	302,392	55,938	358,330	72217	286,113
1928-1929	66,072	427,240	162,140	33,036	195,176	102248	92,928
1929-1930	52,371	535,874	209,161	26,186	235,347	89568	145,778
1930-1931	38,833	373,733	134,576	19,416	153,993	135239	18,754
1931-1932	83,502	515,606	202,675	41,751	244,426	157029	87,397
1932-1933	67,450	642,886	261,046	33,725	294,771	150625	144,146
1933-1934	168,626	629,104	257,803	84,313	342,116	164630	177,486
1934-1935	136,198	467,775	179,165	68,099	247,264	158939	88,325
1935-1936	29,996	415,079	157,276	14,998	172,274	154081	18,193
1936-1937	34,049	501,013	200,243	17,025	217,268	141569	75,699
1937-1938	65,261	572,355	230,239	32,631	262,870	167871	94,999
1938-1939	59,343	402,919	149,980	29,672	179,651	169372	10,280
1939-1940	37,779	364,005	128,091	18,889	146,980	134081	12,899
1940-1941	32,833	334,820	110,255	16,417	126,672	128147	-1,475
1941-1942	94,041	535,874	206,729	47,021	253,749	167359	86,390
1942-1943	63,397	676,125	278,071	31,698	309,769	118249	191,520
1943-1944	36,319	317,795	107,013	18,160	125,172	110950	14,223
1944-1945	46,453	505,878	200,243	23,227	223,470	177518	45,952
1945-1946	76,854	535,874	206,729	38,427	245,156	193840	51,316
1946-1947	86,745	625,051	245,642	43,373	289,015	138936	150,079
1947-1948	71,342	724,767	307,256	35,671	342,927	115071	227,856
1948-1949	35,428	456,425	170,247	17,714	187,961	152758	35,204
1949-1950	96,473	766,923	321,038	48,237	369,274	154032	215,243
1950-1951	141,062	883,664	372,112	70,531	442,643	84100	358,543
1951-1952	82,692	517,227	200,243	41,346	241,589	107211	134,378
1952-1953	62,505	787,191	336,441	31,253	367,694	116480	251,214
1953-1954	62,586	796,109	332,388	31,293	363,681	106963	256,718
1954-1955	79,287	589,380	237,535	39,643	277,179	111946	165,232
1955-1956	89,177	652,615	265,099	44,589	309,688	195063	114,625
1956-1957	59,343	545,602	221,321	29,672	250,993	172388	78,605
1957-1958	58,533	531,009	205,918	29,266	235,184	172575	62,610
1958-1959	93,231	715,039	287,799	46,615	334,414	221291	113,124
1959-1960	95,663	483,178	184,029	47,831	231,861	174296	57,565
1960-1961	58,533	566,680	223,754	29,266	253,020	205050	47,970
1961-1962	60,722	495,338	186,461	30,361	216,822	189806	27,016
1962-1963	99,716	510,742	201,054	49,858	250,912	224210	26,702
1963-1964	44,345	763,681	321,038	22,173	343,210	173136	170,074
1964-1965	68,018	671,261	270,774	34,009			
1965-1966	71,099	577,219	226,996	35,549	262,546	185298	77,248
1966-1967	66,072	680,989	286,988	33,036	320,024	129160	190,865
1967-1968	94,852	584,516	227,807	47,426	275,233	216021	59,213
1968-1969	78,962	543,170	212,404	39,481	251,885	167592	84,293
1969-1970	53,831	599,108	248,075	26,915	274,990	165684	109,306
1970-1971	67,369	689,907	284,556	33,685	318,241	165030	153,211
1971-1972	86,745	753,141	310,499	43,373	353,871	201947	151,924
1972-1973	54,641	406,972	153,223	27,321	180,543	152795	27,748
1973-1974	106,202	689,096	286,988	53,101	340,089	206074	134,016
1974-1975	40,535	826,915	354,276	20,268	374,544	99191	275,353
1975-1976	120,794	581,273	229,428	60,397	289,826	207222	82,604
1976-1977	38,022	329,145	106,202	19,011	125,213	101951	23,262
1977-1978	59,019	621,808	245,642	29,510	275,152	101320	173,832
1978-1979	60,965	496,14	194,568	30,482	225,051	12908	95,968
1979-1980	36,563	951,27	214,836	18,281	233,117	39946	33,649
1980-1981	108,634	547,22	219,700	54,317	274,017	83183	42,182
1981-1982	46,372	556,14	222,132	23,186	245,318	5 99411	145,907
1982-1983	48,642	419,94	157,276	24,321	181,597	17852	3,073
1983-1984	67,369	432,914	158,897	33,685	192,582	464063	28,519
1984-1985	40,940	543,981	206,729	20,470	227,199	215658	11,541
1985-1986	133,766	477,503	175,111	66,883	241,994	135679	106,315
1986-1987	70,207	487,231	184,840	35,103	219,943	177517	42,426
1987-1988	31,942	402,108	147,548	15,971	163,518	177153	-13,635
1988-1989	65,424	628,293	249,696	32,712	282,408	277452	4,956
1989-1990	159,708	598,298	235,103	79,854	314,957	206868	108,090
1990-1991	111,877	733,685	308,877	55,938	364,816	218415	146,401
1991-1992	47,994	387,515	132,955	23,997	156,952	137617	19,335
1992-1993	60,884	510,742	190,515	30,442	220,957	188073	32,883
1993-1994	64,694	432,914	163,762	32,347	196,109	162709	33,400
1994-1995	74,909	711,796	295,906	37,454	333,360	85535	247,826
1995-1996	189,704	632,347	254,560	94,852	349,412	149082	200,330
1996-1997	76,287	743,413	306,445	38,143	344,589	172506	172,083
1997-1998	50,588	512,363	204,297	25,294	229,591	214210	15,381
1998-1999	49,128	565,869	222,132	24,564	246,696	179577	67,120
1999-2000	128,091	444,264	165,383	64,045	229,428	178700	50,729
2000-2001	26,753	338,873	126,469	13,377	139,846	131122	8,724
2001-2002	55,938	795,298	340,495	27,969	368,464	152412	216,052

SUMMARY STATISTICS FOR ALL YEARS								
Upper Quartile	84,310	657,280	266,520	42,160		313,660	Upper 1/4ile	168,860
Average	**71,900**	**567,900**	**225,400**	**36,000**	#	**258,70**		
Median	64,978	553,709	221,727	32,489		251,43	155,555	87,861
Lower Quartile	49,570	481,760	182,810	24,790		220,200	Lower 1/4ile	34,040

SUMMARY STATISTICS FOR A1919-1960 PERIOD								
Upper Quartile						309,690	Upper 1/4ile	187,170
Average	**70,600**	**568,100**	**225,700**	**35,300**	#	**256,700**		
Median	64,978	540,738	215,241	32,489		250,993	135,239	113,124
Lower Quartile						217,270	Lower 1/4ile	56,690

SUMMARY STATISTICA FOR 1961-2002 PERIOD								
Upper Quartile						318,240	Upper 1/4ile	146,400
Average	**73,300**	**567,600**	**225,100**	**36,600**	#	**260,700**		
Median	65,059	561,005	222,132	32,529		251,885	177,153	67,120
Lower Quartile						220,960	Lower 1/4ile	27,750

Data Source: Report to the IJC on the Division of the Waters of the St. Mary and Milk Rivers for the Year 2002, Appendix A (Table 7)

Table 11.3 – Quantities of U.S. share it did not capture and divert.

Quantity not diverted (acre-feet)	Number of years	Percent of years
10,000 ac-ft or less	6 of 82	7.3
20,000 ac-ft or less	13 of 83	15.8
30,000 ac-ft or less	18 of 82	21.9

11.3 Determine the Median U.S. Entitlements Rather than the Average

Within Figure 5.5 it was stated that, based on the Treaty and Order, the U.S., on average, was entitled to 45.5% and Canada to 54.5% of the combined flow at the Canada-U.S. border of the St. Mary River, Milk River, Battle Creek, Lodge Creek and Frenchman River. The Joint Initiative Team requested that the Technical Team provide estimates as to the median annual quantities that the U.S. and Canada were entitled to for that same period.

Table 11.4 a provides a summary of the Canadian annual water entitlements from the flow of each of the St. Mary River, Milk River, Battle Creek, Lodge Creek, and Frenchman River, as well as the total combined flow, during the 1950 to 2002 period. As indicated, on average Canada was entitled to 54.35% of the combined flow of these stream courses while its median annual entitlement was about 54.16%.

Table 11.5 provides a summary of the U.S. annual water entitlements from the flow of each of the St. Mary River, Milk River, Battle Creek, Lodge Creek and Frenchman River, as well as the total combined flow, during the 1950 to 2002 period. As indicated, on average the U.S. was entitled to 45.65% of the combined flow of these stream courses while its median annual entitlement was about 45.84%.

Quick Facts

- **The Joint Initiative Team requested estimates of the median annual quantities of the St. Mary River, Milk River, Battle Creek, Lodge Creek and Frenchman River at the Canada-U.S. border that each country was entitled to.**
- **On average, Canada was entitled to 54.35% of the combined flow of these stream courses while its median annual entitlement was about 54.16%.**

Table 11.4 – Canadian Entitlements at the International Boundary (based on historical IJC computations).

	St. Mary River			Milk River	Lodge Cr.	Battle Cr	Frenchman R.	TOTAL	Canadian Entitlement as % of Total
	Computed Can. Entitlements								
source	IJC	IJC	IJC	IJC	IJC	IJC	IJC	IJC	
Water Year (Starting Nov.1)	Non-Irrigation Season (Nov to Mar)	Irrigation Season (Apr to Oct)	Total Annual	Irrigation Season* (Mar to Oct)	Irrigation Season* (Mar to Oct)	Irrigation Season* (Mar to Oct)	Irrigation Season* (Mar to Oct)	Note- does not include non-irrigation season for Milk, Lodge, Battle, Frenchman	
	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	%
1949-1950	48,237	445,886	494,122	34,779	7,256	9,647	37,819	583,624	53.4
1950-1951	70,531	513,174	583,705	94,041	25,537	14,552	55,533	773,368	51.8
1951-1952	41,346	316,984	358,330	76,773	65,261	55,938	180,381	736,684	52.4
1952-1953	31,253	450,750	482,002	94,852	15,484	18,889	37,454	648,683	51.9
1953-1954	31,293	462,910	494,203	44,264	5,270	16,579	44,589	604,905	53.1
1954-1955	39,643	351,844	391,488	51,480	39,360	44,994	93,231	620,551	52.4
1955-1956	44,589	387,515	432,104	33,725	8,593	12,809	24,199	511,431	54.1
1956-1957	29,672	324,281	353,952	33,077	13,296	13,741	19,457	433,522	54.0
1957-1958	29,266	324,281	353,547	40,211	19,538	13,904	32,185	459,384	55.1
1958-1959	46,615	426,429	473,044	44,183	8,593	9,080	25,942	560,843	54.7
1959-1960	47,831	298,338	346,169	36,482	16,052	13,985	37,698	450,385	55.4
1960-1961	29,266	342,927	372,193	11,431	896	2,825	9,364	396,709	57.6
1961-1962	30,361	308,877	339,238	19,214	10,377	3,685	31,658	404,171	57.2
1962-1963	49,858	309,688	359,546	8,593	5,797	4,021	23,389	401,346	57.0
1963-1964	22,173	442,643	464,816	40,292	3,968	5,310	10,174	524,560	54.0
1964-1965	34,009	400,486	434,495	83,502	38,670	27,321	53,506	637,495	52.8
1965-1966	35,549	350,223	385,772	38,914	17,916	18,606	36,968	498,176	54.5
1966-1967	33,036	394,812	427,848	94,041	36,644	32,631	53,101	644,264	51.8
1967-1968	47,426	356,709	404,135	34,617	1,990	8,148	20,146	469,035	55.0
1968-1969	39,481	330,766	370,247	72,071	14,957	14,390	39,684	511,350	53.7
1969-1970	26,915	351,034	377,949	29,591	11,796	15,525	53,912	488,772	53.5
1970-1971	33,685	405,351	439,035	29,672	10,661	9,647	23,146	512,161	54.0
1971-1972	43,373	442,643	486,015	65,099	11,107	11,147	18,606	591,974	53.5
1972-1973	27,321	253,749	281,070	12,079	843	4,783	11,147	309,923	58.3
1973-1974	53,101	402,108	455,209	27,969	10,944	9,607	42,156	545,886	53.8
1974-1975	20,268	475,882	496,149	95,663	19,457	22,092	37,292	670,653	52.1
1975-1976	60,397	351,844	412,242	30,320	11,958	13,985	36,765	505,270	54.7
1976-1977	19,011	222,943	241,954	9,242	499	2,371	5,148	259,214	62.7
1977-1978	29,510	375,355	404,864	81,881	15,079	11,552	27,523	540,900	53.5
1978-1979	30,482	300,770	331,253	77,503	19,051	19,254	43,778	490,839	53.2
1979-1980	18,281	336,441	354,722	24,240	867	4,037	13,539	397,406	56.3
1980-1981	54,317	327,523	381,840	27,726	511	3,608	7,337	421,021	54.7
1981-1982	23,186	334,009	357,195	44,670	15,728	14,633	46,615	478,841	53.8
1982-1983	24,321	262,667	286,988	11,269	1,889	7,175	17,916	325,237	58.0
1983-1984	33,685	274,017	307,702	7,377	380	2,225	4,824	322,508	60.1
1984-1985	20,470	337,252	357,722	13,863	8,634	8,431	17,227	405,878	57.9
1985-1986	66,883	303,202	370,085	23,672	38,062	30,482	43,373	505,675	55.8
1986-1987	35,103	302,392	337,495	14,106	12,687	14,755	32,266	411,309	56.8
1987-1988	15,971	254,560	270,531	8,837	1,212	4,029	5,472	290,081	59.9
1988-1989	32,712	378,597	411,309	31,050	1,686	3,482	9,242	456,769	55.9
1989-1990	79,854	363,194	443,048	31,374	12,079	7,864	13,944	508,310	55.0
1990-1991	55,938	424,807	480,746	34,698	5,634	7,621	40,940	569,639	53.0
1991-1992	23,997	254,560	278,557	9,728	161	3,036	4,499	295,982	61.4
1992-1993	30,442	320,227	350,669	41,184	18,727	13,985	31,334	455,898	55.0
1993-1994	32,347	269,153	301,500	58,857	11,431	13,944	39,684	425,415	54.5
1994-1995	37,454	415,890	453,344	60,073	1,524	7,175	10,174	532,290	52.7
1995-1996	94,852	254,560	349,412	61,208	27,726	32,185	68,504	539,035	43.4
1996-1997	38,143	436,968	475,111	48,885	18,606	25,537	77,827	645,967	53.6
1997-1998	25,294	308,066	333,360	21,889	1,374	4,905	7,904	369,433	55.8
1998-1999	24,564	343,737	368,302	17,835	2,801	4,621	33,887	427,446	56.3
1999-2000	64,045	279,692	343,737	8,999	71	2,310	11,877	366,994	58.3
2000-2001	13,377	212,404	225,780	5,375	57	1,816	4,783	237,811	60.0
2001-2002	27,969	455,614	483,583	37,211	5,103	9,566	24,240	559,703	51.6
Average (1950-2002)	**37,711**	**350,391**	**388,103**	**39,428**	**12,336**	**12,989**	**32,705**	**485,561**	**54.35**
Median (1950-2002)	**33,036**	**342,927**	**372,193**	**34,617**	**10,661**	**9,647**	**31,334**	**490,839**	**54.16**

Table 11.5 – U.S. Entitlement at the International Boundary (based on historical IJC computations).

