Upper Milk River Watershed

Water Supply and Water Use Study Report: 2006 – 2009

Montana Department of Natural Resources
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Introduction

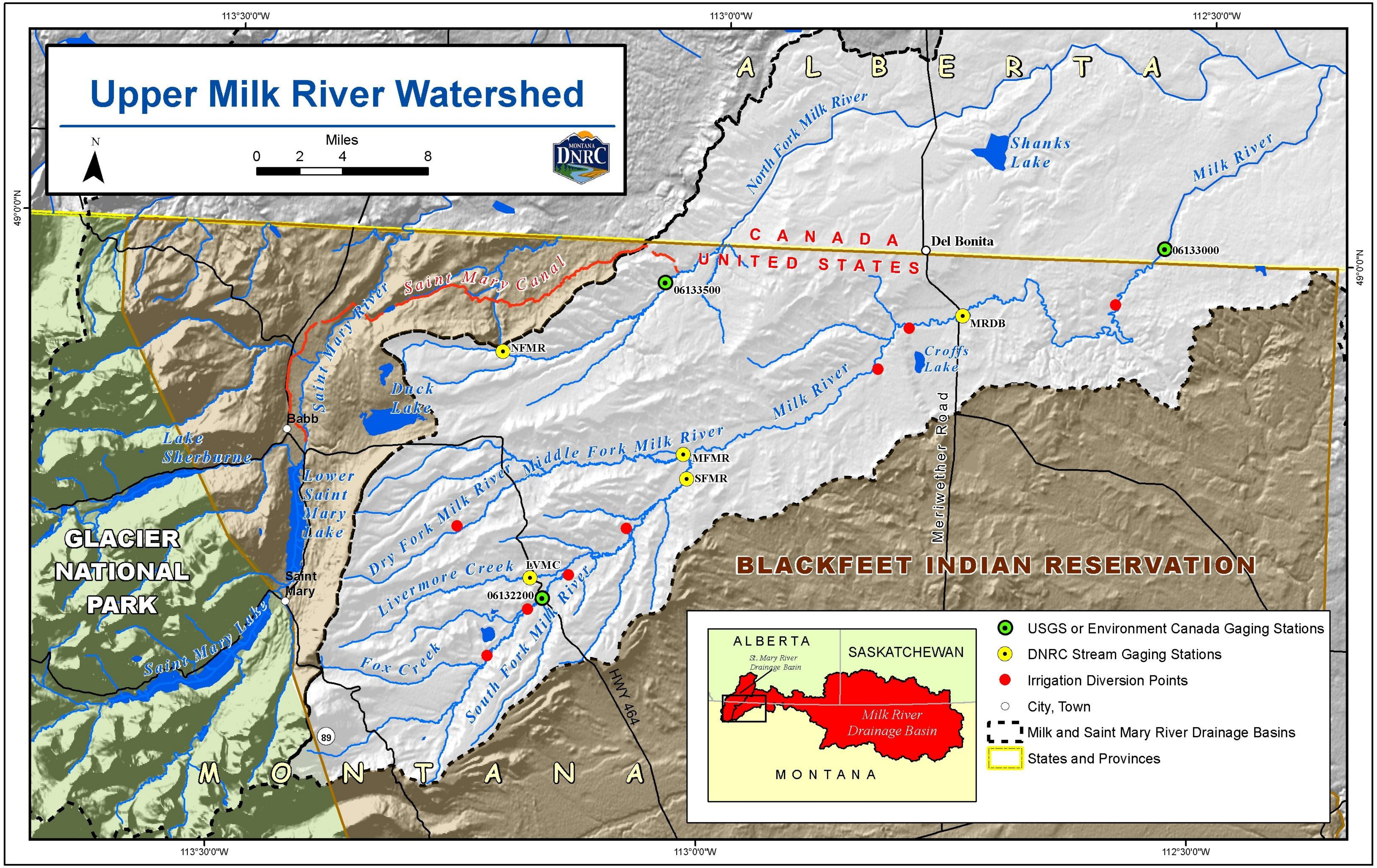
The purpose of this report is to characterize the hydrology and the current extent of water use within the upper Milk River watershed for the 2006 through 2009 irrigation seasons. The seasonal patterns of upper Milk River flow and the relative contributions of the various tributaries are described. Depletions of flow from irrigation water use and channel losses also have been estimated. The areas examined include the Milk River above the Western Crossing of the International Boundary, and the North Fork of the Milk River upstream of the International Boundary (Map 1).

The headwaters of the Milk River are in the foothills of the Rocky Mountains within the Blackfeet Indian Reservation in northwestern Montana. There are many demands for and claims to the water that originates in the upper Milk River watershed. Article 6 of *the Boundary Waters Treaty of 1909* divides the "natural flow" of the Milk River between the United States and Canada. The Blackfeet Tribe and the Tribes of the Fort Belknap Indian Reservation both have Federal Reserved Water Rights for Milk River natural flow. Landowners within the upper Milk River watershed hold Montana state-based water rights for irrigation and other uses. Water that originates in the Upper Milk River watershed also can be stored in Fresno Reservoir in central Montana and used by irrigators downstream. The U.S. Geological Survey (1961) estimates that 75% of the natural flow of the Milk River at the Eastern Crossing of the International Boundary north of Havre originates in the Milk River watershed upstream of the Western Crossing of the International Boundary, including the North Fork of the Milk River watershed.

This study was undertaken by the Montana Department of Natural Resources and Conservation (DNRC). Funding for travel, equipment, and measuring device installation was provided by the United States Bureau of Reclamation. The Blackfeet Tribe provided field assistance on stream gaging aspects of the project.

We hope that this report will provide a better understanding of the hydrology and water uses of the upper Milk River watershed; leading to a more accurate computation and apportionment of Milk River natural flow between the United States and Canada.

Map 1. Upper Milk River Watershed



General Basin Description

The portions of the Milk River watershed examined in this report include the Milk River main stem and its tributaries upstream of its Western Crossing of the International Boundary east of Del Bonita, and the North Fork of the Milk River upstream of where it crosses the International Boundary (Map 1). These headwaters of the Milk River primarily are located in the Blackfeet Indian Reservation, with a small portion originating in Glacier National Park. The Saint Mary River Ridge and Divide, and White Calf Mountain separate the Milk River drainage from that of the St. Mary River, which flows north into Canada and east towards Hudson Bay. To the south, the Milk River Ridge separates the Milk River watershed from the Cut Bank Creek drainage, which is in the Marias River watershed. After crossing the International Boundary near Del Bonita, the Milk River flows into Canada and then east for about 170 river miles before again crossing the International Boundary and flowing back into the United States at the "Eastern Crossing". The Milk River eventually joins the Missouri River in eastern Montana downstream of Fort Peck Dam.

The headwaters portions of the upper Milk River watershed consist of wooded foothills to the Rocky Mountains. The highest elevations are in the South Fork of the Milk River drainage, with a maximum elevation of about 8,900 feet. The foothills area receives more snow than the rest of the watershed and this snow can persist into June, although most of the melt generally occurs from April through May. Although these higher foothill areas make up a relatively small proportion of the upper Milk River watershed area, they produce a large percentage of the total flow--accounting for about 75 percent or more of the flow at the Western Crossing.

To the east of the foothills, the watershed primarily is rangeland, with subirrigated and irrigated hay meadows adjacent to the streams. Progressing further east, the land use becomes a mixture of grazing lands, hay meadows, and cropland. The elevation of the Milk River at the Western Crossing of the International Boundary is about 3,800 feet. Lower elevation snowmelt can cause an early flow peak on the Milk River in March or April, or even late February. This early peak generally is lower than the main May or early June peak that is driven by snowmelt in the higher foothills and by spring rain.

The North Fork of the Milk River watershed does not have the higher elevation wooded foothills that the South Fork watershed contains; the highest elevations in the North Fork watershed are about 5,300 feet. The North Fork watershed primarily is rangeland, with sub-irrigated meadows near the stream. Where the St. Mary Canal discharges into the North Fork, the elevation is about 4,200 feet.

The underlying geology of the area primarily is composed of Cretaceous Period sandstones and shale. These geological beds are in many areas covered by much more recent glacial deposits. The climate of the watershed is cool and semi-arid overall. Annual precipitation ranges from up to 60 inches in the highest elevations of the upper South Fork of the Milk River drainage, to about 14 inches per year near the Western Crossing. Annual average precipitation ranges from 14-to-34 inches for the largest portion of the upper Milk River basin (Montana NRIS, 2011).

Streamflow Data and Stream Gaging Stations

Temporary streamflow-gaging stations were installed for this study on the Milk River and its larger tributary streams, including the South Fork of the Milk River, Livermore Creek, and the Middle Fork of the Milk River. A temporary gage also was installed on the upper North Fork of the Milk River, at the North Fork Ranch. These temporary gages were used in conjunction with existing U.S. Geological Survey (USGS) streamflow-gaging stations on the Milk River, South Fork of the Milk River, and North Fork of the Milk River to characterize watershed flow. The streamflow-gaging station locations are depicted on Map 1. Table 1 contains information for each station.

Table 1. Upper Milk River Watershed Streamflow Gaging Stations

Station Name (Map Code)	Operated By	Drainage Area above (mi^2)	Approximate Acres Irrigated Upstream During Study*
South Fork Milk River near Babb (06132200)	USGS	70.4	206
Livermore Creek at Highway 464 Crossing near mouth (LVMC)	DNRC	22.6	0
Middle Fork Milk River above confluence with South Fork Milk River (MFMR)	DNRC	64.7	100
South Fork Milk River above confluence with Middle Fork (SFMR)	DNRC	147	771
Milk River near Del Bonita (MRDB)	DNRC	325	1,194
Milk River at Western Crossing of International Boundary (06133000)	USGS	401	1,267
North Fork Milk River at North Fork Ranch (NFMR)	DNRC	13.2	0
North Fork Milk River above St. Mary Canal near Browning (0633500)	USGS	59.0	0

* These are estimates of the amount of acres irrigated at some time during the most recent years. Not all of these acres were irrigated during all years of this study, and some of the acres may not have been irrigated at all during the study period. There are additional lands in the watershed that have been historically irrigated but were not considered to be actively irrigated during the time of this study.

Discharge measurements were made at the DNRC temporary station about once each month during the irrigation season to establish a stage-discharge relationship or “discharge rating”. The discharge rating was then used in conjunction with recorded stage data to develop continuous streamflow estimates at each gaging station. The Aquatic Informatics AQUARIUS software was used to develop the stage-discharge ratings. A summary of the discharge measurements made during the study at the DNRC stations is contained in Appendix A.

Streamflow data were collected at the gages during the 2006, 2007, 2008 and 2009 seasons, although early spring data are not available for the DNRC gages for 2006 and 2007.

Streamflow data from the “upper gages” were used to estimate natural inflows from the relatively higher elevation areas of the watershed. These upper gages included the South Fork of the Milk River near Babb, Livermore Creek, Middle Fork of the Milk River, and North Fork of the Milk River at the North Fork Ranch. There were some irrigation diversions above the upper gaging stations; these were measured during the 2008 and 2009 seasons or estimated based on the landowner’s approximation of the acres of land irrigated and amount of water applied. The “lower gages” were at locations where the incremental flow losses due to irrigation and natural losses could best be accounted for, and were used to determine other watershed inflows during the early runoff season.

Upper Milk River Watershed Streamflow Characteristics by Subbasin and Stream Reach