	St. Mary River			Milk River	Lodge Cr.	Battle Cr	Frenchman R.	TOTAL	U.S. Entitlement as % of Total
	Computed U.S. Entitlements								
source	IJC	IJC	IJC	IJC	IJC	IJC	IJC	IJC	
Water Year (Starting Nov.1)	Non-Irrigation Season (Nov to Mar)	Irrigation Season (Apr to Oct)	Total Annual	Irrigation Season* (Mar to Oct)	Irrigation Season* (Mar to Oct)	Irrigation Season* (Mar to Oct)	Irrigation Season* (Mar to Oct)	Note- does not include non-irrigation season for Milk, Lodge, Battle, Frenchman	
	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	%
1949-1950	48,237	321,038	369,274	85,934	7,256	9,647	37,819	509,931	46.6
1950-1951	70,531	372,112	442,643	183,218	25,537	14,552	55,533	721,484	48.3
1951-1952	41,346	200,243	241,589	124,848	65,261	55,938	180,381	668,018	47.5
1952-1953	31,253	336,441	367,694	162,140	15,484	18,889	37,454	601,662	48.1
1953-1954	31,293	332,388	363,681	102,959	5,270	16,579	44,589	533,077	46.8
1954-1955	39,643	237,535	277,179	107,823	39,360	44,994	93,231	562,586	47.5
1955-1956	44,589	265,099	309,688	78,881	8,593	12,809	24,199	434,171	45.9
1956-1957	29,672	221,321	250,993	71,666	13,296	13,741	19,457	369,153	46.0
1957-1958	29,266	205,918	235,184	72,720	19,538	13,904	32,185	373,531	44.8
1958-1959	46,615	287,799	334,414	85,124	8,593	9,080	25,942	463,154	45.2
1959-1960	47,831	184,029	231,861	61,938	16,052	13,985	37,698	361,532	44.5
1960-1961	29,266	223,754	253,020	26,591	896	2,825	9,364	292,696	42.5
1961-1962	30,361	186,461	216,822	39,319	10,377	3,685	31,658	301,861	42.8
1962-1963	49,858	201,054	250,912	19,214	5,797	4,021	23,389	303,332	43.0
1963-1964	22,173	321,038	343,210	84,313	3,968	5,310	10,174	446,976	46.0
1964-1965	34,009	270,774	304,783	146,737	38,670	27,321	53,506	571,017	47.2
1965-1966	35,549	226,996	262,546	79,935	17,916	18,606	36,968	415,971	45.5
1966-1967	33,036	286,988	320,024	157,276	36,644	32,631	53,101	599,676	48.2
1967-1968	47,426	227,807	275,233	78,314	1,990	8,148	20,146	383,831	45.0
1968-1969	39,481	212,404	251,885	119,173	14,957	14,390	39,684	440,089	46.3
1969-1970	26,915	248,075	274,990	68,666	11,796	15,525	53,912	424,889	46.5
1970-1971	33,685	284,556	318,241	74,017	10,661	9,647	23,146	435,711	46.0
1971-1972	43,373	310,499	353,871	119,984	11,107	11,147	18,606	514,714	46.5
1972-1973	27,321	153,223	180,543	23,997	843	4,783	11,147	221,313	41.7
1973-1974	53,101	286,988	340,089	66,640	10,944	9,607	42,156	469,437	46.2
1974-1975	20,268	354,276	374,544	167,004	19,457	22,092	37,292	620,389	48.2
1975-1976	60,397	229,428	289,826	65,099	11,958	13,985	36,765	417,633	45.2
1976-1977	19,011	106,202	125,213	20,916	499	2,371	5,148	154,147	37.3
1977-1978	29,510	245,642	275,152	141,062	15,079	11,552	27,523	470,369	46.5
1978-1979	30,482	194,568	225,051	124,037	19,051	19,254	43,778	431,171	46.7
1979-1980	18,281	214,836	233,117	56,344	867	4,037	13,539	307,904	43.7
1980-1981	54,317	219,700	274,017	64,208	511	3,608	7,337	349,680	45.4
1981-1982	23,186	222,132	245,318	88,366	15,728	14,633	46,615	410,661	46.2
1982-1983	24,321	157,276	181,597	26,429	1,889	7,175	17,916	235,006	41.9
1983-1984	33,685	158,897	192,582	14,187	380	2,225	4,824	214,199	39.9
1984-1985	20,470	206,729	227,199	33,806	8,634	8,431	17,227	295,298	42.1
1985-1986	66,883	175,111	241,994	47,669	38,062	30,482	43,373	401,581	44.3
1986-1987	35,103	184,840	219,943	33,158	12,687	14,755	32,266	312,809	43.2
1987-1988	15,971	147,548	163,518	20,268	1,212	4,029	5,472	194,499	40.1
1988-1989	32,712	249,696	282,408	63,640	1,686	3,482	9,242	360,458	44.1
1989-1990	79,854	235,103	314,957	66,640	12,079	7,864	13,944	415,484	45.0
1990-1991	55,938	308,877	364,816	85,124	5,634	7,621	40,940	504,135	46.9
1991-1992	23,997	132,955	156,952	21,808	161	3,036	4,499	186,456	38.6
1992-1993	30,442	190,515	220,957	89,177	18,727	13,985	31,334	374,179	45.1
1993-1994	32,347	163,762	196,109	93,231	11,431	13,944	39,684	354,398	45.4
1994-1995	37,454	295,906	333,360	125,659	1,524	7,175	10,174	477,892	47.3
1995-1996	94,852	254,560	349,412	101,338	27,726	32,185	68,504	579,165	46.6
1996-1997	38,143	306,445	344,589	92,420	18,606	25,537	77,827	558,979	46.4
1997-1998	25,294	204,297	229,591	48,480	1,374	4,905	7,904	292,254	44.2
1998-1999	24,564	222,132	246,696	44,426	2,801	4,621	33,887	332,432	43.7
1999-2000	64,045	165,383	229,428	19,700	71	2,310	11,877	263,386	41.8
2000-2001	13,377	126,469	139,846	12,242	57	1,816	4,783	158,743	40.0
2001-2002	27,969	340,495	368,464	118,362	5,103	9,566	24,240	525,735	48.5
Average (1950-2002)	**37,711**	**234,308**	**272,019**	**77,853**	**12,336**	**12,989**	**32,705**	**407,903**	**45.65**
Median (1950-2002)	**33,036**	**223,754**	**262,546**	**74,017**	**10,661**	**9,647**	**31,334**	**415,484**	**45.84**

11.4 Investigate and Confirm Operations and Maintenance Costs for Storage Projects

In 2003, Alberta Environment retained Klohn Crippen Consultants Ltd. to investigate both on-stream and off-stream storage alternatives in the Milk River Basin. Their report, *Past and Ongoing Water Management Investigations within Alberta,* initially summarized the costs in 2003 dollars associated with various water storage options as follows (Table 11.6):

Table 11.6 – Cost Summary for Alberta Milk River Basin Storage Projects.

Storage Option	Storage Capacity	Development Costs (2003 C$)	Ongoing Operations and Maintenance Costs (2003 C$)
Milk River Site 2 Dam (3 alternative sizes)	127,975 ac-ft up to 243,220 ac-ft	$106,000,000 to $123,400,000	$17,900,000 to $21,000,000
Shanks Lake	27,980 ac-ft	$35,900,000	$30,600,000
Lonely Valley			
- Alternative A	87,590 ac-ft	$88,700,000	$20,900,000
- Alternative B	85,979 ac-ft	$77,500,000	$18,200,000
Verdigris Lake	104,619 ac-ft	$64,900,000	$15,300,000
McDonald Creek	44,600 ac-ft	$60,100,000	$29,800,000

As the operations and maintenance costs provided appeared excessive relative to development costs, the Joint Initiative Project Team requested that they be investigated and confirmed. A re-examination of the consultants report indicates that the operation and maintenance costs indicated in Table 11.6 were in fact the accumulated operations and maintenance costs over the life of the projects and were presented in the above fashion to allow for a comparison of total costs to total benefits. The revised development costs, including land acquisition, and annual operations and maintenance costs are summarized in Table 11.7.

Table 11.7 – Revised Cost Summary for Alberta Milk River Basin Storage Projects.

Storage Option	Storage Capacity	Development Costs (2003 C$)	Ongoing Annual Operations and Maintenance Costs (2003 C$)
Milk R. Site 2 Dam - Intermediate II	127,975 ac-ft up to 243,220 ac-ft	$105,950,000 $115,020,000	$352,000 $378,000
- High Level - Topographic Limit		$123,400,000	$411,000
Shanks Lake	27,980 ac-ft	$35,930,000	$646,000
Lonely Valley - Alternative A	87,590 ac-ft	$88,730,000	$296,000
- Alternative B	85,979 ac-ft	$77,480,000	$249,000
Verdigris Lake	104,619 ac-ft	$64,940,000	$214,000
McDonald Creek	44,600 ac-ft	$60,129,000	$353,000

11.5 Channel Conveyance Losses within Milk River through Alberta

The sharing of the waters of the Milk River between Canada and the U.S. is based on the natural flow for the Milk River at the Eastern Crossing of the International Boundary. The flow of the Milk River at the Eastern Crossing has been significantly altered by upstream human activities, including:

i. U.S. diversions from the St. Mary River into the Milk River,

ii. Canadian consumptive uses, and

iii. Enhanced channel conveyance losses (evaporation from a larger surface area, seepage from a higher level of flow, etc) associated with the conveyance of U.S. water over more than 150 miles across southern Alberta.

Thus, complex computational procedures have been developed to estimate the natural flow that would have occurred in the absence of human activity.

During the 1980s and 1990s, there were a number of instances in which the natural flow computational procedures generated a "negative" natural flow, thereby indicating an error in the estimation of one or more of the parameters used in the procedures. To address this error, in 2003 the IJC Field Officers created the Milk River Technical Working Group (MRTWG) to review and report on potential improvements to the natural flow computational procedures for the Milk River. As one of the more likely potential sources of the error was deemed to be the estimate of channel conveyance losses (both natural and enhanced), two synoptic surveys (in which an attempt is made to measure the same block of water at a number of locations as it travels along a stream) were carried out in 2007 to assess and improve the accuracy of current estimates.

Quick Facts

- **An inter-agency technical working group is reviewing the current procedures for estimating channel losses due to seepage, consumptive use, and natural and enhanced evaporation along the Milk River as it flows across Canada.**
- **If significant changes are identified, the natural flow computation procedures may be revised with some fine-tuning to the computed natural flow.**

The MRTWG subsequently appointed Environment Canada (EC) to review the data collected and to report on what, if any, improvements in the estimation of channel losses may be suggested by the field data. The Joint Initiative Team requested that the Technical Team report on the status of this study. Environment Canada has reported that they expect to complete the initial assessment of the data and provide a report for the consideration of the MRTWG by the fall of 2009. The preliminary results would then be reviewed by the MRTWG (AB, MT, USBR, EC, and USGS) for technical merit. If the MRTWG has no concerns, it would then make a recommendation to the IJC Field Officers that the necessary changes be made to the Milk River Natural Flow computation procedures.

It is important to note that this study will not create any new water within the Milk River. Rather, what the study hopes to achieve is a refinement in the current estimates of channel losses (seepage, natural and enhanced evaporation) along the Milk River as it flows across Canada. If significant changes in gains or losses to flows in the Milk River are identified, the natural flow computation procedures probably would be revised to account for these. The end result might be some fine-tuning to the computed natural flow and likely a minor adjustment to the amount of Milk River natural flow which each country receives.

11.6 What Quantity of U.S. St. Mary River Entitlements that are not Diverted and Flowing into Canada are (1) being put to beneficial use, and (2) being spilled?

11.6.1 Quantity of U.S. St. Mary River Entitlements not Diverted that Flow into Canada

The quantity of U.S. St. Mary River entitlements that are not being diverted into the Milk River Basin and flow into Canada was presented in Section 11.2 and summarized in Table11.2. Table 11.8 below provides a summary of the quantity of U.S. St. Mary entitlements not being diverted and flowing into Canada during wet and dry years for the more recent years (1985-2002).

Table 11.8 – Quantity of U.S. St. Mary Entitlements not Diverted and Flowing into Canada.

Water Year	U.S. Entitlements (ac-ft)	U.S Diversions (ac-ft)	U.S Entitlements not Diverted and Flowing into Canada (ac-ft)
Dry Years			
1986-1987	219,943	177,517	42,426
1987-1988	163,518	177,153	-13,635
1991-1992	156,952	137,617	19335
1993-1994	196,109	162,709	33,400
2000-2001	139,846	131,122	8,724
Mean	**175,274**	**157,224**	**18,050**
Average Years			
1988-1989	282,408	277,452	4,956
1992-1993	220,957	188,073	32,883
1997-1998	229,591	214,210	15,381
1998-1999	246,696	179,577	67,120
1999-2000	229,428	178,700	50,729
Mean	**241,816**	**207,602**	**34,214**
Wet Years			
1989-1990	314,957	206,868	108,000
1990-1991	364,816	218,415	146,401
1994-1995	333,360	85,535	247,826
1995-1996	349,412	149,802	200,330
1996-1997	344,589	172,506	172,083
2001-2002	368,464	152,412	216,052
Mean	**345,933**	**164,256**	**181,782**

As indicated in Table 11.8, the quantity of U.S. St. Mary entitlements which Montana (the USBR) did not divert during the 1985-2002 period was about 18,000 ac-ft during dry years, 34,000 ac-ft during average years and 182,000 ac-ft during wet years. It is believed that since the implementation of the Letter of Intent in 2001, Montana is able to divert and use an even greater portion of its entitlement. However, there is insufficient data for verification. Further, this period, including the period since the implementation of the Letter of Intent, may not reflect all current management practices. Thus, a more detailed assessment, using a model which reflects all current practices, will be required to truly answer the question posed by the Joint Initiative Team.

11.6.2 Quantity of U.S. St. Mary River Entitlements not diverted put to beneficial use and being spilled.

As indicated in Section 9.3, Alberta has an extensive and complex water management system which captures, stores, and diverts water from the Waterton and Belly Rivers to the St. Mary Reservoir (Figure 11.2) where it is stored along with waters from the St. Mary River. Water stored within the St. Mary Reservoir is subsequently diverted to the various irrigation projects and to additional reservoirs internal to the irrigation district. It is also released to meet in-stream flow requirements downstream of the reservoir. At times, water entering the reservoir exceeds its storage capacity and it is spilled. The quantity spilled from the St. Mary Reservoir is dependent on the quantity entering from the St. Mary River and on the quantity being diverted into the reservoir from the Waterton-Belly headworks system.

During the 1968 to 1995 period, the quantity of water diverted from the Waterton and Belly Rivers to the St. Mary River has averaged about 256,000 ac-ft per year, although it has varied from 76,000 ac-ft to over 530,000 ac-ft. During this same period, Alberta's combined spills and releases from St. Mary Reservoir averaged about 290,000 ac-ft per year, although they varied from a low of about 66,000 ac-ft to over 800,000 ac-ft.

Quick Fact

- **A cursory analysis indicates that in all but one year, Alberta has or could have spilled to Saskatchewan all the water that Montana spilled to Canada. However, if more detailed examination is required a more detailed model is required.**

Within this context, it is difficult to obtain a precise accounting as to the quantities of Waterton and Belly water as opposed to U.S. St. Mary entitlements not diverted and flowing into Canada that were being spilled versus waters that were beneficially used. For the purposes of this discussion, beneficially used water will be considered that moving through the Alberta irrigation system plus that which is released specifically for instream flow needs downstream of St. Mary Reservoir. Spilled water will be considered all other water that flows through the St. Mary Dam, no matter whether it is released through the outlet works or flows over the dam spillway.

Not-withstanding the above noted limitation, a cursory estimate of the quantity of U.S. St. Mary entitlements not diverted within the U.S., flowing across into Canada, and subsequently spilled by Alberta to Saskatchewan was carried out for the 1968-2002 period using historical recorded flows. The 1968 to 2002 period represents the period since completion date of the current Waterton-St. Mary system and therefore it is reasonably representative of near current operations. However, it does not include the recent years (which includes years since the time when the Letter of Intent has been implemented) as natural flows, which can be used to determine local inflows, have not been developed. The results are summarized in Table 11.9

Table 11.9, column 8, identifies the quantity of U.S. St. Mary Entitlements which the U.S. did not divert that flowed into Canada and into the St. Mary Reservoir. Column 12 identifies the annual spills from the St. Mary Reservoir after the removal of releases required to maintain the instream flow needs below the St. Mary Reservoir. As shown in column 13, in all years except two (1976-77, and 1983-84), Alberta has spilled more water from the St. Mary Reservoir to Saskatchewan than the U.S. entitlements which were not diverted by the U.S and flowed into Canada.

During one of these two years (1983-84), additional water from the Waterton and Belly Rivers, which was being spilled into those systems, could have been diverted to the St. Mary thereby increasing the spill from the St. Mary Reservoir to Saskatchewan. This excess water from the Waterton and Belly Rivers ultimately spilled to Saskatchewan.

This cursory analysis indicates that in all but one year, Alberta has or could have spilled to Saskatchewan all the water that Montana spilled to Canada. If further information is required, it is recommended that operations for years subsequent to 2002 be included in the analysis when the data becomes available and that a more detailed model be used for the assessment.

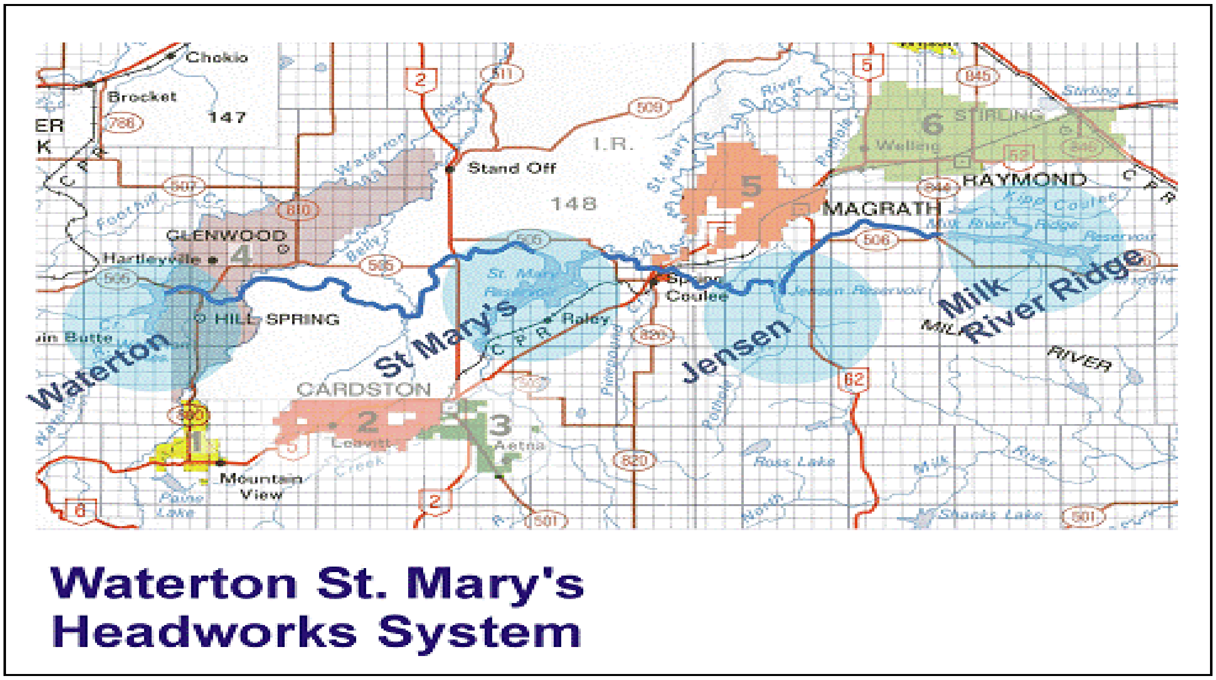

Figure 11.2 – Waterton-St. Mary Headworks System.