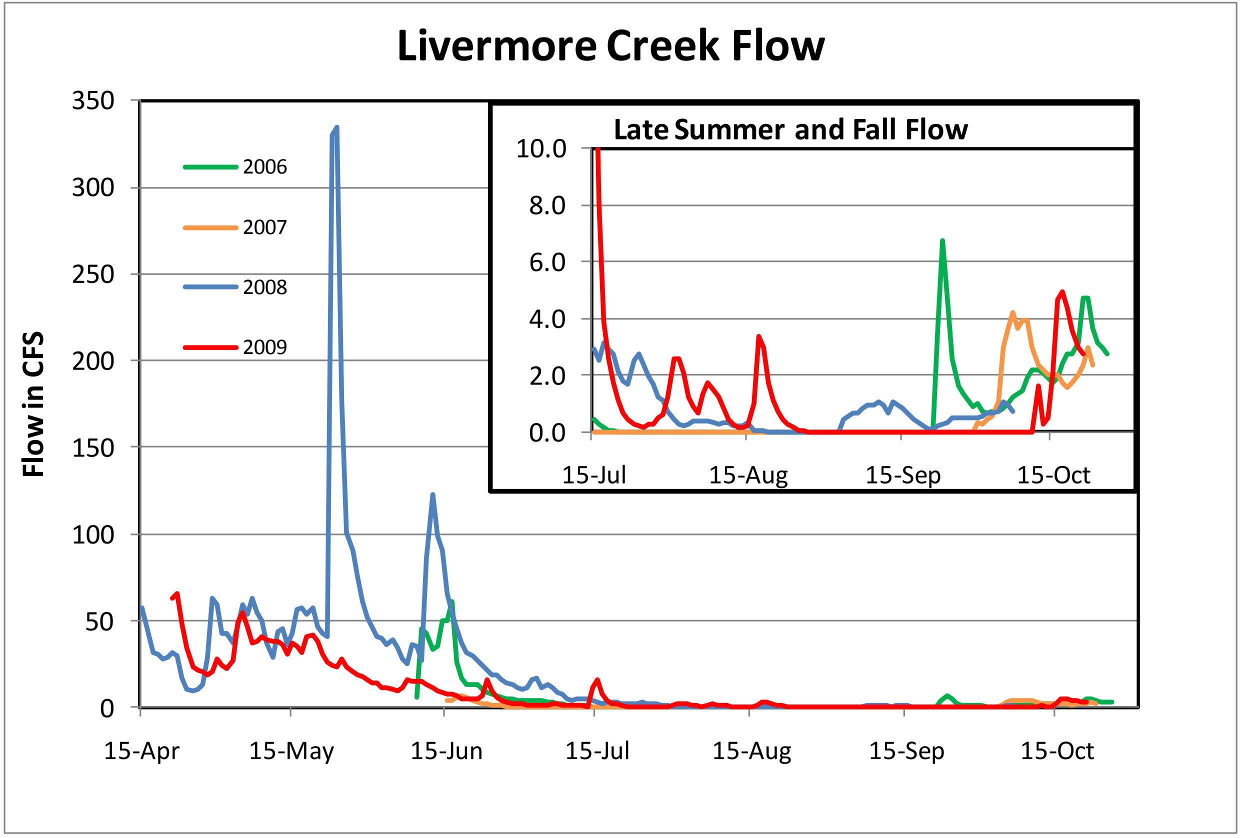
Livermore Creek

Livermore Creek at DNRC gaging station

Livermore Creek is the largest tributary to the South Fork of the Milk River, with a drainage area of about 22.6 square miles, and elevations range from about 6,100 feet in the headwaters to 4,600 feet at its junction with the South Fork. No land was found to be irrigated during the years of this study in the Livermore Creek watershed—although a 1969 evaluation by the Montana Water Resources Board identified 171 acres of flood irrigation at that time and there are ditches that could be used to bring irrigated land back into production.

Figure 1 is a hydrograph plot of the flow for Livermore Creek during the 2006 through 2009 seasons. Flow typically peaked during May and early June and declined rapidly during late June. The inset graph focuses on the late summer and fall, when flow generally was lowest. There were times of zero flow during all years. There are many beaver dams on the creek upstream of the gage, and evaporation and evapotranspiration associated with these dams could contribute to the lack of summer and early fall flow at the gage. Flow consistently increased during the fall, probably as a result of decreased water use by plants following the first frost and from water added by fall precipitation. The DNRC gaging station was located near the Highway 464 crossing, about 1.5 miles upstream of where Livermore Creek discharges into the South Fork of the Milk River. Flow data presented in this report are in units of cubic feet per second (cfs).

Figure 1. Livermore Creek Streamflow at DNRC gaging station.



South Fork of the Milk River

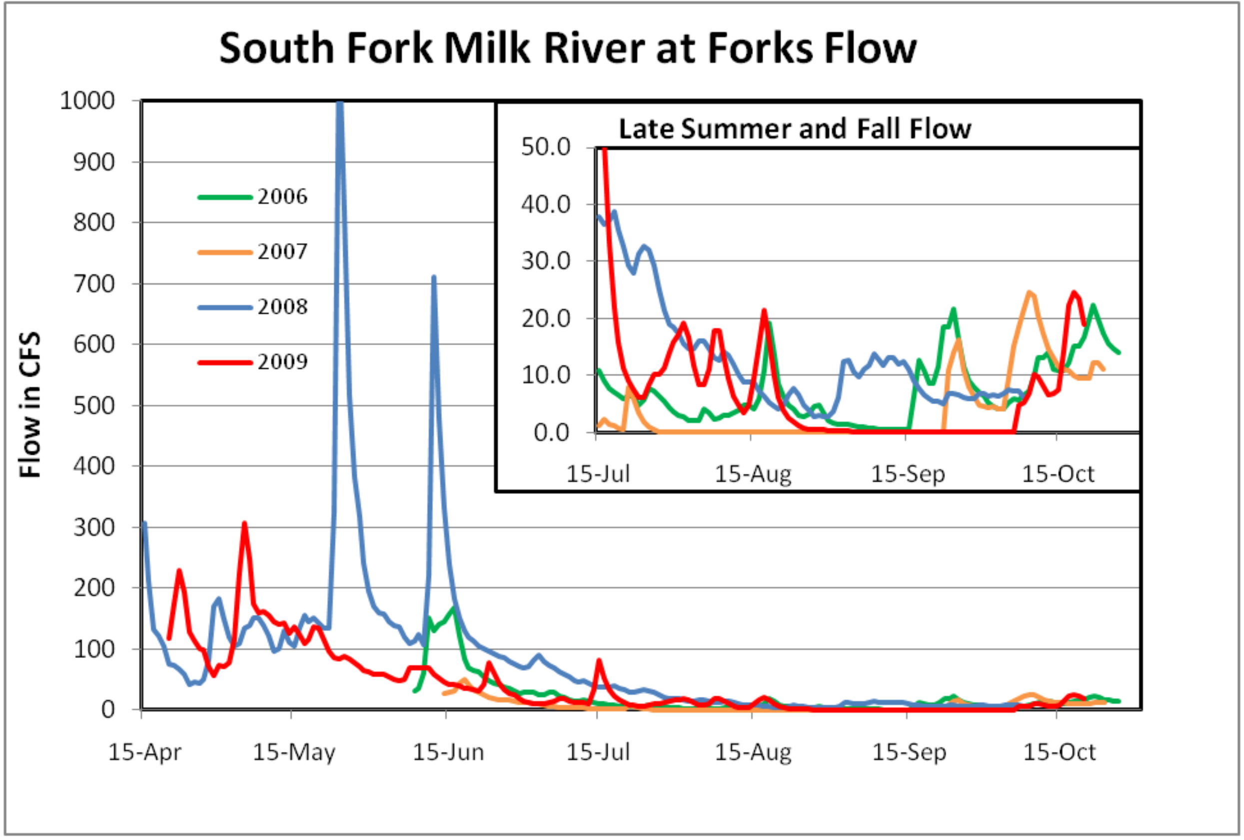
South Fork of the Milk River above Forks at the DNRC gaging station

During the study period, the South Fork of the Milk River, excluding Livermore Creek, contributed about half of the flow of the Milk River measured at the Western Crossing of the International Boundary gage. The South Fork of the Milk River drainage contains the highest areas in the Milk River watershed. Elevations range from about 8,900 feet in Glacier National Park, to about 4,400 feet where the South Fork joins the Middle Fork to form the Milk River. During the winter, more snow usually accumulates in the South Fork watershed and persists for longer into the summer than in the other sub-basins. Quaternary terrace and pediment deposits cover extensive areas in the upper portions of the South Fork watershed (USGS 1996). These deposits typically have high infiltration rates, and the water that infiltrates potentially sustains stream base flow later during the season. Thick snow drifts also accumulate in the hilly topography of the upper watershed, and these drifts tend to melt more slowly, which can help to sustain flow.