Table 11.9 – Quantity of U.S. St. Mary River entitlements that are not diverted, flow into Canada and are subsequently spilled by Alberta to Saskatchewan.

Column 1	Column 2	Column 3	Column 4	Column 5		Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13
	Computed Natural Flow		**U.S Entitlements**				**U.S. Diversions**	**U.S. St Mary Entitlements not Diverted (Col. 6 - Col.7)**	**Recorded Flow**	**Local Inflow**	**Canadian IFN Releases**	**Canadian Spills**	**U.S. St Mary Entitlements not Diverted by U.S and not Spilled**
Source	IJC	IJC	IJC	50%			USGS and WSC						
Water Year (Starting Nov.1)	Non-Irrigation Season (Nov to Mar)	Irrigation Season (Apr to Oct)	Irrigation Season	Non-Irrigation Season		Total	USGS St.# 05018500, WSC St. # 05AE029		WSC St. St. Mary @ Lethbridge	St Mary Dam to Lethbridge	97 cfs release from St. Mary Dam	**Col. 9 - Col. 10 - col.11**	
	ac-ft	ac-ft	ac-ft	ac-ft		ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft	ac-ft
1967-1968	94,852	721,000	281,000	47,426		328,426	266461	61,965	259,105	19,670	70,396	169,038	0
1968-1969	78,962	670,000	262,000	39,481		301,481	206725	94,756	399,424	30,851	70,396	298,177	0
1969-1970	53,831	599,108	248,075	26,915	0	274,990	165,684	109,306	236,616	7,099	70,396	159,121	0
1970-1971	67,369	689,907	284,556	33,685	0	318,241	165,030	153,211	373,194	14,126	70,396	288,672	0
1971-1972	86,745	753,141	310,499	43,373	0	353,871	201,947	151,924	582,267	43,871	70,396	468,000	0
1972-1973	54,641	406,972	153,223	27,321	0	180,543	152,795	27,748	126,921	-	70,396	56,525	0
1973-1974	106,202	689,096	286,988	53,101	0	340,089	206,074	134,016	276,519	6,755	70,396	199,368	0
1974-1975	40,535	826,915	354,276	20,268	0	374,544	99,191	275,353	864,390	37,170	70,396	756,823	0
1975-1976	120,794	581,273	229,428	60,397	0	289,826	207,222	82,604	277,152	16,238	70,396	190,518	0
1976-1977	38,022	329,145	106,202	19,011	0	125,213	101,951	23,262	70,152	-	70,152	0	23,262
1977-1978	59,019	621,808	245,642	29,510	0	275,152	101,320	173,832	506,289	19,125	70,396	416,768	0
1978-1979	60,965	496,149	194,568	30,482	0	225,051	129,083	95,968	348,031	34,898	70,396	242,737	0
1979-1980	36,563	551,277	214,836	18,281	0	233,117	199,468	33,649	243,086	12,047	70,396	160,643	0
1980-1981	108,634	547,223	219,700	54,317	0	274,017	231,835	42,182	293,364	9,202	70,396	213,766	0
1981-1982	46,372	556,141	222,132	23,186	0	245,318	99,411	145,907	243,124	11,902	70,396	160,826	0
1982-1983	48,642	419,943	157,276	24,321	0	181,597	178,524	3,073	109,191	-	70,396	38,795	0
1983-1984	67,369	432,914	158,897	33,685	0	192,582	164,063	28,519	66,304	-	66,304	0	28,519
1984-1985	40,940	543,981	206,729	20,470	0	227,199	215,658	11,541	84,963	-	70,396	14,567	0
1985-1986	133,766	477,503	175,111	66,883	0	241,994	135,679	106,315	292,307	4,390	70,396	217,522	0
1986-1987	70,207	487,231	184,840	35,103	0	219,943	177,517	42,426	183,532	7,758	70,396	105,378	0
1987-1988	31,942	402,108	147,548	15,971	0	163,518	177,153	-13,635	81,499	-	70,396	11,103	0
1988-1989	65,424	628,293	249,696	32,712	0	282,408	277,452	4,956	114,011	5,799	70,396	37,817	0
1989-1990	159,708	598,298	235,103	79,854	0	314,957	206,868	108,090	323,057	-	70,396	252,661	0
1990-1991	111,877	733,685	308,877	55,938	0	364,816	218,415	146,401	515,340	10,224	70,396	434,720	0
1991-1992	47,994	387,515	132,955	23,997	0	156,952	137,617	19,335	113,299	-	70,396	42,903	0
1992-1993	60,884	510,742	190,515	30,442	0	220,957	188,073	32,883	563,415	30,050	70,396	462,969	0
1993-1994	64,694	432,914	163,762	32,347	0	196,109	162,709	33,400	296,761	10,964	70,396	215,402	0
1994-1995	74,909	711,796	295,906	37,454	0	333,360	85,535	247,826	609,031	38,218	70,396	500,417	0
1995-1996	189,704	632,347	254,560	94,852	0	349,412	149,082	200,330	516,158	-	70,396	445,762	0
1996-1997	76,287	743,413	306,445	38,143	0	344,589	172,506	172,083	373,983	-	70,396	303,587	0
1997-1998	50,588	512,363	204,297	25,294	0	229,591	214,210	15,381	227,360	-	70,396	156,964	0
1998-1999	49,128	565,869	222,132	24,564	0	246,696	179,577	67,120	209,049	-	70,396	138,653	0
1999-2000	128,091	444,264	165,383	64,045	0	229,428	178,700	50,729	207,883	-	70,396	137,487	0
2000-2001	26,753	338,873	126,469	13,377	0	139,846	131,122	8,724	89,194	-	70,396	18,798	0
2001-2002	55,938	795,298	340,495	27,969	0	368,464	152,412	216,052	417,031	-	70,396	346,635	0

11.7 Glacial Contributions to St. Mary River Flows

Quick Fact

- **The total area of glaciers in the Milk-St. Mary River system is small. As such, while these glaciers are receding, their eventual loss will have a minor impact on river flow, with most of the impact being in the late-summer of low-flow years.**

A question was asked concerning what we know and understand about how glaciers affect the St. Mary River system. The surface area of named glaciers in the St. Mary River watershed is about 2.1 mi^2. Including small un-named glaciers and perennial snow and ice fields might almost double this figure. In any case, glaciers and other snow and ice fields probably make up less than 1.5 percent of the 276 mi^2 drainage area of the St. Mary River near Babb.

The glaciers in the park are shrinking. In Glacier National Park, there has been a 73% reduction in the area covered by glaciers (USGS 2004). Some predictions are that the glaciers will be gone by 2030 or 2050. Other predictions are that glaciers in shaded areas might persist as much smaller perennial snowfields. Photos 11.1 and 11.2 depict the wasting of the Grinnell Glacier, which is above Sherburne Reservoir, from 1938 to 2006.

As glaciers and perennial ice and snow fields waste away, the water that was stored in them contributes to streamflows. When the wasting of glacial ice is complete, this water that has come out of ice storage will not be replenished and will no longer be available to supplement streamflows. There has not been research specifically to determine how significant the glacial and perennial snow and ice contribution is to streamflows in the St. Mary watershed. Given that snow and ice comprise less than 1.5 percent of the watershed area and that the glaciers in the park are relatively thin, it doesn't appear that the wastage of glacial ice is a large relative contributor to St. Mary River flows.

The next nearest concentration of glaciers is in the Banff area and north in the Canadian Rockies in Alberta. The contributions of glacial melt water to the flows of the Bow River have been investigated by Young (1996). Young found that in the Bow River watershed, glaciers make up about 3.3 percent of the watershed area. On average, about 2.5 percent of the streamflow of the Bow River at Banff is derived from wasting glaciers. However, in the five lowest flow years, glacial wastage accounted for 7.8 to 16.8 percent of the flow. Glacial wastage was a proportionally larger contributor to streamflows during the late summer. During August, on average 7.5 percent of the flow in the Bow River was from glacial wastage.

Because the glaciers in the St. Mary River watershed make up a smaller percentage of the watershed area and are less massive than those in the Bow River Valley, it is likely that their contributions to St. Mary River flows are proportionately much less than those described above. From a water volume standpoint, however, the potential loss of water might not be entirely negligible. For instance, if the glacial wastage were contributing one percent to the average flow of about 550,000 ac-ft of the St. Mary River near Babb, the loss of flow would be about 5,500 ac-ft per year. In addition, the largest losses would likely occur late in the summer, when flows are generally near seasonal lows.

Grinnell Glacier

Photo 11.1 Grinnell Glacier, 1938.
Photo: T.J. Hileman, (GNP Archives)

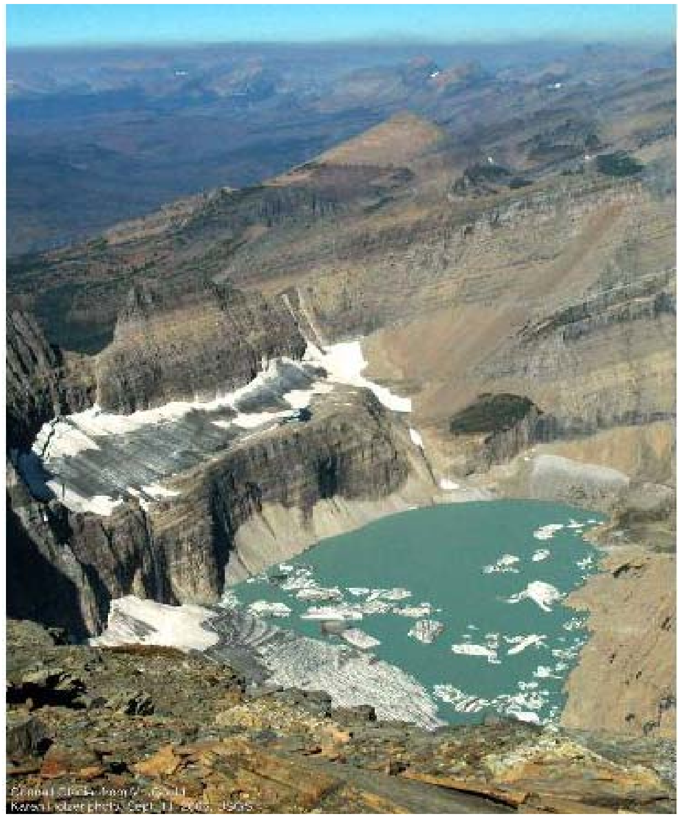

Photo 11.2 Grinnell Glacier, 2006.
Photo: Karen Holzer, USGS

References

U.S. Geological Survey 2004. *Glacier Monitoring in Glacier National Park*. http:/www/nrmsc.usgs.gov/research/glaciers.htm.

Young, G. J. 1996. *Contribution of Glacier Melt Water to Flow of the Bow River, Phase 1 (b)*. Final report to Alberta Department of Environmental Protection. Edmonton, AB.

12. In Summary

Larry Dolan, Hydrologist, Montana Department of Natural Resources and Conservation
Sal Figliuzzi, P.Eng. Section Head, Transboundary Water Policy Branch, Alberta Environment

The waters of the St. Mary and Milk Rivers, important to irrigators and other users in these basins, have been shared by Alberta and Montana for nearly a century. The St. Mary River originates in western Montana and flows northward into Alberta. At its confluence with the Oldman River, it drains an area of about 1,360 mi^2 and carries a mean annual natural flow of about 700,000 ac-ft. The Milk River also originates in Montana and flows north into Canada. However, it then turns southeast back into eastern Montana. At its confluence with the Missouri, it has a drainage area of 23,000 mi^2, and a mean annual recorded flow of 464,000 ac-ft. (including U.S. St. Mary diversions minus Canadian and U.S. consumption).

Like all watersheds, these rivers are influenced by climate. As they flow east, temperatures rise and mean annual precipitation tends to decrease, with 40-50 inches in the mountainous west declining to less than 15 inches in semi-arid eastern Montana. Net evaporative losses from reservoirs and other waterbodies range from 11 inches to 20 inches. Impacting agriculture, average annual crop water deficits range from 11.6 inches to 23.8 inches.

The total area of glaciers in this system is relatively small. As such, while these glaciers are receding, their eventual loss will likely have only a small impact on river flow. Of greater influence on flows are tributaries, storage infrastructure and diversions. Primary tributaries to the St. Mary River include the Swift Current and Kennedy Creeks in the U.S. and Lee Creek in Canada. Water from the Waterton and the Belly Rivers is also diverted into the St. Mary Reservoir. However, at the International Boundary and Lethbridge, recorded flows of the St. Mary River are lower than naturalized flows due to reservoir operations and irrigation diversions.

Primary northern tributaries of the Milk River include Lodge Creek, Battle Creek and the Frenchman River. Major southern tributaries include Big Sandy, Clear, Peoples, and Beaver Creeks, which are entirely in Montana. Tributaries make a significant contribution to the flows in the Milk River in wet years but may be minimal in a dry year. Upstream of the Eastern Crossing into Montana, flow of the Milk River is primarily influenced by U.S. diversions from the St. Mary River which tend to stabilize flows during the irrigation season in Alberta. Downstream of the Eastern Crossing, it is significantly influenced by irrigation diversions and reservoir storage.

The sharing of the waters of the Milk and St. Mary Rivers are governed by the 1909 *Boundary Waters Treaty* overseen by the International Joint Commission. In 1921, the IJC issued an *Order* which specifies how the St. Mary and Milk Rivers are to be apportioned. Each country's entitlements are based on the natural flow at the International Boundary, computed daily and balanced bi-monthly. At the annual general meeting, the data and computed apportionment balances for the previous year are reviewed and approved by the Canadian and U.S. Field Officers and by representatives for Alberta and Montana.

In Alberta, the sharing of the waters of the South Saskatchewan River, including the contributions by its tributary the St. Mary River, with Saskatchewan and Manitoba is governed by the *Master Agreement on Apportionment.* This agreement requires each province to permit one-half of the natural flow of each watercourse to flow into the downstream province. Similarly, Montana utilizes "compacts" or agreements to establish water entitlements with federal agencies and Indian Tribes claiming federal reserved water rights.

Montana water rights are based on the principle of Prior Appropriation. Alberta water rights are based on Prior Allocation. In times of shortages, both systems rely on the “first-in-time, first-in-right” principle, where those first acquiring a right have priority in receiving available supplies over those coming later.

In Alberta, the *Water Act* (1999) enables the management of water use under licensed allocations. Alberta Environment is the provincial government department responsible for the management of water use and allocations. In Alberta, the St. Mary and Milk River Basins are largely allocated. The St. Mary River is subject to a Water Conservation Objective established in 2005 as 45% of natural flow. No Instream Objective exists for the Milk River. However, the Milk River Watershed Council Canada is currently (2009) developing a water conservation objective.

In 1973, the *Montana Water Use Act* established an adjudication process for determining priorities among Water Rights Claims existing prior to July 1, 1973 and a permit system for obtaining new water rights. The Montana Department of Natural Resources and Conservation is responsible for the management of the permitting system and some aspects of the adjudication process. In Montana, there are no state-based instream flow water rights on the mainstem of the St. Mary or Milk Rivers. The conveyance of irrigation water, minimum releases from Fresno Reservoir, and irrigation return flows maintain instream flows in many segments of the Milk River.

The U.S. government recognized the need for supplemental irrigation water in the Milk River Basin as early as the 1890s. Construction of the 29-mile U.S. St. Mary Canal, diverting water from the St. Mary River to the Milk River, started in 1906. Designed for a capacity of 850 cfs, the U.S. St. Mary Canal currently conveys up to 675 cfs. In Montana, a system of dams, dikes and pumping stations delivers water to a number of irrigation districts, contract pumpers and private licence-holders to irrigate about 145,000 acres. The U.S. St. Mary Canal and infrastructure is nearly a century old and is beginning to show its age. The U.S. has not been able to capture and divert its full entitlement from the St. Mary River although U.S. diversions have improved form 54% of entitlements during the 1919-1960 period to 70% of during the 1961-2002 period. The failure of any of the systems numerous components (siphons, drops, etc.) could leave many Montana Milk River irrigators with little water and cause considerable damage downstream. A complete rehabilitation of the U.S. St. Mary Canal is estimated to cost $153 million and take ten years to complete.

In Alberta, the Government of Canada built the Waterton-St. Mary Headworks system capable of capturing and storing up to 390,000 ac-ft of the flow in the Waterton, Belly and St. Mary Rivers. This, in combination with off-stream storage within the St. Mary project, provides over 1,100,000 ac-ft of storage. This is conveyed across more than 1,500 miles of canals to supply water to over 500,000 acres of irrigated lands.

Studies have been undertaken by both jurisdictions to examine how to provide a secure water supply for existing irrigators and to support the expansion of irrigated agriculture. These include looking at enhanced diversions/flows, increased storage, structural improvements (enlarging dams, adding canals, etc) as well as improvements to on-farm conservation and improved efficiencies. In addition, both jurisdictions use a variety of models to operate and assess the potential implication and performance of various planning alternatives and to support water allocations decisions.

To continue this tradition of continuous improvement and knowledge building, both jurisdictions have agreed to develop a single shared model for the entire St. Mary – Milk River system. A team has been formed to complete the model and to evaluate water management options proposed by the Joint Initiative Team. Future work to improve methods for conservation, efficiency and productivity and to incorporate the impacts of climate change may also be areas of further cooperation.

GLOSSARY

Allocation	The volume, rate and timing of a diversion of water.
Basin, Catchment or Watershed	A geographic area of land that drains to a common point or body of water.
Crop Water Deficit	The amount of additional water required to meet the requirements of a crop for optimum growth and production equal to the evapotranspiration (ET) of a crop minus the effective precipitation available to the crop over the growing season.
Diversion of Water	The impoundment storage, consumption taking or removal of water for any purpose, except the taking or removing for the sole purpose of removing an ice jam, drainage, flood control, erosion control or channel realignment and any other thing defined as a diversion in legislation and regulations.
Evapotranspiration (ET)	The return of moisture to the air through both of evaporation from the soil and transpiration by plants. AET = Actual Evapotranspiration PET = Potential Evapotranspiration
Instream Flow Needs	The scientifically determined amount of water, flow rate, water level or water quality that is required in a river or other body of water to sustain a healthy aquatic environment or to meet human needs such as recreation, navigation, waste assimilation or aesthetics.
Irrigation Storage	That part of the total reservoir storage that can be diverted for irrigation usage.
Live Storage	That part of the total reservoir storage that can be released from the reservoir.
Naturalized Flow	The river flow that would have occurred in the absence of any man-made effects. For the purposes of water management, natural flow is a calculated value based on the recorded flows of contributing rivers, a number of factors concerning the river reaches (*e.g.* evaporation, channel losses, etc.) and water diversions.
Probable Maximum Flood	The flood that might be expected as a result of a storm that produced the maximum amount of precipitation theoretically possible over a specific drainage area in combination with the most severe hydrologic conditions possible for that drainage.

Language Equivalents

Canada	United States
gauge	gage
licence (noun) or license (verb)	license

APPENDICES

Appendix A – Joint Initiative Team Terms of Reference

Montana – Alberta

St. Mary and Milk Rivers

Water Management Initiative

Terms of Reference

November 2008

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List of Appendices

1. Introduction, Background and Geography

Introduction
Montana and Alberta have shared the water of the St. Mary and Milk Rivers for one hundred years, under Article VI of the Boundary Waters Treaty (1909).

Montana and Alberta agree that the shared water of the St. Mary and Milk Rivers is an important resource to both jurisdictions.

Montana and Alberta believe there are opportunities for the two jurisdictions to work together to improve access to this shared water.

These terms of reference define the purpose, scope, principles, objectives, membership, code of conduct, and related process matters to guide the efficient functioning of the St. Mary and Milk Rivers water management joint initiative team (Joint Initiative Team).

The Joint Initiative Team will make recommendations to the governments of Montana and Alberta on options to increase the ability of each jurisdiction to better access the shared waters of the St. Mary and Milk River systems.

Background
In April 2003, Montana Governor Judy Martz requested the International Joint Commission (IJC) to undertake a review of the IJC 1921 Order pursuant to Article VI of the Boundary Waters Treaty, regarding the sharing of water between Canada and the United States. The IJC responded by forming a St. Mary / Milk Rivers Administrative Measures Task Force which issued a report in April 2006. The IJC also suggested that Montana and Alberta begin high level, cross-border discussions regarding the use and management of the shared waters.

This Initiative, in part, is in response to the IJC's request that Montana and Alberta seek opportunities to *"explore the fundamental and interrelated issues of collaboration on the use and management of transboundary waters, cooperation on the rehabilitation of the St. Mary Canal and future arrangements for increasing the ability of each country to better access the full amount of water available to it under the current apportionment."* (see Appendix 1)

The respective water management agencies have been instructed by their governments to work together to explore opportunities and to make recommendations for the consideration of both jurisdictions.

The United States has authorized the rehabilitation of the St. Mary Diversion Works and the reinvestment in this project represents a one time opportunity for both Montana and Alberta to improve the water infrastructure that connects the St. Mary and Milk Rivers.

The focus is on the water users in the St. Mary and Milk River watersheds and their access to the water at the time it is required.

Geography
This Initiative is defined by the watersheds of the St Mary River to its confluence with the Oldman River, and the Milk River to its confluence with the Missouri River, and includes the St. Mary River Irrigation Project, for the purpose of understanding use of St. Mary River water in Alberta.

The Initiative will not discuss management options that affect the water entitlement of the Province of Saskatchewan. However, if an option being evaluated has the potential to impact Saskatchewan's entitlement, then discussions will be held with Saskatchewan in a timely manner.

2. Purpose

The purpose of this Initiative is to explore and evaluate options for improving both Montana's and Alberta's access to the shared water of the St. Mary and Milk Rivers, and to make joint recommendation(s) on preferred options to both governments for their consideration and approval.

3. Scope

The Initiative will focus on the timing and access by both jurisdictions to their share of the water in the St. Mary and Milk Rivers, under Article VI of the Boundary Waters Treaty.

There are many uses for water within the St. Mary and Milk River basins, including municipal, power production, agriculture and in-stream flow needs for the environment. All uses will be considered when evaluating options, however, this initiative will focus on the two largest uses: irrigation and in-stream flow needs for the environment.

Recommendations to modify existing treaty instruments, including the Letter of Intent, the Administrative Procedures, and the 1921 Order, may be evaluated if those instruments present a barrier to implementing preferred options.

In addition, projects that could be jointly developed for benefit on both sides of the border should be evaluated, specifically, rehabilitation of the St. Mary Canal.

Out of scope
Changes to the Boundary Waters Treaty are not the focus of this Initiative.

Water quality and ecosystem health are implicated in any water sharing option and must be understood when recommending options, but are not the focus of this Initiative.

Water right compacts negotiated by the State of Montana, Blackfeet Tribal Government, Ft. Belknap Indian Community Tribal Government, and/or the US Government are not the focus of this Initiative.

Alberta's sharing of water with Saskatchewan under the Master Agreement on Apportionment is not part of this Initiative.

4. Principles

The Boundary Waters Treaty forms the foundation for sharing the water of the St. Mary and Milk Rivers.

The Joint Initiative Team will strive toward developing a dynamic, forward-looking, joint working relationship and aim to create enduring options for sharing the water of the St. Mary and Milk Rivers.

Water sharing options will consider implications for users in both watersheds.

Water sharing options will account for the special circumstances associated with low water years.

In evaluating options, the Joint Initiative Team must have an understanding of the procedures for managing water and making decisions in each jurisdiction.

All proposed options will be evaluated for compliance with the following treaty instruments, in the following order:

1. The Letter of Intent
2. The Administrative Procedures, and
3. The 1921 Order of the IJC

as follows:

- If the proposed options are beneficial and in accord with the treaty instruments, then the process can proceed.
- If the proposed options are beneficial but constrained by one or more of the treaty instruments, then recommendations will be made to enter into agreements that improve the instrument(s).

Options should seek to maximize and balance the long-term benefits to water users in both jurisdictions. Each jurisdiction is responsible for determining what constitutes its own long-term benefits.

Options may consider other tools that build on grass-roots cooperation and give decision makers the flexibility to meet the irrigation and in-stream flow needs of water users in both jurisdictions.

5. Objectives, Outcomes and Deliverables

Objectives

Participants in this Initiative will aim to develop a better understanding of the similarities and differences in how Montana and Alberta manage water.

This Initiative will work to identify constraints to improving access to the shared water, including differences in supply and demand; accounting for surpluses and deficits; and emerging uses.

This Initiative will link water management decision-making more closely with the needs of water users in both jurisdictions. Management flexibility is required to moderate the effects of the distinct and variable natural hydrographs in the St. Mary and Milk Rivers.

Outcomes
Montana and Alberta work together for the long-term benefit of water users and the environment in both jurisdictions.

Montana and Alberta develop an adaptive, dynamic, joint water management decision-making process driven by the needs of water users and the environment at the local level.

Opportunities for beneficial use of the water of the St. Mary and Milk River systems for people and the environment are maximized.

Water supplies for people and the environment are secured.

Montana and Alberta will recommend that the IJC closes its file on Montana's 2003 request to review the 1921 Order.

Deliverables
A report to be submitted to the governments of Montana and Alberta that:

- recommends projects, initiatives, tasks and administrative procedures necessary to improve access to the shared water,
- evaluates the options recommended and options not recommended, and
- includes a description of the positive and negative impacts, if any, associated with each option.

6. Membership and Responsibilities

Membership
Each jurisdiction will have an equal number of members that are appointed by the State and the Province from their respective jurisdictions. Membership will include those interests that will be directly affected by the Initiative. Co-chairs will be identified from the water management agencies in Montana and Alberta. Members will not be supported by alternates.

Montana	Alberta
Montana Department of Natural Resources & Conservation (co-chair) (1)	Alberta Environment (co-chair) (1)

Milk River – (2)	Oldman Watershed Council (2)
St. Mary – Blackfeet Tribe (1)	Milk River Watershed Council Canada (2)
Ft. Belknap Indian Community (1)	Alberta Agriculture and Rural Development (1)
State representative (Lt. Governor's office) (1)	Secretariat (1)
Secretariat (1)	

Additional Participants
There are other individuals and organizations that are necessary to either support the Initiative or that must be communicated with and made aware of it. They include technical support personnel, direct stakeholders, and those who will receive communication notices.

Participant Type	Organization
Technical Support	IJC Accredited Officer(s), U.S. Bureau of Reclamation, Montana Department of Natural Resources & Conservation, Blackfeet Tribal Agencies, U.S. Army Corps of Engineers, Alberta Environment, Alberta Agriculture and Rural Development, Alberta International and Intergovernmental Relations, Canadian federal departments, other agencies as needed.
Direct Stakeholders	U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, U.S. Geological Survey, Blackfeet Tribal Business Council, Ft. Belknap Tribal Business Council, membership of the U.S. St. Mary Rehabilitation Working Group. In Alberta, direct stakeholders are defined by the membership of the Oldman Watershed Council and Milk River Watershed Council Canada.
Communication Notice	International Joint Commission, Canadian federal departments, other Alberta Government Departments, U.S. Fish and Wildlife, Provincial Members of the Legislative Assembly.

Responsibilities
Members are expected to:

- Attend and participate in all meetings.
  - Members will notify their respective co-chair immediately if they are unable to attend a meeting.
  - Members will notify their co-chair with any concerns about an upcoming decision, if a scheduled decision is to be made at a meeting that the member cannot attend.
- Review relevant information and be prepared to fully participate in meetings.
- Fully explore and understand all the issues before reaching conclusions.
- Seek areas of agreement and uphold agreements that are reached.
- Explore all options and make recommendations.
- Seek the advice of their constituency throughout the process.
- Make every effort to represent and speak for their constituency by:

- o Objectively explaining and interpreting the process and its proposed outcome to their constituency
  - o Keeping their constituency informed of the activities and ideas emerging from the process
- Keep their respective hierarchy of decision-makers informed on progress and seek direction as required to support upcoming decisions and recommendations.
- Maintain their values and interests.

7. Code of Conduct and Procedures

Code of Conduct and Quorum
All participants are encouraged to contribute openly to this Initiative, as full and open contribution is important to building trustworthy relationships.

Quorum – All meetings must have a quorum of participants to proceed. A quorum is a minimum of four (4) representatives from each jurisdiction.

Participants will endeavour to:

- Support a fair, transparent and collaborative process
- Treat others with courtesy and respect
- Candidly identify and share their interests while maintaining an open mind to other's interests and the opportunity for compromise
- Listen carefully to each other, ask questions to understand and make statements to explain or educate
- Challenge ideas, not people
- Share relevant information regarding the issues under consideration, and further agree to respect the need for confidentiality of certain types of information
- Let opposing views co-exist but focus on collective goals
- Speak in terms of interests (underlying concerns) rather than positions (predetermined solutions)
- Be concise, and stay on topic
- Use a "parking lot" for issues that are external to the day's agenda

Procedures for finding agreement
The Joint Initiative Team will seek consensus on all decisions and recommendations.

Consensus will be measured by asking participants how they feel about a particular recommendation, proposal or action according to the following method.

Level of Support	Signified by	Meaning
1	Thumbs Up	I agree and will support this recommendation, proposal, or action.
2	Thumbs	I'm neutral or may not prefer this recommendation,

	Sideways	proposal, or action but I will support it, either because it's not important enough to block, or because it seems to be the best solution at this time, and we reached a conclusion fairly and deliberately.
3	Thumbs Down	I cannot support this recommendation, proposal or action, but here is my suggestion on how the group might move past or address this disagreement or impasse.

Consensus is reached if all participants respond with either 1 or 2, and the Team can proceed.

When participants disagree with a recommendation, proposal, or action or choose support level 3, they should articulate their concern to the larger group, and provide a constructive alternative(s) that seeks to accommodate the interests of all participants.

The Joint Initiative Team will continue with this procedure until consensus is achieved or the group decides to disagree.

Procedures in the event of not reaching consensus
If the Joint Initiative Team has tried in good faith but is still unable to reach consensus, and still wants to move forward on the recommendation, proposal, or action at hand, they may use the following fallback mechanisms:

- Define the issue (issue: a subject of discussion, negotiation or problem solving – the *what,* the problem to be solved)
- Identify interests (interest: one party's concerns, needs or desires underlying the issue – *why* the issue is being raised [interests may be mutual or separate]. This is the motivation to solve the problem.)
- Brainstorm options for moving ahead (option: potential – often partial – solutions to meet one or more interests – *how* the problem might be solved)
- Identify standards (standard: agreed upon qualities of an acceptable solution – that is – *how well* an option solves the problem)
- Evaluate options
- Choose an option

If the Team is unable to reach agreement on an issue, further follow-up may be assigned to a task group. The task group will attempt to develop additional proposals or actions to resolve the issue and report its recommendations to the Team.

When appropriate, external resources may be engaged to provide an independent opinion.

If none of the above helps the Joint Initiative Team make progress, the Team will seek further direction from the governments of both jurisdictions.

8. Tasks and Resources

Tasks will include:

	Task	Resources
	Collect background materials (maps, reports, models)	Joint Technical Support Team
	Develop information on aggregate water supply, actual use, and demand by sector	Joint Technical Support Team
	Develop information on and recommend an appropriate hydrological modeling software	Joint Technical Support Team
	Evaluate options to improve access to the shared water for both jurisdictions	Joint Initiative Team
	Recommend options improve access to the shared water for both jurisdictions	Joint Initiative Team

9. Schedule

Phase 2 is to start in December 2008 and be completed by April 1, 2010, to provide its first recommendations to the governments of Montana and Alberta. This leaves time for further review and analysis to be undertaken later in 2010.

The elapsed time for Initiative completion should be about 18 months, as follows:

- Learning Phase - Approximately 3 meetings over 3 months. This phase will have considerable technical support needs.
- Options Evaluation Phase – Approximately 3 or 4 meetings over 9-12 months.
- Recommendations Phase – Approximately 3 meetings over 3 months.

10. Budget

The budget for this Initiative falls within the operational budget of each jurisdiction.

International Joint Commission
Canada and United States

Commission mixte internationale
Canada et États-Unis

October 19, 2007

The Honorable Brian A. Schweitzer
Governor of Montana
Helena, MT 59620-0801

Premier Ed Stelmach
Office of the Premier
Room 307, Legislature Building
10800 – 97th Avenue
Edmonton, AB T5K 2B6

Dear Governor Schweitzer:

Dear Premier Stelmach:

On July 20, as a follow up to our meetings with each of you, we sent the draft of a letter, that ultimately would be directed to you, to contacts we had in your respective governments. The purpose of sending the draft (enclosed) was to seek comments on how we might improve the formal letter to the two of you. Feedback regarding our draft has been quite positive. It has included the Governor's direct response (enclosed) as well as verbal comments from Alberta. We thank you both for the prompt and serious consideration given to our draft.

Clearly there is a shared interest in beginning Governor/Premier level discussions concerning the use and management of the St. Mary/Milk Rivers. We are pleased that this is the case. We continue to believe that the approach outlined in our draft provides the best opportunity for real progress now and into the future. In particular, we think that an early initial meeting between the two of you can set the process in motion and lead to your establishment of a small group to explore the fundamental and interrelated issues of collaboration on the use and management of transboundary waters, cooperation on the rehabilitation of the St. Mary Canal, and future arrangements for increasing the ability of each country to better access the full amount of water available to it under the current apportionment. We also think that this group should initially be composed of senior officials from Montana and Alberta who have your confidence and the U.S.–Canada St. Mary and Milk Rivers field representatives who are responsible for implementing the current apportionment.

While it is important that this group be asked to report back to you in fairly short order, the experience of the group, which could be referred to as an "interim watershed council", could point the way to more comprehensive consultations or arrangements in the future.

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Thank you again for meeting with us earlier this year to discuss the extremely important issues regarding water use in the St. Mary and Milk Rivers basins. All Commissioners and staff are available to provide you with additional information or any other support you might find to be helpful.

Sincerely,

The Honorable Allen I. Olson
Commisioner, U.S. Section

The Honorable Jack Blaney
Commissioner, Canadian Section

Enclosures

Appendix B – Typical and Statistical temperatures and precipitation of some weather stations across the Milk and St. Mary River Basins in Montana and Alberta.