Figure 2 is a hydrograph plot of the flow for the South Fork of the Milk River during the study at the DNRC gage, about 1 mile upstream of the confluence with the Middle Fork. Most of the flow was produced during the April through June runoff season. After runoff, the flow in the lower river dropped to low levels and was at zero for periods during the late summer and fall in 2007 and 2009, and near zero during late August and early September of 2006. At the South Fork Milk River USGS gage, at the Highway 464 crossing about 16 miles upstream, there always was some flow in the river, although it dropped to about 2 cubic feet per second (cfs) at times during the late summer.

In the South Fork watershed, there are active sprinkler systems, some tributary flood irrigation above the Highway 464 crossing, and flood irrigation diversions downstream to the Forks. Although there were some sprinkler irrigation diversions from the upper South Fork in the later part of the summer, there were no flood irrigation diversions during the study past mid-July, except for a very small diversion during late July of 2009. Discussions with landowners indicate that there is a significant loss of flow from the river between about 7 and 12 miles upstream of the confluence of the South and Middle Forks. It is not known for certain what the causes of this loss might be. The stream crosses several geologic formation outcrops in this area, but the most likely explanation is that the stream simply loses water to the Quaternary alluvial deposits that fill the stream valley in this area and are thought to be relatively thick. The width of the valley and these associated fill deposits increases substantially below the Highway 464 crossing, where losses are thought to increase. Water could be seeping from the stream into the alluvial-fill aquifer and, where the water table is close to the surface, evapotranspiration by pasture grass, hay fields, and riparian vegetation could be consuming much of this water which seeps into the shallow aquifer.

Figure 2. Streamflow at South Fork of Milk River at Forks DNRC gaging station.



Middle Fork of the Milk River

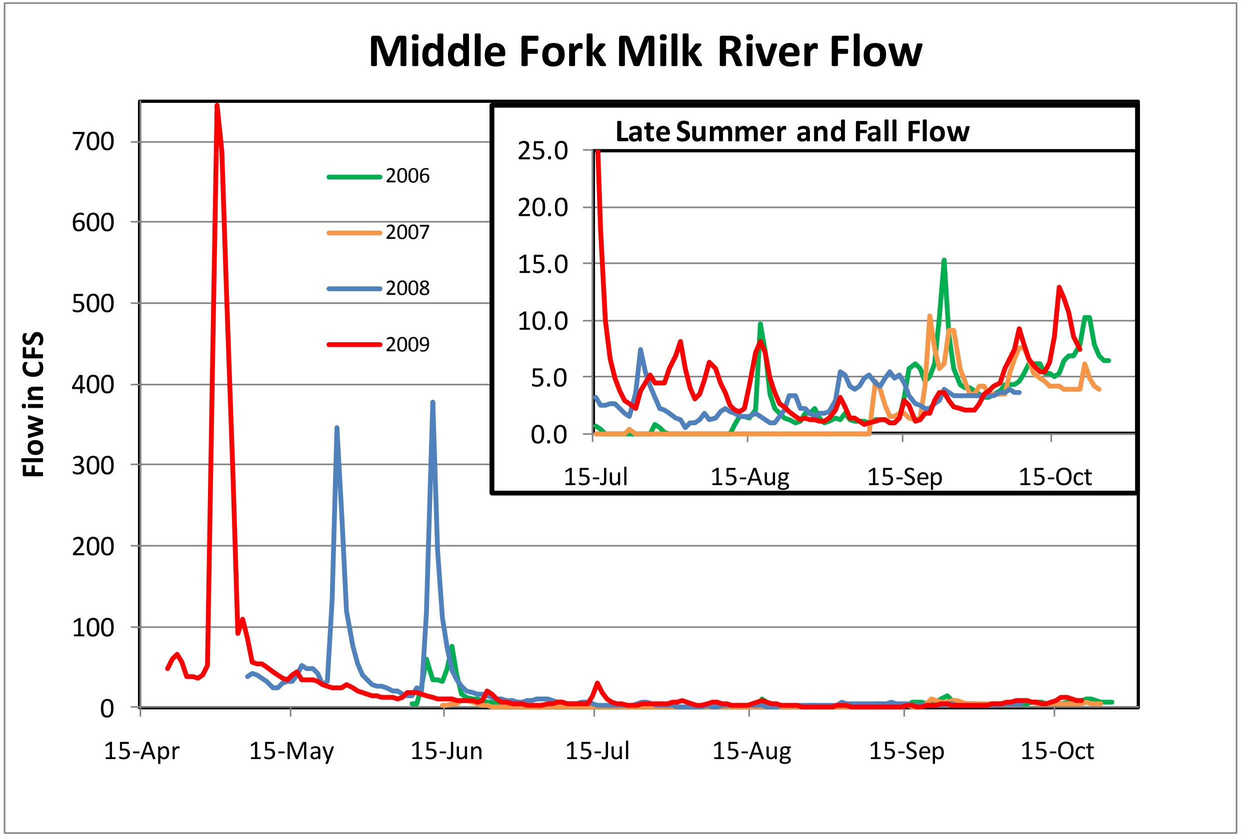
Middle Fork of the Milk River at the DNRC gaging station above the Forks

The Middle Fork of the Milk River drains the area between the South Fork and the North Forks of the Milk River. The headwaters of the Middle Fork extend to the St. Mary Ridge, and the Dry Fork is a major tributary to the Middle Fork. Elevations in the Middle Fork watershed range from about 5,900 feet in the upper portion, to about 4,400 feet at the confluence with the South Fork. The DNRC gaging station on the Middle Fork was located on the stream just upstream of where it joins with the South Fork to form the Milk River main stem.

Figure 3 is a hydrograph plot for the Middle Fork of the Milk River gage during the 2006-2009 seasons. Flows were highest in April, May, and early June due to snowmelt and spring rains. After that, flows rapidly declined. During 2006 and 2007, there was no flow at times during the later part of the summer and early fall. And there were times of very low flow during 2008 and 2009.