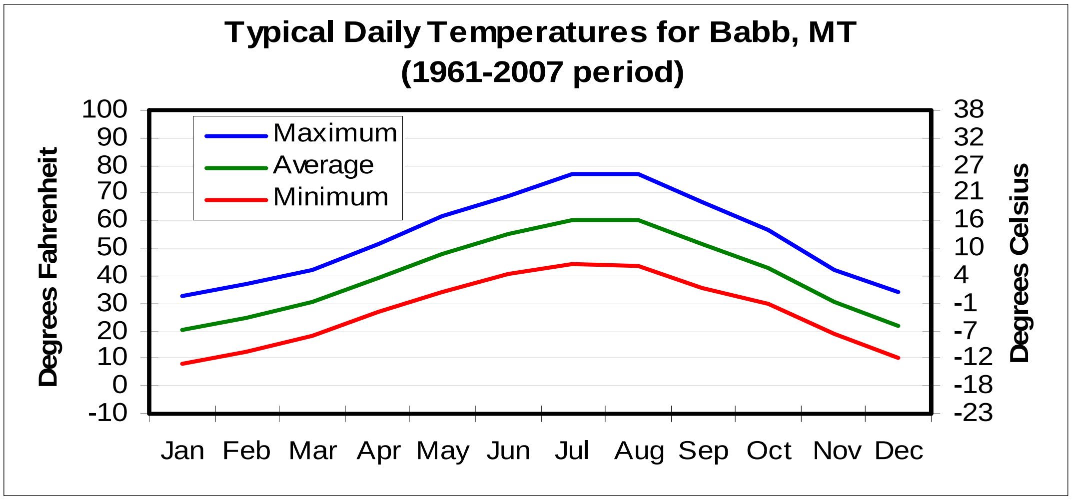

Figure B.1 - Typical daily temperature ranges for Babb, MT (source data: Western Regional Climate Center, wrcc@dri.edu).

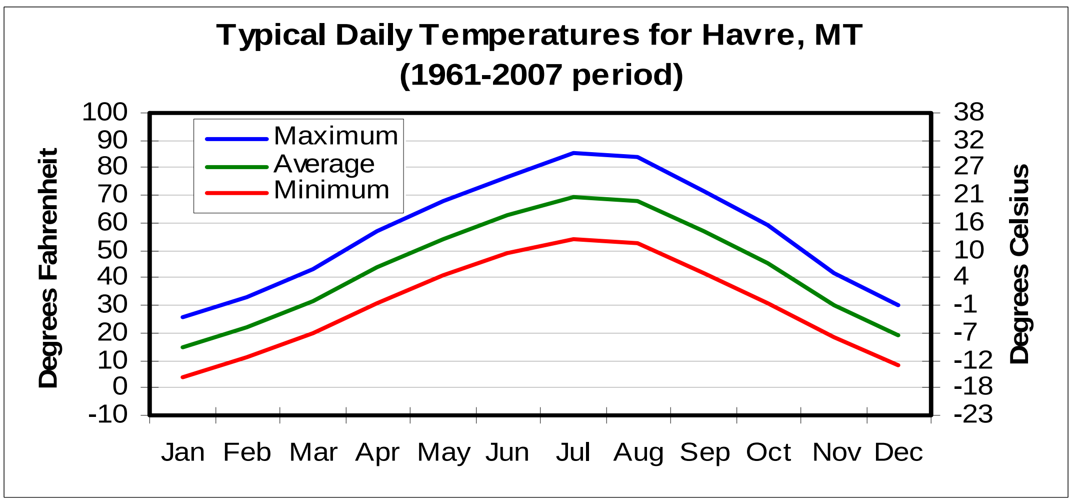

Figure B.2 - Typical daily temperature ranges for Havre, MT (source data: Western Regional Climate Center, wrcc@dri.edu).

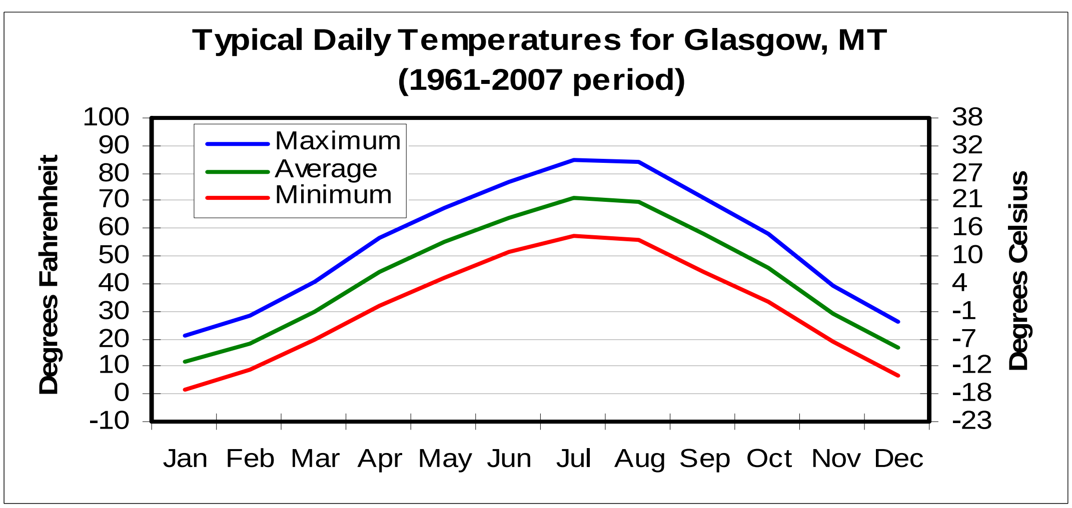

Figure B.3 - Typical daily temperature ranges for Glasgow, MT (source data: Western Regional Climate Center, wrcc@dri.edu).

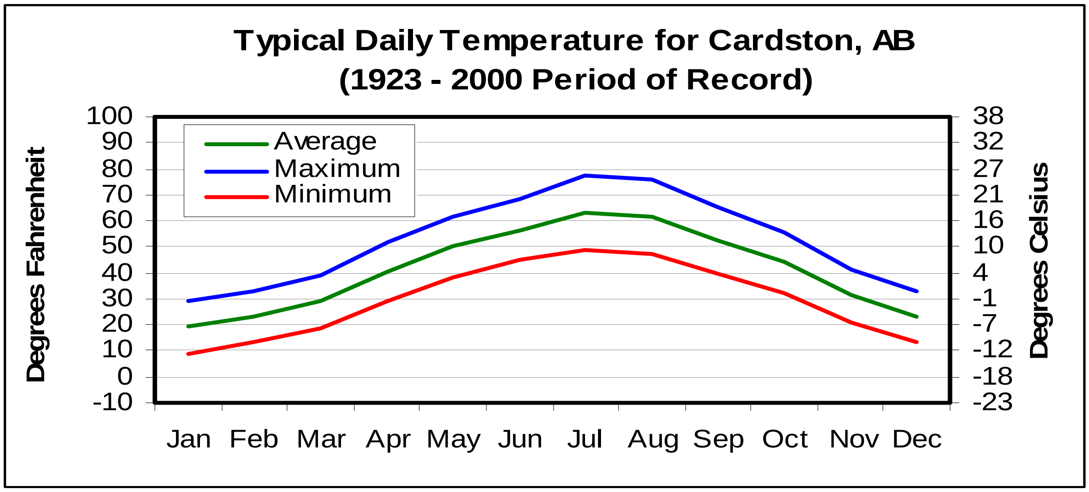

Figure B.4 - Typical daily temperature ranges for Cardston, AB. (Source data: Alberta Environment AENV_HYDSTRA TSM)

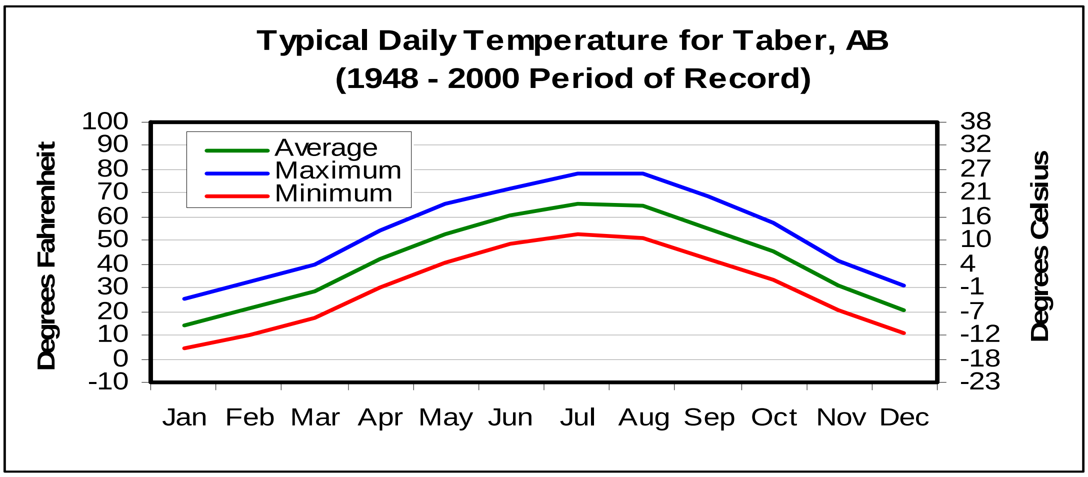

Figure B.5 - Typical daily temperature ranges for Taber, AB. (Source data: Alberta Environment AENV_HYDSTRA TSM)

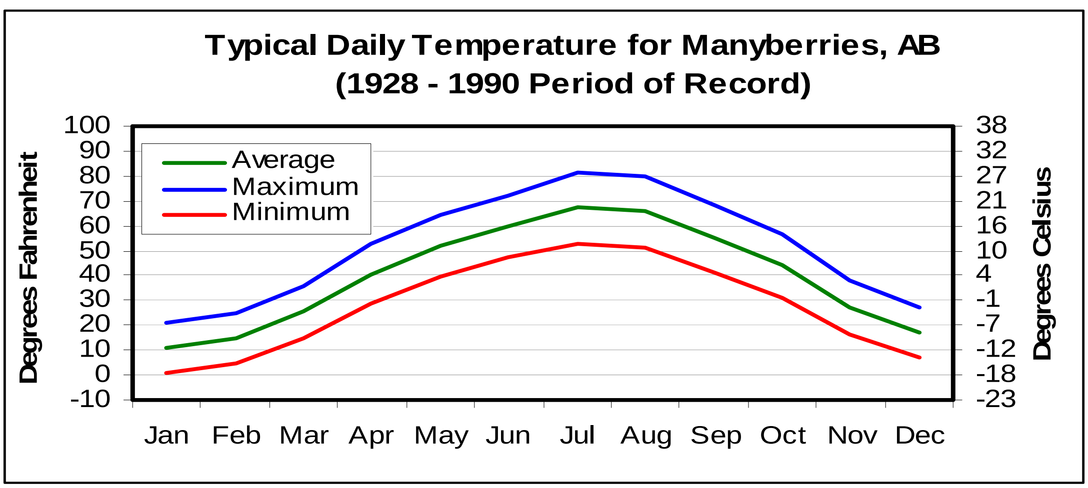

Figure B.6 - Typical daily temperature ranges for Manyberries, AB. (Source data: Alberta Environment AENV_HYDSTRA TSM)

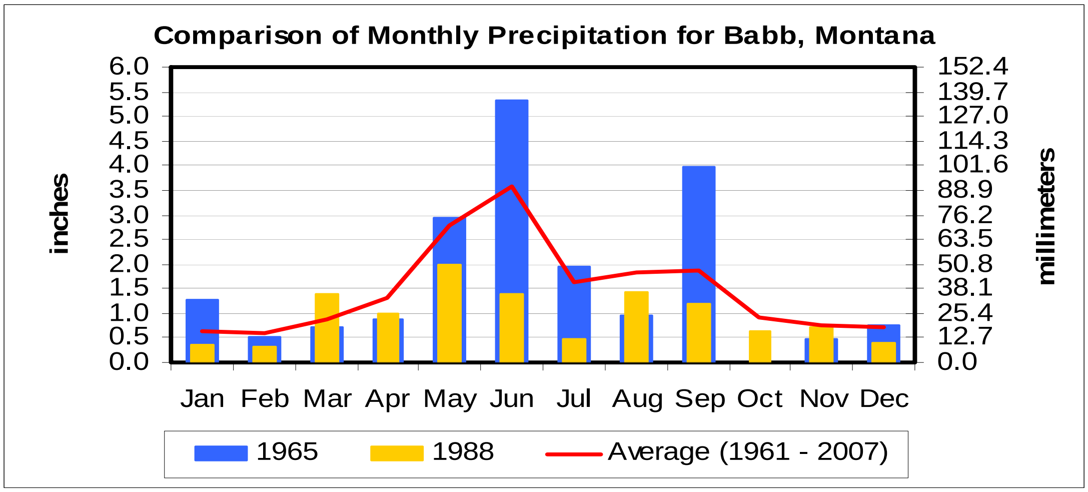

Figure B.7 – Comparison of Monthly Precipitation for Babb, MT., (source data: Western Regional Climate Center, wrcc@dri.edu).

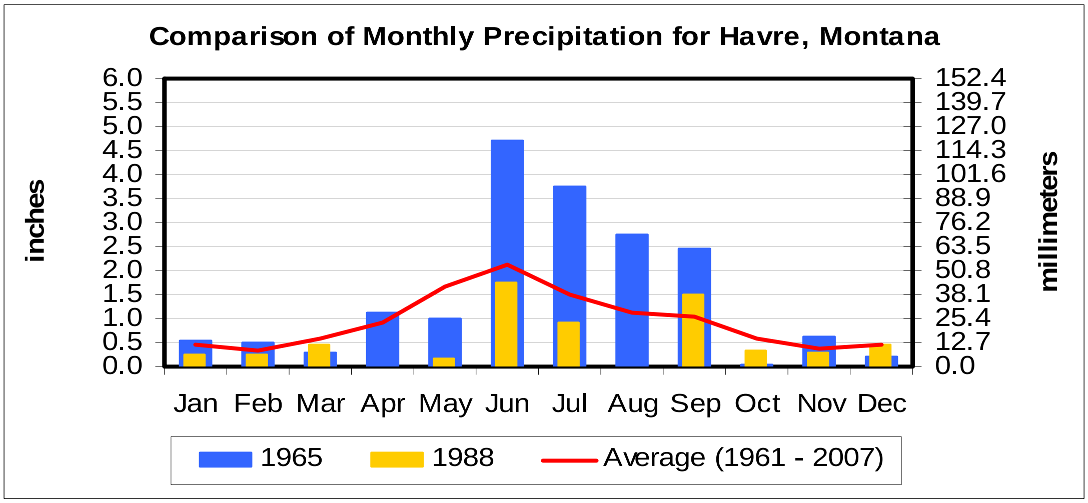

Figure B.8 – Comparison of Monthly Precipitation for Havre, MT., (source data: Western Regional Climate Center, wrcc@dri.edu).

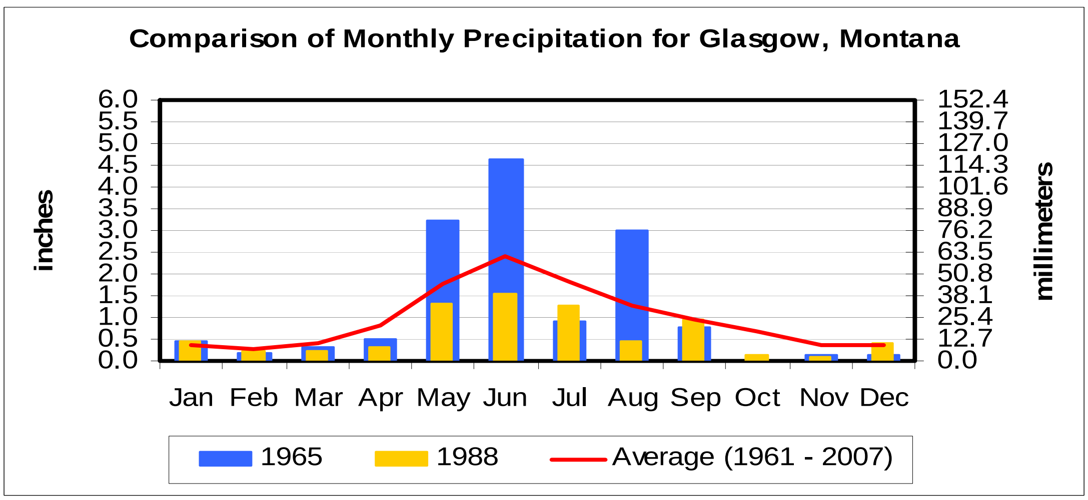

Figure B.9 – Comparison of Monthly Precipitation for Glasgow, MT., (source data: Western Regional Climate Center, wrcc@dri.edu).

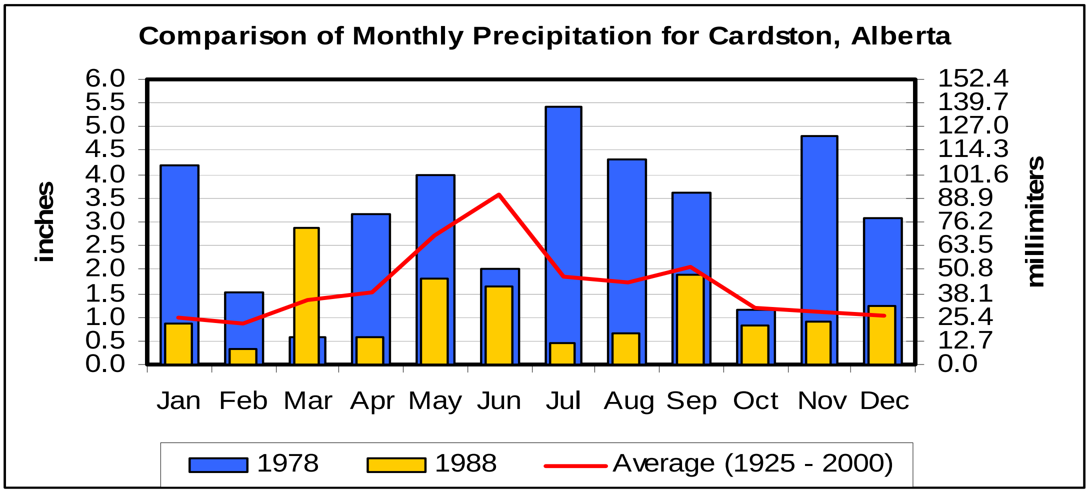

Figure B.10 – Comparison of Monthly Precipitation for Cardston, AB., (Source data: Alberta Environment AENV_HYDSTRA TSM).