The Middle Fork of the Milk River appears to lose water in its lower reaches during the late summer and early fall. Although the upper portion of the stream was not gaged during this study, at least a small amount of flow always was observed in the upper portion of the stream where it crosses Highway 464, even when there was little or zero flow at the gage at the mouth. No land was actively being irrigated during the study in the Middle Fork drainage, except for early-season irrigation of about 100 acres from a tributary to the Dry Fork. A DNRC examination in 2005 identified lands that had irrigation facilities on the Middle Fork, and the Water Resources Survey in 1969 identified 549 acres of flood irrigation in the sub-basin. It is possible that some of these older flood irrigation systems might be partially functioning and spreading some water during times of high flow. There are many beaver dams between the Highway 464 Bridge and the DNRC gaging station, and observed late summer and fall flow losses likely are due to channel evaporation, water use by riparian plants, and perhaps channel seepage.

Figure 3. Streamflow at DNRC Middle Fork of Milk River gage.



Milk River Main Stem

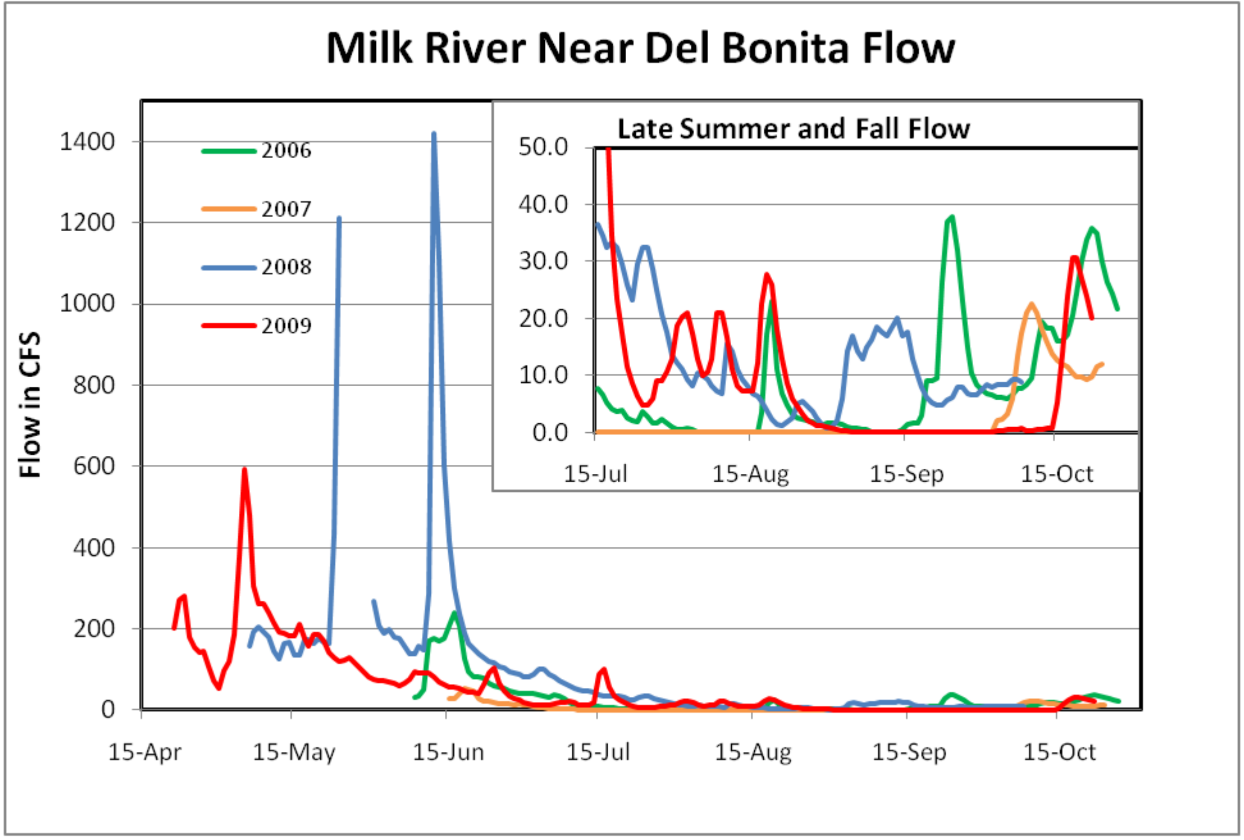
Milk River at the DNRC gage near Del Bonita

The Milk River main stem is considered to begin at the confluence of the South Fork of the Milk River and Middle Fork of the Milk River. The elevation at the confluence is about 4,400 feet, while at the Western Crossing of the International Boundary, about 49 miles downstream, the elevation of the Milk River is about 3,800 feet.

Figure 4 is a hydrograph of the flow of the Milk River near Del Bonita. The DNRC Milk River near Del Bonita gage is located near the mid-way point of the stream in the United States: about 28 stream miles upstream of the Western Crossing gage and about 21 stream miles downstream of the junction of the South and Middle Forks of the Milk River.

The flow patterns in the Milk River are similar to those of its major tributaries, peaking in the April-June period and quickly dropping during the summer. The flow at the Del Bonita gage reached zero at some point during the late summer and early fall of all years except 2008, when it dropped to very low levels in late August. When the flow was considered to be zero at the Del Bonita gage, there always was at least some standing water in the pools, and often a tiny trickle of water through the cobbles at riffles could be observed. There was one irrigator who consistently used water during the summer from this reach of the river until the flow became too low to pump, which was in early August during 2008 and 2009. The flow of the stream generally picked up some later in the fall, following the end of the growing season and from fall precipitation.

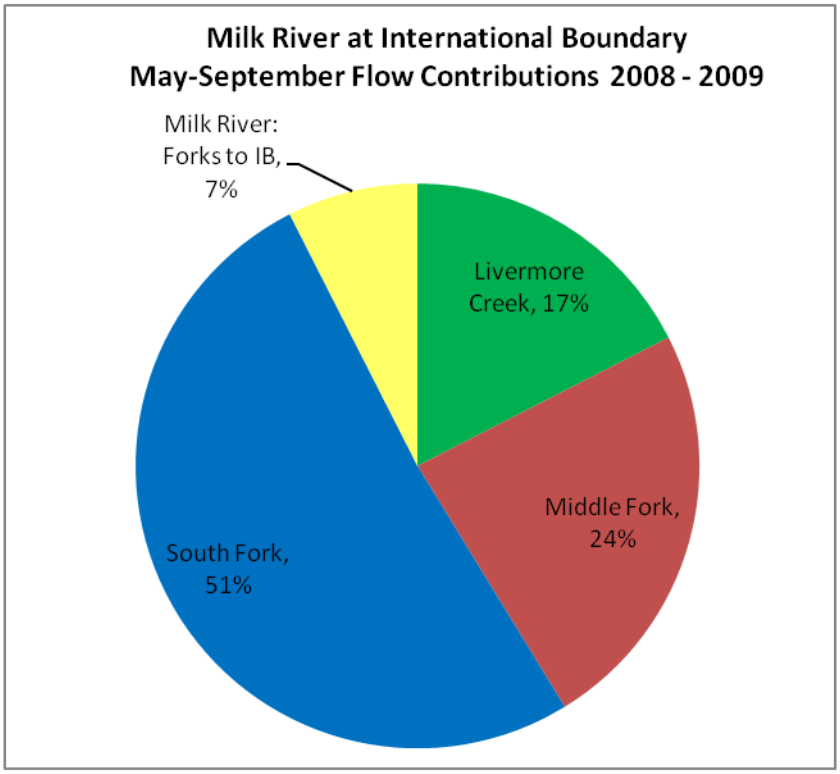
Figure 4. Streamflow at DNRC Milk River at Del Bonita gaging station.



Flow Contributions of Milk River Tributaries to Western Crossing

Most of the Milk River flow at the Western Crossing of the International Boundary originates from the upper portions of the watershed. This is depicted in Figure 5 which compares the approximate relative flow contributions of the various upper Milk River tributaries during May through September for the 2008 and 2009 seasons (streamflow data for the years 2006 and 2007 were not included because the DNRC gaging stations were not started until mid-June during those years). Over 90 percent of Milk River flow at the Western Crossing during the 2008 and 2009 seasons originated above the confluence of the South and Middle Forks, even though these drainages only make up about half of the total drainage area at the Western Crossing. The South Fork of the Milk River alone contributed about half. Livermore Creek and the Middle Fork of the Milk River also are important flow contributors. The rest of the drainage area, between the Forks and the Western Crossing of the International Boundary, did not contribute a large percentage of the May through September flow during these years. It is likely that these areas contribute a larger percentage of the early season flow (March and April) when the snow on the prairie typically melts. It also is possible that the proportional flow contribution from this lower portion of the watershed is higher during wetter years.

Figure 5. Relative flow contributions of tributaries and river reach segments to the average May through September flow of the Milk River at the Western Crossing of the International Boundary for 2008 and 2009.



North Fork of the Milk River Streamflow Characteristics

North Fork of the Milk River near the DNRC upper gaging station

The North Fork of the Milk River is discussed separately in this analysis because it does not flow into the Milk River until downstream in Alberta, and because its hydrology differs from that of the Milk River upstream of the Western Crossing and the South Fork and Middle Fork. The North Fork originates at elevations of about 5,400 feet: substantially lower than the highest elevations in the South Fork watershed. The elevation just upstream of where the St. Mary Canal discharges into the North Fork is about 4,200 feet. Below the St. Mary Canal discharge, the irrigation season flow in the North Fork is dominated by the flow added by the St. Mary Canal. A temporary gaging station was operated by DNRC on the North Fork of the Milk River near the North Fork Ranch headquarters. This station is about 11 stream miles upstream of the North Fork Milk River USGS gaging station which is about 16 miles upstream of where the North Fork Crosses the International Boundary and just upstream of the St. Mary Canal discharge point. There were no irrigation diversions affecting flow in the North Fork during the study.

Figure 6 is a hydrograph of the flow for the North Fork of Milk River at North Fork Ranch DNRC gage for the 2006-2009 seasons. Base flow in the North Fork of the Milk River varied by year during the study, dependent on water supply conditions. For instance during 2008, the wettest year of the study, the flow was about double that during 2007, the driest year. In all years though, a relatively stable baseflow seemed to be maintained throughout the late summer and fall.

The more stable baseflow in the North Fork could be due to the prevalence of gravel-capped pediments and terraces in the watershed, such as those of Freezeout Flat, Radar Ridge, and

Hungry Horse Flat. These terraces are likely to be highly permeable, and rain and melting snow could percolate slowly through them before reaching the stream or the tributaries and springs that discharge from the surrounding slopes to the North Fork. Springs occur in the watershed where unconsolidated deposits and bedrock intersect (USGS 1996). The numerous small lakes and depressions in the upper part of the watershed also might be capturing and infiltrating rain and snow in a similar manner.

Figure 6. Streamflow at DNRC North Fork of Milk River at North Fork Ranch gaging station.