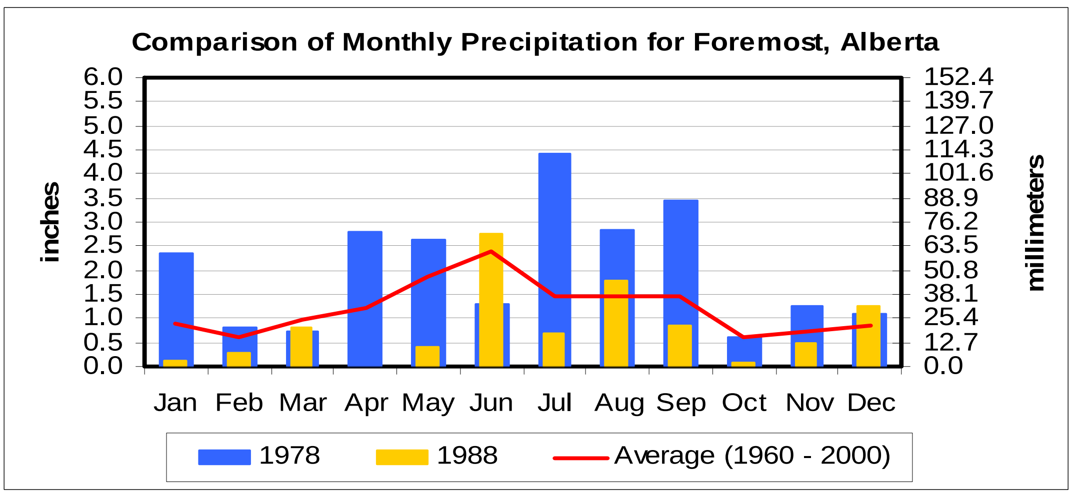

Figure B.11 – Comparison of Monthly Precipitation for Formost, AB., (Source data: Alberta Environment AENV_HYDSTRA TSM).

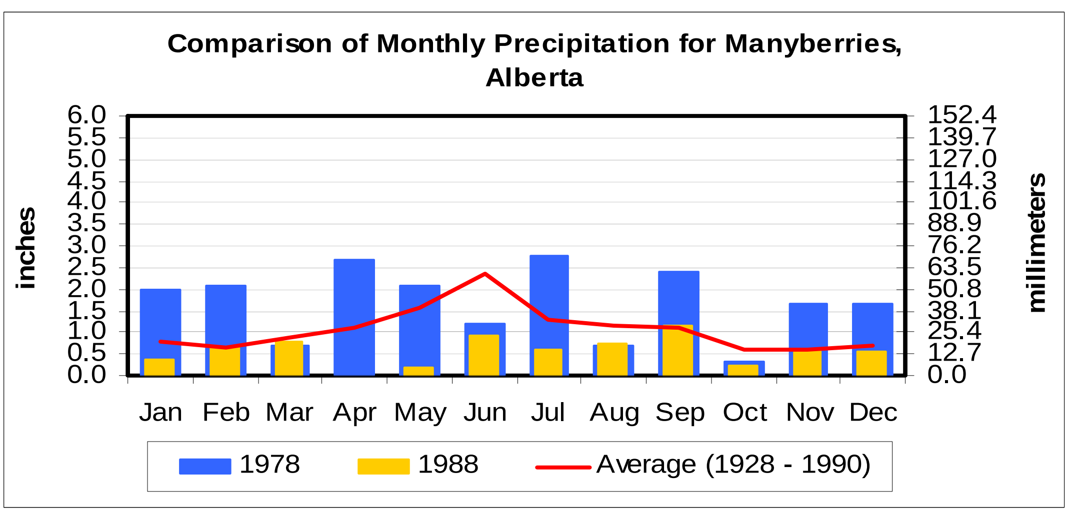

Figure B.12 – Comparison of Monthly Precipitation for Manyberries, AB., (Source data: Alberta Environment AENV_HYDSTRA TSM).

Table B.1 Precipitation summary for Montana Stations (source data: Western Regional Climate Center, wrcc@dri.edu).

Total Monthly Precipitation (mm)

Month	Babb, MT 1906 to 2007			Havre, MT 1961 to 2007			Glasgow, MT 1955 to 2007		
	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Jan	0.0	20.8	77.2	0.0	11.4	59.2	0.0	9.4	31.5
Feb	0.0	19.1	69.6	0.0	8.6	26.4	0.8	7.1	24.6
Mar	0.0	25.4	80.3	0.8	14.5	51.6	1.3	9.9	32.3
Apr	0.8	37.3	121.4	0.0	23.4	65.8	1.8	20.1	50.5
May	2.5	67.6	257.6	0.0	42.4	126.7	0.8	44.2	167.9
Jun	7.1	88.9	252.0	4.1	54.4	133.9	2.3	61.5	136.1
Jul	0.0	45.5	234.2	0.3	37.6	136.7	0.3	43.9	150.6
Aug	0.0	47.5	150.9	0.0	28.4	113.5	0.0	31.8	145.8
Sep	0.0	49.0	154.9	1.0	26.9	146.3	1.0	22.9	105.2
Oct	0.0	26.4	117.1	0.8	14.5	52.3	0.0	16.8	77.5
Nov	0.0	21.3	105.2	0.0	9.7	31.2	0.0	9.7	38.9
Dec	0.3	20.8	103.9	0.3	11.2	51.8	0.3	8.6	26.2
Total		469.6			283.0			285.8	

Total Monthly Precipitation (Inches)

Month	Babb, MT 1906 to 2007			Havre, MT 1961 to 2007			Glasgow, MT 1955 to 2007		
	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Jan	0.0	0.82	3.04	0.0	0.45	2.33	0.0	0.37	1.24
Feb	0.0	0.75	2.74	0.0	0.34	1.04	0.03	0.28	0.97
Mar	0.0	1.0	3.16	0.03	0.57	2.03	0.05	0.39	1.27
Apr	0.03	1.47	4.78	0.0	0.92	2.59	0.07	0.79	1.99
May	0.1	2.66	10.14	0.0	1.67	4.99	0.03	1.74	6.61
Jun	0.28	3.5	9.92	0.16	2.14	5.27	0.09	2.42	5.36
Jul	0.0	1.79	9.22	0.01	1.48	5.38	0.01	1.73	5.93
Aug	0.0	1.87	5.94	0.0	1.12	4.47	0.0	1.25	5.74
Sep	0.0	1.93	6.1	0.04	1.06	5.76	0.04	0.9	4.14
Oct	0.0	1.04	4.61	0.03	0.57	2.06	0.0	0.66	3.05
Nov	0.0	0.84	4.14	0.0	0.38	1.23	0.0	0.38	1.53
Dec	0.01	0.82	4.09	0.01	0.44	2.04	0.01	0.34	1.03
Total		**18.5**			**11.1**			**11.3**	

Table B.2 Precipitation summary for Alberta Stations (Source data: Alberta Environment AENV_HYDSTRA TSM).

Total Monthly Precipitation (mm)

Month	Cardston, AB 1928 to 1990			Taber, AB 1948 to 1990			Manyberries, AB 1928 to 1990		
	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Jan	0.0	25.9	106.1	2.0	25.0	78.1	0.0	20.1	62.1
Feb	1.3	23.3	71.5	0.5	17.6	50.6	1.0	16.7	81.8
Mar	10.0	33.9	97.5	0.0	23.1	44.4	0.3	21.9	97.8
Apr	3.5	38.7	137.9	0.0	31.6	138.7	0.0	27.8	139.9
May	5.5	66.3	253.8	5.3	45.1	133.3	3.1	40.1	138.8
Jun	12.5	88.4	243.2	8.8	62.3	190.0	6.4	60.0	185.1
Jul	1.5	45.7	154.2	8.9	36.1	117.4	0.8	33.3	114.8
Aug	0.0	44.9	153.7	2.5	36.6	119.0	0.5	29.6	99.1
Sep	0.0	48.8	192.3	2.8	34.9	130.2	0.0	28.3	180.8
Oct	0.0	28.4	118.2	0.0	15.8	52.6	0.0	15.3	54.7
Nov	0.0	26.9	122.5	1.3	17.5	55.8	0.0	15.1	54.9
Dec	0.0	27.3	78.5	0.0	22.3	66.4	2.5	18.0	62.2
Total		498.5			367.8			326.3	

Total Monthly Precipitation (Inches)

Month	Cardston, AB 1928 to 1990			Taber, AB 1948 to 1990			Manyberries, AB 1928 to 1990		
	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
Jan	0.0	1.0	4.2	0.1	1.0	3.1	0.0	0.8	2.4
Feb	0.1	0.9	2.8	0.0	0.7	2.0	0.0	0.7	3.2
Mar	0.4	1.3	3.8	0.0	0.9	1.7	0.0	0.9	3.9
Apr	0.1	1.5	5.4	0.0	1.2	5.5	0.0	1.1	5.5
May	0.2	2.6	10.0	0.2	1.8	5.2	0.1	1.6	5.5
Jun	0.5	3.5	9.6	0.3	2.5	7.5	0.3	2.4	7.3
Jul	0.1	1.8	6.1	0.4	1.4	4.6	0.0	1.3	4.5
Aug	0.0	1.8	6.1	0.1	1.4	4.7	0.0	1.2	3.9
Sep	0.0	1.9	7.6	0.1	1.4	5.1	0.0	1.1	7.1
Oct	0.0	1.1	4.7	0.0	0.6	2.1	0.0	0.6	2.2
Nov	0.0	1.1	4.8	0.1	0.7	2.2	0.0	0.6	2.2
Dec	0.0	1.1	3.1	0.0	0.9	2.6	0.1	0.7	2.4
Total		19.6			14.5			12.8	

Appendix C - Additional statistics on stream flows for stations in the St. Mary and Milk River watersheds.

Flow Summaries

The following tables contain streamflow statistics for representative stations in the Montana and Alberta portions of the St. Mary and Milk River watersheds. The streamflows are presented as percentile exceedence values, averages, and maximum and minimums. Percentile exceedence flows are the monthly flow values that are equaled or exceeded the stated percent of the time. For instance, the 80th percentile exceedence flow is representative of a low flow because flows in the stream are equal or higher during 80 percent (4/5) of the time. The 20th percentile exceedence flow would be a higher flow that is only equaled or exceeded during about 20 percent (1/5) of the time. The 50th percentile flow is the median or middle flow, because half of the time flows would be above it, and the other half of the time flows would be below it. The average, maximum and minimum monthly average flows also are presented. These percentile exceedence flows essentially represent the range of variability in the monthly flows.

For gauge stations in Montana, the source data used to compute these flow statistics were from the United States Geological Survey (USGS). For recorded data at Alberta gauges, Water Survey of Canada (WSC) data was used to compute the statistics of each gauge. In other cases, estimated "natural" flows are presented, which have been produced using stream gauging station data and modeling to remove the effects of reservoir operations and irrigation withdrawals.

St. Mary River Basin

Table C.1 - Upper St. Mary River above Swift Current Creek, estimated natural flow distributions for 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	302	248	375	529	1959	3879	2107	842	633	591	951	721
20th	138	138	121	371	1,535	2,653	1,440	600	423	374	315	173
50th(median)	100	87.9	96.5	263	1178	2004	1131	473	280	262	168	101
80th	68.6	63.9	66.7	112	970	1,555	749	347	223	122	103	79.6
Minimum	36.2	32.8	37.8	77.9	734	971	484	232	118	50.3	45.0	36.1
Average	108	101	107	259	1,222	2,089	1,136	485	316	260	237	140

Upper St. Mary River in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	8.55	7.02	10.6	15.0	55.4	109.8	59.6	23.8	17.9	16.7	26.9	20.4
20th	3.90	3.91	3.42	10.5	43.5	75.1	40.8	17.0	12.0	10.6	8.91	4.91
50th(median)	2.82	2.49	2.73	7.45	33.3	56.7	32.0	13.4	7.93	7.40	4.76	2.85
80th	1.94	1.81	1.89	3.17	27.5	44.0	21.2	9.83	6.31	3.46	2.92	2.25
Minimum	1.02	0.93	1.07	2.20	20.8	27.5	13.7	6.56	3.35	1.42	1.27	1.02
Average	3.05	2.85	3.03	7.33	34.6	59.1	32.1	13.7	8.94	7.36	6.70	3.97

Table C.2 - Swift Current Creek at Sherburne Reservoir, estimated total natural inflows for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	138	111	168	298	751	1,252	613	283	328	271	340	163
20th	55.9	58.9	72.8	235	649	904	441	195	158	169	139	67.9
50th(median)	40.1	31.1	42.0	174	517	672	343	153	93.9	93.5	74.7	45.6
80th	29.3	25.6	27.6	94.9	429	486	239	114	74.2	54.4	45.2	36.0
Minimum	16.3	16.9	20.4	29.3	342	329	151	66.9	37.1	24.3	15.9	25.0
Average	47.2	42.5	51.8	165.3	534	698	343	157	120	111	101	58.1

Swift Current Creek in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	3.89	3.14	4.76	8.43	21.2	35.4	17.4	8.00	9.27	7.67	9.63	4.62
20th	1.58	1.67	2.06	6.66	18.4	25.6	12.5	5.51	4.48	4.77	3.93	1.92
50th(median)	1.13	0.88	1.19	4.92	14.6	19.0	9.71	4.34	2.66	2.64	2.11	1.29
80th	0.83	0.72	0.78	2.68	12.1	13.8	6.76	3.22	2.10	1.54	1.28	1.02
Minimum	0.46	0.48	0.58	0.83	9.68	9.31	4.27	1.89	1.05	0.69	0.45	0.71
Average	1.34	1.20	1.47	4.68	15.1	19.8	9.69	4.43	3.40	3.13	2.86	1.64

Table C.3 - St. Mary River at the International Boundary streamflow statistics based on recorded USGS streamflow data for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	377	373	512	1,077	1,633	5,941	1,244	1,065	1,191	988	1,423	844
20th	186	209	235	565	1,946	3,229	1,540	657	612	556	381	215
50th(median)	129	127	158	396	1,380	1,966	1,023	499	357	328	226	145
80th	91	92	100	233	1,003	1,332	741	391	283	186	139	114
Minimum	56.9	43.0	54.7	136	803	837	496	246	153	88.4	80.3	64.3
Average	144	145	182	417	1,461	2,305	1,159	537	441	382	318	192

St. Mary River at International Boundary in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	10.7	10.6	14.5	30.5	46.2	168.1	35.2	30.1	33.7	28.0	40.3	23.9
20th	5.26	5.90	6.65	16.0	55.1	91.4	43.6	18.6	17.3	15.7	10.8	6.08
50th(median)	3.65	3.60	4.46	11.2	39.1	55.6	29.0	14.1	10.1	9.3	6.40	4.10
80th	2.57	2.60	2.84	6.6	28.4	37.7	21.0	11.1	8.02	5.27	3.94	3.23
Minimum	1.61	1.22	1.55	3.86	22.7	23.7	14.0	6.97	4.32	2.50	2.27	1.82
Average	4.09	4.11	5.15	11.8	41.3	65.2	32.8	15.2	12.5	10.8	9.01	5.44

Table C.4 - St. Mary River at the International Boundary estimated natural streamflows for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	462	483	666	1,070	3,052	6,428	3,047	1,200	1,065	1,023	1,436	984
20^{th}	239	260	288	786	2,630	4,302	2,141	945	690	629	492	283
50^{th}(median)	168	161	196	562	2,039	3,042	1,650	696	447	438	298	188
80^{th}	116	119	148	336	1,709	2,221	1,057	529	376	236	210	157
Minimum	75.8	58.9	76.0	167	1,271	1,362	730	377	192	112	96.3	174.1
Average	191	187	232	568	2,112	3,247	1,672	732	521	454	401	244

St. Mary River estimated natural flows in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	13.1	13.7	18.9	30.3	86.4	182	86.2	34.0	30.1	28.9	40.6	27.8
20^{th}	6.76	7.37	8.14	22.2	74.4	122	60.6	26.8	19.5	17.8	13.91	8.02
50^{th}(median)	4.74	4.57	5.54	15.9	57.7	86.1	46.7	19.7	12.7	12.4	8.45	5.33
80^{th}	3.28	3.37	4.18	9.51	48.4	62.9	29.9	15.0	10.6	6.67	5.94	4.45
Average	5.41	5.28	6.55	16.1	59.8	91.9	47.3	20.7	14.7	12.8	11.4	6.92
Minimum	2.15	1.67	2.15	4.73	36.0	38.6	20.7	10.7	5.43	3.18	2.72	4.93