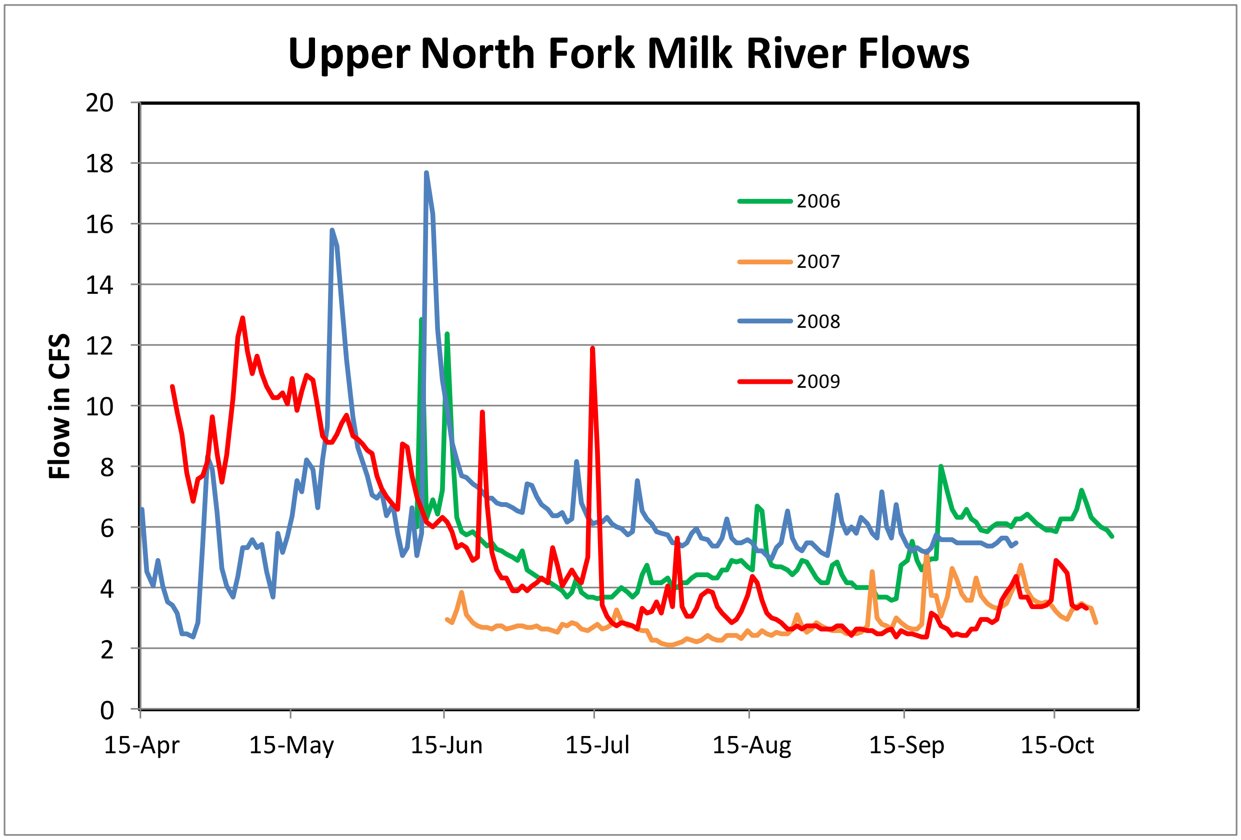


Figure 7 compares the flow of the North Fork Milk River at the North Fork Ranch gage to that at the USGS gage just upstream of the St. Mary Canal discharge point. The North Fork gains water in this reach, with the flow at the North Fork above the St. Mary Canal gage consistently running about 3 times higher than the flow at the North Fork Ranch gage. The drainage area at the North Fork Ranch gage is 13.2 square miles while that for the gage above the St. Mary Canal is 59 square miles, or about 4.5 times greater. The higher elevation contributing area for the upper gage likely accounts for the greater upstream flow per unit area.

Figure 8 compares the flow of North Fork of the Milk River above the St. Mary Canal gage to that of upper USGS South Fork of the Milk River gage at the Highway 464 Bridge. The drainage area of the upper South Fork is somewhat larger, at 70.4 square miles versus 59 square miles for the North Fork. During the March through October period, the South Fork produces almost twice the volume of water as the North Fork. This probably is due to the higher elevation and associated higher precipitation in the South Fork drainage. By the end of the late summer and through the early fall though, the North Fork was generally flowing more water than the South Fork due to its steady base flow.

Figure 7. North Fork of Milk River flow Comparison.

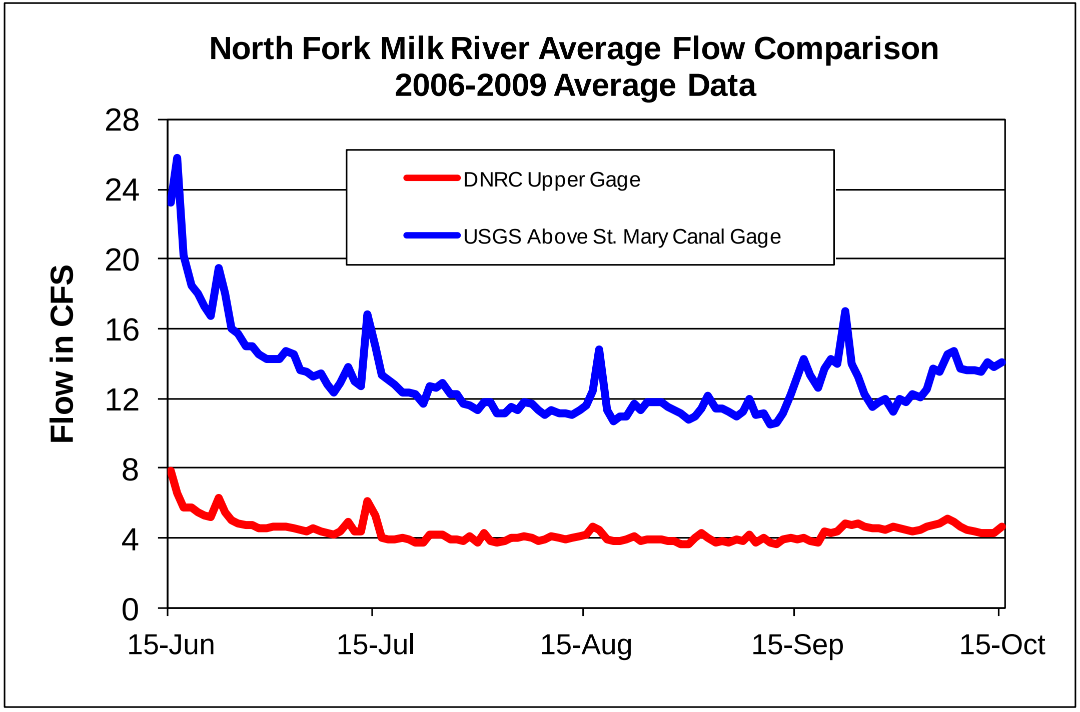
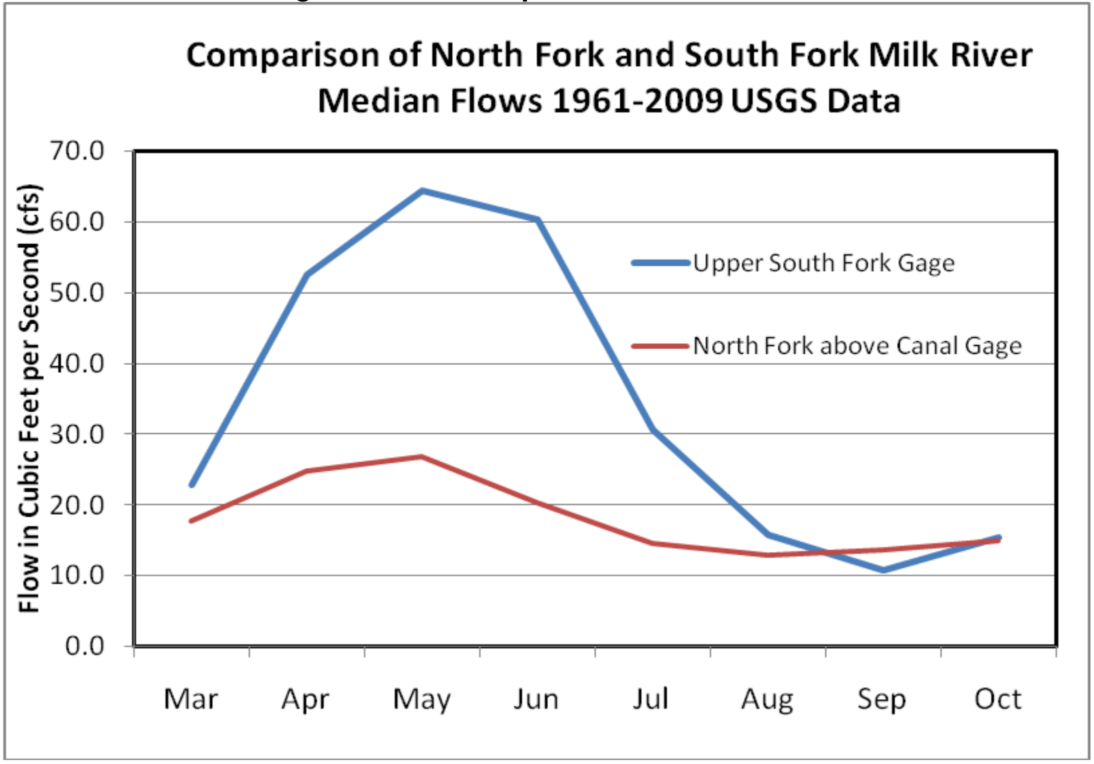