Table C.5 - St. Mary River At hydrometric station 05AE006 near Lethbridge observed streamflows for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	4	15	19	27	23	41	48	37	30	35	22	2
20^{th}	185	206	417	457	1,415	2,085	836	414	451	410	323	228
50^{th}(median)	107	121	148	135	877	1,048	322	201	142	192	155	112
80^{th}	31	50	58	75	112	166	117	103	77	74	78	34
Minimum	439	476	1,318	1,266	3,742	6,772	2,447	1,362	2,170	1,309	1,369	1,002
Average	4	15	19	27	23	41	48	37	30	35	22	2

St. Mary River at hydrometric station 05AE006 near Lethbridge in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	12.4	13.5	37.3	35.9	106.0	191.8	69.3	38.6	61.5	37.1	38.8	28.4
20^{th}	5.2	5.8	11.8	13.0	40.1	59.0	23.7	11.7	12.8	11.6	9.1	6.5
50^{th}(median)	3.0	3.4	4.2	3.8	24.8	29.7	9.1	5.7	4.0	5.4	4.4	3.2
80^{th}	0.9	1.4	1.6	2.1	3.2	4.7	3.3	2.9	2.2	2.1	2.2	1.0
Minimum	0.1	0.4	0.5	0.8	0.7	1.2	1.4	1.1	0.8	1.0	0.6	0.1
Average	3.5	3.9	7.7	9.0	25.6	38.7	15.9	7.9	9.6	8.0	7.6	4.8

Table C.6 - St. Mary River Naturalized Monthly flows at hydrometric station 05AE006 near Lethbridge streamflows for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	556	733	1,745	1,478	3,807	7,217	3,494	1,355	1,377	1,044	1,382	858
20th	267	333	681	962	2,834	4,491	2,352	1,013	733	668	523	302
50th(median)	171	209	316	744	2,200	3,178	1,764	752	424	481	313	180
80th	130	151	195	431	1,687	2,260	1,186	512	313	252	191	145
Minimum	71	50	125	235	1,156	1,189	592	198	61	149	94	51
Average	208	255	454	749	2,292	3,476	1,799	754	518	488	402	243

St. Mary River Naturalized Monthly flows at hydrometric station 05AE006 near Lethbridge in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	15.8	20.8	49.4	41.8	107.8	204.4	98.9	38.4	39.0	29.6	39.1	24.3
20th	7.6	9.4	19.3	27.2	80.3	127.2	66.6	28.7	20.8	18.9	14.8	8.5
50th(median)	4.9	5.9	9.0	21.1	62.3	90.0	49.9	21.3	12.0	13.6	8.9	5.1
80th	3.7	4.3	5.5	12.2	47.8	64.0	33.6	14.5	8.9	7.1	5.4	4.1
Minimum	2.0	1.4	3.5	6.7	32.7	33.7	16.8	5.6	1.7	4.2	2.7	1.4
Average	5.9	7.2	12.9	21.2	64.9	98.4	51.0	21.3	14.7	13.8	11.4	6.9

Milk River Basin

Table C.7 - South Fork of the Milk River near Babb streamflow statistics based on recorded USGS streamflow data for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum			135.6	153.2	238.8	465.3	96.6	42.6	43.8	37.0		
20th			52.8	98.7	139.3	119.6	52.0	26.4	24.9	22.5		
50th(median)			23.6	61.6	68.9	69.5	33.5	17.2	11.2	16.3		
80th			10.9	33.3	41.1	27.5	13.5	5.9	6.0	8.5		
Minimum			5.8	20.7	10.2	0.9	0.0	0.4	0.2	5.1		
Average			31.8	66.9	86.8	87.7	37.0	17.2	15.0	16.7		

South Fork of Milk River in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum			3.84	4.34	6.76	13.17	2.73	1.21	1.24	1.05		
20th			1.50	2.79	3.94	3.38	1.47	0.75	0.71	0.64		
50th(median)			0.67	1.74	1.95	1.97	0.95	0.49	0.32	0.46		
80th			0.31	0.94	1.16	0.78	0.38	0.17	0.17	0.24		
Minimum			0.16	0.59	0.29	0.03	0.00	0.01	0.01	0.14		
Average			0.90	1.89	2.46	2.48	1.05	0.49	0.42	0.47		

Table C.8 - North Fork of the Milk River above the St. Mary Canal streamflow statistics based on recorded USGS streamflow data for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum			72.1	111.7	163.8	147.4	101.4	61.9	49.6	55.0		
20th			35.3	43.7	48.4	37.6	27.3	21.5	25.1	25.3		
50th(median)			18.2	29.8	30.0	20.3	15.7	13.6	14.4	15.2		
80th			14.9	16.6	13.9	11.2	9.7	8.1	10.0	10.8		
Minimum			8.1	13.1	10.0	7.0	4.1	4.9	6.3	7.0		
Average			24.4	32.9	34.9	27.4	19.3	16.1	17.2	18.5		

North Fork of Milk River in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum			2.04	3.16	4.64	4.17	2.87	1.75	1.40	1.56		
20th			1.00	1.24	1.37	1.06	0.77	0.61	0.71	0.72		
50th(median)			0.52	0.84	0.85	0.57	0.44	0.38	0.41	0.43		
80th			0.42	0.47	0.39	0.32	0.27	0.23	0.28	0.31		
Minimum			0.23	0.37	0.28	0.20	0.12	0.14	0.18	0.20		
Average			0.69	0.93	0.99	0.78	0.55	0.46	0.49	0.52		

Table C.9 – Naturalized Flows for the South Fork of the Milk River near the International Boundary statistics based Data from Alberta Environment "Milk River Natural Flows 1989 Report" and "Milk River Natural Flows 2002" for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	54	191	718	573	702	607	348	135	144	124	53	56
20th	24	49	190	278	330	283	105	43	40	43	37	25
50th(median)	13	21	73	172	205	145	45	21	16	27	25	14
80th	7	9	43	84	99	55	13	5	5	9	14	6
Minimum	2	0	13	43	37	14	2	1	1	0	1	1
Average	16	35	139	192	220	183	69	27	28	31	25	17

Naturalized Flows of the South Fork of Milk River in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	1.5	5.4	20.3	16.2	19.9	17.2	9.9	3.8	4.1	3.5	1.5	1.6
20th	0.7	1.4	5.4	7.9	9.3	8.0	3.0	1.2	1.1	1.2	1.0	0.7
50th(median)	0.4	0.6	2.1	4.9	5.8	4.1	1.3	0.6	0.5	0.8	0.7	0.4
80th	0.2	0.3	1.2	2.4	2.8	1.5	0.4	0.1	0.1	0.3	0.4	0.2
Minimum	0.0	0.0	0.4	1.2	1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Average	0.5	1.0	3.9	5.4	6.2	5.2	1.9	0.8	0.8	0.9	0.7	0.5

Table C.10 – Naturalized Flows for the North Fork of the Milk River near the International Boundary statistics based Data from Alberta Environment “Milk River Natural Flows 1989 Report” and “Milk River Natural Flows 2002” for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	82	56	156	143	171	236	132	78	83	58	88	32
20th	20	29	65	70	66	66	42	30	38	35	28	22
50th(median)	15	20	28	50	48	36	20	18	20	19	19	16
80th	7	13	17	33	23	16	12	11	13	11	11	12
Minimum	1	5	11	13	10	7	5	6	6	6	7	5
Average	16	21	42	53	51	46	28	22	26	24	22	17

Naturalized Flows of the North Fork of Milk River in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	2.3	1.6	4.4	4.1	4.9	6.7	3.7	2.2	2.3	1.7	2.5	0.9
20th	0.6	0.8	1.8	2.0	1.9	1.9	1.2	0.8	1.1	1.0	0.8	0.6
50th(median)	0.4	0.6	0.8	1.4	1.3	1.0	0.6	0.5	0.6	0.6	0.5	0.5
80th	0.2	0.4	0.5	0.9	0.7	0.5	0.3	0.3	0.4	0.3	0.3	0.3
Minimum	0.0	0.1	0.3	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Average	0.5	0.6	1.2	1.5	1.4	1.3	0.8	0.6	0.7	0.7	0.6	0.5

Table C.11 – Naturalized Flows for the Milk River at the Town of Milk River statistics based Data from Alberta Environment “Milk River Natural Flows 1989 Report” and “Milk River Natural Flows 2002” for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	121	424	1025	1094	1222	850	360	145	241	149	141	99
20th	43	105	398	387	432	310	152	76	84	82	67	47
50th(median)	18	40	155	245	282	207	69	41	46	45	44	31
80th	9	17	70	146	105	80	37	19	20	28	22	12
Minimum	1	1	19	54	29	3	0	0	4	8	9	2
Average	27	69	240	301	297	238	95	50	56	56	47	33

Naturalized Flows of the Milk River at the Town of Milk River in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	3.4	12.0	29.0	31.0	34.6	24.1	10.2	4.1	6.8	4.2	4.0	2.8
20th	1.2	3.0	11.3	11.0	12.2	8.8	4.3	2.2	2.4	2.3	1.9	1.3
50th(median)	0.5	1.1	4.4	6.9	8.0	5.9	1.9	1.2	1.3	1.3	1.3	0.9
80th	0.2	0.5	2.0	4.1	3.0	2.3	1.0	0.5	0.6	0.8	0.6	0.3
Minimum	0.0	0.0	0.5	1.5	0.8	0.1	0.0	0.0	0.1	0.2	0.2	0.1
Average	0.8	2.0	6.8	8.5	8.4	6.7	2.7	1.4	1.6	1.6	1.3	0.9

Table C.12 - Milk River at the Eastern Crossing of the International Boundary streamflow statistics based on recorded USGS streamflow data for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum			1,522	1,691	1,032	1,402	1,009	775	740	566		
20th			709	724	1,002	957	751	690	635	220		
50th(median)			306	524	707	774	632	602	523	111		
80th			130.1	316.6	473.3	611.5	544.4	518.2	138.0	35.1		
Minimum			16.3	156	284	335	262	77.4	2.2	0.2		
Average			450	553	757	804	647	574	440	132		

Milk River at Eastern Crossing in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum			43.1	47.9	29.2	39.7	28.6	21.9	20.9	16.0		
20th			20.1	20.5	28.3	27.1	21.3	19.5	18.0	6.22		
50th(median)			8.65	14.8	20.0	21.9	17.9	17.0	14.8	3.13		
80th			3.68	8.96	13.4	17.3	15.4	14.7	3.91	0.99		
Minimum			0.46	4.41	8.03	9.49	7.41	2.19	0.06	0.00		
Average			12.7	15.6	21.4	22.7	18.3	16.3	12.4	3.73		

Table C.13 – Naturalized Flows for the Milk River at the Eastern Crossing statistics based Data from Alberta Environment "Milk River Natural Flows 1989 Report" and "Milk River Natural Flows 2002" for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	167	624	1477	1691	1814	1241	468	260	339	215	101	87
20th	57	125	632	541	513	451	190	81	89	99	65	47
50th(median)	20	51	258	318	361	294	92	42	53	61	45	34
80th	10	21	112	145	124	128	30	25	25	33	26	17
Minimum	3	2	19	55	27	4	2	3	3	1	8	2
Average	35	82	398	385	392	329	128	61	71	69	47	35

Naturalized Flows of the Milk River at Eastern Crossing in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	4.7	17.7	41.8	47.9	51.4	35.2	13.3	7.4	9.6	6.1	2.9	2.5
20th	1.6	3.5	17.9	15.3	14.5	12.8	5.4	2.3	2.5	2.8	1.8	1.3
50th(median)	0.6	1.4	7.3	9.0	10.2	8.3	2.6	1.2	1.5	1.7	1.3	1.0
80th	0.3	0.6	3.2	4.1	3.5	3.6	0.9	0.7	0.7	0.9	0.7	0.5
Minimum	0.1	0.1	0.5	1.6	0.8	0.1	0.1	0.1	0.1	0.0	0.2	0.1
Average	1.0	2.3	11.3	10.9	11.1	9.3	3.6	1.7	2.0	2.0	1.3	1.0

Table C.14 - Milk River near Havre streamflow statistics based on recorded USGS streamflow data for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	172	691	1,762	1,864	2,191	1,573	1,581	1,125	957	628	325	144
20th	62.9	80.5	313	495	1,048	1,094	1,195	916	550	263	105	74.3
50th(median)	44.3	49.9	94.8	238	855	912	1,030	831	415	128	53.1	44.5
80th	33.0	37.4	47.2	133	731	723	777	598	229	45.8	35.8	30.5
Minimum	12.0	22.0	23.9	25.0	399	416	253	50.9	36.3	27.8	20.3	10.1
Average	51.4	78.2	254	403	918	913	982	756	407	161	72.1	52.7

Milk River at Havre in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	4.85	19.5	49.9	52.8	62.0	44.5	44.7	31.8	27.1	17.8	9.2	4.06
20th	1.78	2.28	8.85	14.0	29.6	31.0	33.8	25.9	15.6	7.43	2.97	2.10
50th(median)	1.25	1.41	2.68	6.74	24.2	25.8	29.1	23.5	11.7	3.63	1.50	1.26
80th	0.93	1.06	1.33	3.76	20.7	20.5	22.0	16.9	6.49	1.30	1.01	0.86
Minimum	0.34	0.62	0.68	0.71	11.29	11.76	7.15	1.44	1.03	0.79	0.57	0.29
Average	1.46	2.21	7.19	11.4	26.0	25.8	27.8	21.4	11.5	4.55	2.04	1.49

Table C.15 - Peoples Creek near Hayes streamflow statistics based on recorded USGS streamflow data for the 1967-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	30.0	74.9	285	122	190	123	51.5	21.3	57.6	37.1	20.5	12.9
20th	6.14	9.33	27.6	34.8	56.9	37.5	18.3	3.42	3.56	5.72	7.57	5.62
50th(median)	0.61	3.27	14.3	9.55	9.55	9.17	1.68	0.13	0.07	0.20	0.45	0.86
80th	0.02	0.11	2.32	1.43	2.72	1.00	0.11	0.01	0.01	0.01	0.02	0.02
Minimum	0.00	0.00	0.12	0.14	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Average	3.66	9.49	29.6	18.5	31.4	21.8	8.68	2.49	3.81	3.52	3.42	2.83

Peoples Creek in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	0.85	2.12	8.07	3.45	5.39	3.48	1.46	0.60	1.63	1.05	0.58	0.37
20th	0.17	0.26	0.78	0.98	1.61	1.06	0.52	0.10	0.10	0.16	0.21	0.16
50th(median)	0.02	0.09	0.40	0.27	0.27	0.26	0.05	0.00	0.00	0.01	0.01	0.02
80th	0.00	0.00	0.07	0.04	0.08	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average	0.10	0.27	0.84	0.52	0.89	0.62	0.25	0.07	0.11	0.10	0.10	0.08

Table C.16 - Rock Creek near International Boundary streamflow statistics based on recorded USGS streamflow data for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	1.78	96.10	370	437	89.0	102	63.6	13.4	12.5	9.33	2.79	2.19
20th	0.54	5.94	172	196	27.2	19.1	16.8	1.82	1.63	2.76	2.29	1.32
50th(median)	0.11	0.20	40.2	22.5	6.19	6.44	2.89	0.51	0.64	1.56	1.25	0.53
80th	0.00	0.00	5.96	7.88	3.65	2.09	1.02	0.01	0.01	0.51	0.92	0.31
Minimum	0.000	0.000	0.000	3.970	1.460	0.167	0.004	0.000	0.000	0.001	0.100	0.026
Average	0.30	6.46	83.8	87.29	16.03	12.6	10.40	1.33	1.12	1.89	1.52	0.75

Rock Creek in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	0.05	2.72	10.46	12.36	2.52	2.88	1.80	0.38	0.35	0.26	0.08	0.06
20th	0.02	0.17	4.88	5.55	0.77	0.54	0.47	0.05	0.05	0.08	0.06	0.04
50th(median)	0.00	0.01	1.14	0.64	0.18	0.18	0.08	0.01	0.02	0.04	0.04	0.01
80th	0.00	0.00	0.17	0.22	0.10	0.06	0.03	0.00	0.00	0.01	0.03	0.01
Minimum	0.00	0.00	0.00	0.11	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average	0.01	0.18	2.37	2.47	0.45	0.36	0.29	0.04	0.03	0.05	0.04	0.02

Table C.17 - Milk River near Nashua streamflow statistics based on recorded USGS streamflow data for the 1959-2001 period, in cubic feet per second (CFS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	843	2,337	6,678	10,140	5,207	3,731	3,578	1,754	2,138	6,837	768	487
20th	195	350	2,925	2,790	1,815	1,296	1,206	392	302	293	264	203
50th(median)	130	160	721	426	374	443	375	207	181	167	184	152
80th	99.1	104	168	61.5	82.6	180	133	87.8	96.7	95.1	118	97.7
Minimum	60.0	59.8	86.7	15.1	10.5	28.0	3.6	3.4	12.6	34.4	61.2	39.7
Average	165	282	1,475	1,659	1,013	794	729	293	290	358	216	163

Milk River near Nashua in cubic meter per second (CMS)

Percentile Exceedence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	23.8	66.1	189.0	287.0	147.4	105.6	101.3	49.6	60.5	193.5	21.7	13.8
20th	5.53	9.90	82.8	78.9	51.4	36.7	34.1	11.1	8.5	8.30	7.47	5.75
50th(median)	3.67	4.54	20.4	12.1	10.6	12.5	10.6	5.86	5.11	4.73	5.22	4.30
80th	2.80	2.93	4.76	1.74	2.34	5.09	3.77	2.48	2.74	2.69	3.33	2.77
Minimum	1.70	1.69	2.45	0.43	0.30	0.79	0.10	0.10	0.36	0.97	1.73	1.12
Average	4.67	7.98	41.7	47.0	28.7	22.5	20.6	8.28	8.20	10.13	6.12	4.60

INTERNATIONAL JOINT COMMISSION

IN THE MATTER OF THE MEASUREMENT AND APPORTIONMENT OF THE WATERS OF THE ST. MARY AND MILK RIVERS AND THEIR TRIBUTARIES IN THE UNITED STATES AND CANADA

UNDER ARTICLE VI OF THE TREATY OF JANUARY 11, 1909
BETWEEN THE UNITED STATES AND
GREAT BRITAIN

ORDER
OTTAWA, OCTOBER 4, 1921
RECOMMENDATIONS
OTTAWA, OCTOBER 6, 1921

WASHINGTON
GOVERNMENT PRINTING OFFICE
1923

INTERNATIONAL JOINT COMMISSION.

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INTERNATIONAL JOINT COMMISSION.

ORDER.

IN THE MATTER OF THE MEASUREMENT AND APPORTIONMENT OF THE WATERS OF THE ST. MARY AND MILK RIVERS AND THEIR TRIBUTARIES IN THE STATE OF MONTANA AND THE PROVINCES OF ALBERTA AND SASKATCHEWAN.

Whereas by Article VI of the Treaty entered into between the United States of America and His Majesty, the King of the United Kingdom of Great Britain and Ireland and of the British Dominions beyond the Seas, Emperor of India, signed at Washington on the 11th of January, 1909, it is provided as follows:

> The High Contracting Parties agree that the St. Mary and Milk Rivers and their tributaries (in the State of Montana and the Provinces of Alberta and Saskatchewan) are to be treated as one stream for the purposes of irrigation and power, and the waters thereof shall be apportioned equally between the two countries, but in making such equal apportionment more than half may be taken from one river and less than half from the other by either country so as to afford a more beneficial use to each. It is further agreed that in the division of such waters during the irrigation season, between the 1st of April and 31st of October, inclusive, annually, the United States is entitled to a prior appropriation of 500 cubic feet per second of the waters of the Milk River, or so much of such amount as constitutes three-fourths of its natural flow, and that Canada is entitled to a prior appropriation of 500 cubic feet per second of the flow of St. Mary River, or so much of such amount as constitutes three-fourths of its natural flow.
>
> 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. The provisions of Article II of this treaty shall apply to any injury resulting to property in Canada from the conveyance of such waters through the Milk River.
>
> The measurement and apportionment of the water to be used by each country shall from time to time be made jointly by the properly constituted reclamation officers of the United States and the properly constituted irrigation officers of His Majesty under the direction of the International Joint Commission.

And whereas the said Reclamation and Irrigation Officers have been unable to agree as to the manner in which the waters mentioned in the said Article VI should be measured and apportioned;

And whereas, before giving directions as to the measurement and apportionment of the said waters, the International Joint Commission deemed it proper to hear such representations and suggestions thereon as the Governments of the United States and Canada, the Provinces of Alberta and Saskatchewan, and the State of Montana, and as corporations and persons interested might see fit to make, and for such purposes sittings of the Commission were held at the following times and places: At the city of St. Paul, in the State of Minnesota, on the 24th, 25th, 26th, 27th, and 28th days of May, 1915; at the city of Detroit, in the State of Michigan, on the 15th, 16th, and 17th days of May, 1917; at the city of Ottawa, in the Province of Ontario, on the 3d, 4th, and 5th days of May, 1920; at the village of Chinook, in the State of Montana, on the 15th day of September, 1921; and at the city of Lethbridge, in the Province of Alberta, on the 17th day of September, 1921, when counsel and representatives of the said Governments, corporations, and persons appeared and presented their views;

And whereas, pending final decision as to the proper method of measuring and apportioning said waters, interim orders with reference thereto have been made by the International Joint Commission from time to time, the last of such orders bearing the date of 6th day of April, 1921;

And whereas the members of the International Joint Commission have unanimously determined that the said Reclamation and Irrigation Officers should be guided in the measurement and apportionment of said waters by the directions and instructions hereinafter set forth:

IT IS THEREFORE ORDERED AND DIRECTED by the Commission in pursuance of the powers conferred by the said Article VI of the said Treaty that the Reclamation and Irrigation Officers of the United States and Canada shall, until this order is varied, modified, or withdrawn by the Commission, make jointly the measurement and apportionment of the water to be used by the United States and Canada in accordance with the following rules:

St. Mary River.

I. (*a*) 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.

(*b*) 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.

(*c*) During the nonirrigation 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.

Milk River.

II. (*a*) 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.

(*b*) 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.

(*c*) During the nonirrigation season the natural flow of the Milk River at the Eastern Crossing shall be divided equally between the two countries.

Eastern Tributaries of Milk River.

III. The natural flow of the eastern (otherwise known as the Saskatchewan or northern) tributaries of the Milk River at the points where they cross the international boundary shall be divided equally between the two countries.

Waters not naturally crossing the boundary.

IV. Each country shall be apportioned such waters of the said rivers and of any tributaries thereof as rise in that country but do not naturally flow across the international boundary.

V. For the purpose of carrying out the apportionment directed in Paragraphs I, II, and III hereof the said Reclamation and Irrigation Officers shall jointly take steps—

(*a*) To ascertain and keep a daily record of the natural flow of the St. Mary River at the international boundary, of the Milk River at the Eastern Crossing, and of the eastern tributaries of the Milk River at the international boundary by measurement in each case:

(1) At the gauging station at the international boundary;

(2) At all places where any of the waters which would naturally flow across the international boundary at that particular point are diverted in either country prior to such crossing;

(3) At all places where any of the waters which would naturally flow across the international boundary at that particular point are stored, or the natural flow thereof increased or decreased prior to such crossing;

(*b*) To fix the amount of water to which each country is entitled in each case by applying the directions contained in paragraphs 1, 2, and 3 hereof to the total amount of the natural flow so ascertained in each case.

(*c*) To communicate the amount so fixed to all parties interested, so that the apportionment of the said waters may be fully carried out by both countries in accordance with the said directions.

VI. Each country may receive its share of the said waters as so fixed at such point or points as it may desire. A gauging station shall be established and maintained by the Reclamation or Irrigation Officers of the country in which any diversion, storage, increase, or decrease of the natural flow shall be made at every point where such diversion, storage, increase, or decrease takes place.

VII. International gauging stations shall be maintained at the following points:

St. Mary River near international boundary; the north branch of Milk River near international boundary; the south branch of Milk River near international boundary; Milk River at Eastern Crossing; Lodge Creek, Battle Creek, and Frenchman River, near international boundary; and gauging stations shall be established and maintained at such other points as the Commission may from time to time approve.

VIII. The said Reclamation and Irrigation Officers are hereby further authorized and directed:

(*a*) To make such additional measurements and to take such further and other steps as may be necessary or advisable in order to insure the apportionment of the said waters in accordance with the directions herein set forth.

(*b*) To operate the irrigation works of either country in such a manner as to facilitate the use by the other country of its share of the said waters and subject hereto to secure to the two countries the greatest beneficial use thereof.

(*c*) To report to the Commission the measurements made at all international and other gauging stations established pursuant to this order.

IX. In the event of any disagreement in respect to any matter or thing to be done under this order the said Reclamation and Irrigation Officers shall report to the Commission, setting forth fully the points of difference and the facts relating thereto.

X. The said order of the Commission, dated the 6th day of April 1921, is hereby withdrawn, except with respect to the report to be furnished to the Commission thereunder.

Dated at Ottawa, Canada, this 4th day of October, 1921.

O. Gardner,
C. A. Magrath,
C. D. Clark,
Henry A. Powell,
W. H. Hearst,
Mark A. Smith.

INTERNATIONAL JOINT COMMISSION.

RECOMMENDATIONS.

IN THE MATTER OF THE MEASUREMENT AND APPORTIONMENT OF THE WATERS OF THE ST. MARY AND MILK RIVERS AND THEIR TRIBUTARIES IN THE STATE OF MONTANA AND THE PROVINCES OF ALBERTA AND SASKATCHEWAN, UNDER THE TERMS OF ARTICLE VI OF THE TREATY OF JANUARY 11, 1909.

The Commission finds, as the result of a very thorough investigation of the possibilities of irrigation development in those portions of the State of Montana and the Provinces of Alberta and Saskatchewan capable of irrigation by the waters of the St. Mary and Milk Rivers and their tributaries, that the quantities of land in this international region susceptible of development far exceed the capacity of the rivers in question even under the most exhaustive system of conservation. It is therefore of the utmost importance, not only because of the practical benefits to accrue to the people of this western country, but still more because the St. Mary and Milk Rivers problem is one that might easily become a source of serious irritation and misunderstanding to the people of the two countries, that every effort should be made to obtain the maximum efficiency in irrigation from these waters.

In the first Annual Report of the United States Reclamation Service, 1902, a project was outlined for the storage of 250,000 acre-feet of water by means of a dam across the outlet of the St. Mary Lakes.

And, further, the United States Reclamation Service has already constructed a reservoir at Sherbourne Lake, and the Commission is informed that said Service has in contemplation the construction of what is known as the Chain-of-Lakes Reservoir in the valley of the Milk River after that stream leaves Canada; and that the Reclamation Service of Canada has in contemplation the construction of what is called the Verdigris Coulee Reservoir on the northern side of the Milk River.

The Commission is strongly of the opinion that the construction of said St. Mary Lakes, Chain-of-Lakes, and Verdigris Coulee reservoirs, and the operation of all reservoirs under its direction will make it possible to conserve practically the entire winter flow and flood waters of the two streams and insure the greatest beneficial use of the same to both countries. Because of the international interests involved and as a means of furthering those relations of neighborliness and good fellowship which it is convinced the people of both countries have earnestly at heart, the Commission believes that the cost of construction of the works at the outlet of St. Mary Lakes should not be charged against any particular project, but should be borne jointly by the Governments of the United States and Canada, the legal title of said reservoir to be vested in the United States.

It is therefore ordered that the following recommendations be respectfully submitted to the Governments of the United States and Canada:

That the Governments of the United States and Canada enter into an agreement for the construction of a reservoir at St. Mary Lakes in Montana.

That the Reclamation Service of the United States proceed with the construction of the proposed Chain-of-Lakes Reservoir in Montana, and the Canadian Reclamation Service with the proposed Verdigris Coulee Reservoir in Alberta.

That all reservoirs herein mentioned be constructed, controlled, and operated in the manner, for the purpose, and subject to the conditions above set forth.

Dated at Ottawa, Canada, this 6th day of October, 1921.

O. Gardner,
C. A. Magrath,
C. D. Clark,
Henry A. Powell,
W. H. Hearst,
Mark A. Smith.

Appendix E - 2001 Letter Of Intent

2001 Letter Of Intent to Better Utilize the Waters of the St. Mary and Milk Rivers

Whereas Article VI of the Boundary Waters Treaty of 1909 states that the St. Mary and Milk Rivers and their tributaries are to be treated as one for the purposes of irrigation and power;

And whereas, the Boundary Waters Treaty of 1909 and the International Joint Commission Order of 1921 authorizes the Reclamation and Irrigation Officers of the United States and Canada (currently designated as the Accredited Officers of the United States and Canada) to make the greatest beneficial use of the waters of the St. Mary and Milk Rivers;

And whereas, Canada finds it beneficial to use more than its share of the Milk River in the June-September period each year to supply water to Canadian Milk River irrigators;

And whereas, the United States finds it beneficial to use more than its share of the St. Mary River in the March-May period each year to supply water to United States Milk River irrigators;

It is therefore ordered and directed by said Accredited Officers or their designates that the United States be allowed to accumulate a deficit on the St. Mary River of up to 4,000 cfs-days (9 800 dam^3) between March 1 and May 31 of each year which, at the discretion of the United States, may be reduced to no less than 2,000 cfs-days (4 900 dam^3) between June 1 and July 15 of each year with surplus deliveries of St. Mary River water, and that Canada be allowed to accumulate a deficit on the Milk River of up to 2,000 cfs-days (4 900 dam^3) between June 1 and September 15 of each year. The incurred deficits on the St. Mary and Milk Rivers can be offsetting and the outstanding deficits as of September 15 will be equalized by October 31 of each year under administration by Field Representatives of the Accredited Officers. Detailed accounting procedures for the computation of deficit and surplus deliveries under this Letter Of Intent are outlined in Appendix A, " Procedures for the Computation of Deficit and Surplus Deliveries to Better Utilize Waters of the St. Mary and Milk Rivers".

In signing this letter, the parties recognize this agreement is within the 1921 Order of the International Joint Commission. Additionally, the parties recognize that this Letter of Intent and Appendix A will form part of the St. Mary - Milk River Procedural Manual.

Termination of this Letter Of Intent will be allowed upon request by either the United States or Canada notifying the other party in writing two months prior to the commencement of the irrigation season (April 1st as specified by the 1921 Order).

____
Tim Goos
Accredited Officer of Her Majesty
Dated this 8th day of February, 2001

____
William J. Carswell, Jr. for the
Accredited Officer of the United States
Dated this 8th day of February, 2001

2001 Letter of Intent continued:

<u>Appendix A</u> - PROCEDURES FOR THE COMPUTATION OF DEFICIT AND SURPLUS DELIVERIES TO BETTER UTILIZE WATERS OF THE ST. MARY AND MILK RIVERS

ST. MARY RIVER
As of January 2001, the accounting procedures for the computation of deficit and surplus deliveries during March 1 through September 15 of each year on the St. Mary River are:

1. During March 1 through May 31 of each year, deficit deliveries from the United States to Canada at the end of each division period will carry over from one division period to another for the year, are cumulative for the year, and are allowed up to a cumulative total of 4,000 cfs-days (9 800 dam^3). Deficit deliveries greater than the allowed cumulative total of 4,000 cfs-days (9 800 dam^3) are to be refunded in the subsequent division period. Surplus deliveries at the end of a division period are not cumulative, cannot be used to reduce the accumulated deficit from previous division periods to below the allowed total deficit of 4,000 cfs-days (9 800 dam^3), and cannot be used as a credit to make up future deficits. Exceptions to these procedures for this period are allowed only if agreed upon in writing by the Field Representative for Canada.

2. During June 1 through July 15 of each year, the United States, at its discretion, may reduce the deficit accumulated in the March 1 through May 31 period to 2,000 cfs-days (4 900 dam^3) by making surplus deliveries of St. Mary River water. The remaining deficit is not refundable until after September 15 of that year unless agreed upon in writing by the Field Representative for Canada.

3. During June 1 through September 15 of each year, deficit deliveries from the United States to Canada at the end of each division are not to be incurred. However, if deficits are incurred, they are to be refunded by surplus deliveries in the subsequent division period or at a time agreed upon by both parties. Surplus deliveries do not carry over from one division period to another, are not cumulative, and cannot be used as a credit to make up future deficits.

4. On September 15 of each year, outstanding deficits are to be determined using the best available data, even though those data may be provisional. Any outstanding deficits as of September 15 are to be equalized by October 31 of each year. Deficit deliveries accumulated by Canada on the Milk River can be used to offset deficit deliveries accumulated by the United States on the St. Mary River.

5. The United States Bureau of Reclamation shall contact Canada (Environment Canada), the United States (U.S. Geological Survey), Montana (Montana Department of Natural Resources and Conservation), and Alberta (Alberta Environment) when they plan to begin deficit deliveries during the March 1 through May 31 period and when they plan to make surplus deliveries to reduce the accumulated deficits to 2,000 cfs-days (4 900 dam^3) during June 1 through July 15. On or about July 1, and again by September 15 of each year, the parties shall participate in a conference call or meeting to discuss refund of remaining deficit deliveries.

MILK RIVER
As of January 2001, the accounting procedures for the computation of deficit and surplus deliveries during March 1 through September 15 of each year on the Milk River are:

1. During March 1 through May 31 of each year, deficit deliveries from Canada to the United States at the end of each division period are not to be incurred. However, if deficits are incurred, they are to be refunded by surplus deliveries in the subsequent division period or at a time agreed upon by both parties. Surplus deliveries do not carry over from one division period to another, are not cumulative, and cannot be used as a credit to make up future deficits.

2. During June 1 through September 15 of each year, deficit deliveries from Canada to the United States at the end of each division period will carry over from one division period to another for the year, are cumulative for the year, and are allowed up to a cumulative total of 2,000 cfs-days (4 900 dam^3). Deficit deliveries greater than the allowed total of 2,000 cfs-days (4 900 dam^3) are to be refunded in the subsequent division period. Surplus deliveries at the end of a division period cannot be used to reduce the deficit accumulated during the June 1 through September 15 period to below the lesser of the allowed total deficit of 2,000 cfs-days (4 900 dam^3) or the outstanding United States' deficit accumulated on the St. Mary River in the March 1 through May 31 period, and cannot be used as credits to make up future deficits. The remaining deficit is not refundable until after September 15 of that year unless agreed upon in writing by the Field Representative for the United States.

3. On September 15 of each year, outstanding deficits are to be determined using the best available data, even though those data may be provisional. Any outstanding deficits as of September 15 are to be equalized by October 31 of each year. Deficit deliveries accumulated by Canada on the Milk River can be used to offset deficit deliveries accumulated by the United States on the St. Mary River.

4. Canada (Environment Canada), the United States (U.S. Bureau of Reclamation and U.S. Geological Survey), Alberta (Alberta Environment) and Montana (Montana Department of Natural Resources and Conservation) shall participate in a conference call or meeting on or about July 1, and again by September 15 of each year to decide on the approach to be used to reconcile outstanding deficit deliveries.