Figure 8. Comparison of the median flow of the North Fork Milk River to that of the South Fork Milk River during the 1961-2009 period.



Streamflow and Water Supply Conditions During the Study

Figure 9 compares the March through October irrigation season median monthly flow of the Milk River at the Western Crossing of the International Boundary stream gaging station (USGS gage 06133000) during the 2006-2009 study period to that for the entire 1931-2009 gaging station period of record. The median flow is the middle flow (half the time the flow would be higher; half the time lower), and represents what might be considered "typical" flow for the stream.

Upper Milk River flow generally is highest during the runoff season in April, May, and early June. After runoff, the flow tends to recede relatively quickly, usually being lowest during the late summer and early fall. Note that in the fall, the flow generally will tend to increase some. This coincides with the end of the growing season and end of evapotranspiration by plants, and the onset of some fall precipitation during many years.

When conducting a study of a relatively short duration, such as this one, it is important to understand how conditions during the study compare to the longer-term record. From Figure 10, it appears that the flow of the upper Milk River tracked typical seasonal trends during the study, but generally was lower than the long-term median.

Figure 9: Comparison of Milk River at Western Crossing of the International Boundary median monthly flow during the study to the long-term median monthly flow.

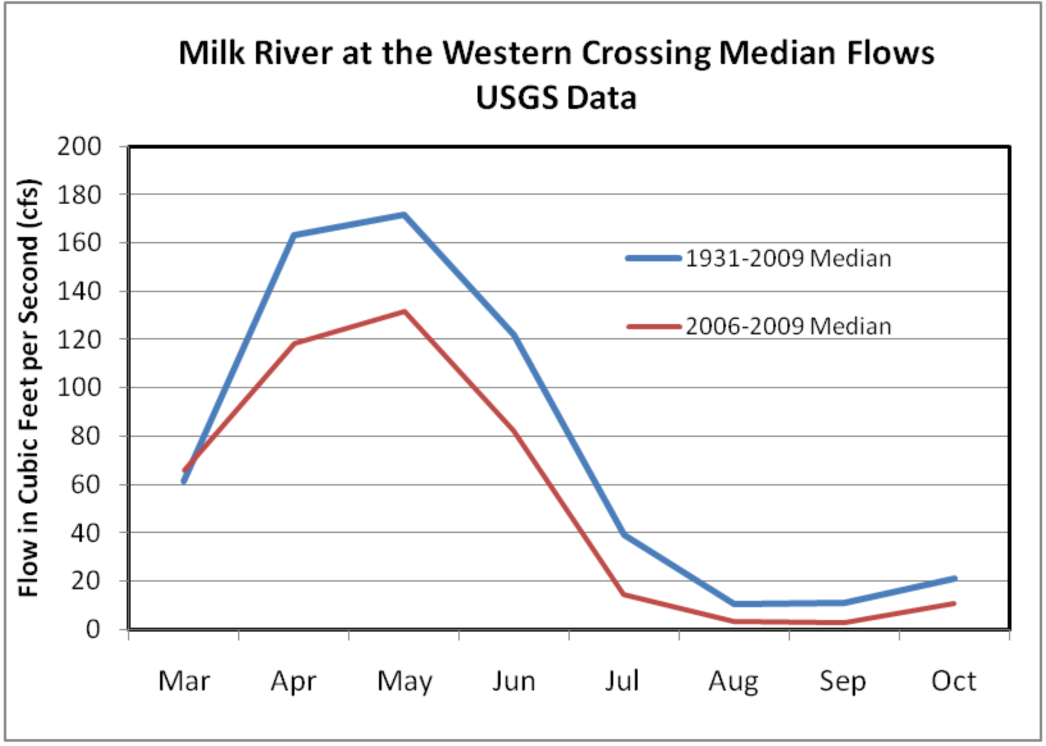


Table 2 lists monthly flow and seasonal volumes (acre-feet) produced at the Milk River at the Western Crossing gage during each year of the study and compares these to other long-term flow statistics for the gage. The seasonal volume during three of the study years was below the long-tem median, with the 2008 season being slightly above median and near the long-term average. Only one of the years was near the lower quartile, with flows at or below the lower quartile indicating very dry conditions (flow would be less than the lower quartile only about 25 percent of the time). Although, from a seasonal volume standpoint, the flow during the study did not seem to be exceptionally low, the flow during the months of July and August of 2006 and 2007 was below the lower quartile for those months, with zero flow during the entire month of August, 2007. Overall, hydrologic conditions during the study might be characterized as ranging from typical (2008) to the moderately dry (2006, 2007, and 2009), with some very low later summer and early fall streamflow occurring during 2006 and 2007.

Table 2. Milk River at Western Crossing of International Boundary monthly flow during the study period compared to long-term monthly flow statistics.

	Average Monthly Flow in CFS								March-October Volume (acre-feet)
Study Year	March	April	May	June	July	August	September	October	
2006	97.4	239	82.7	101	11.0	1.60	5.40	13.4	33,200
2007	145	93.0	77.4	39.1	1.60	0	0.13	8.70	22,200
2008	34.8	101	322	248	45.7	5.18	7.72	12.5	47,000
2009	27.0	136	181	64.0	18.2	7.98	0.11	14.9	27,200
Average	76.0	142	166	113	19.1	3.69	3.34	12.4	32,400
Median	66.1	118	132	82.5	14.6	3.39	2.77	13.0	30,200
	Long-Term Record (1931-2009)								
Average	101	200	202	176	55.1	19.3	19.6	24.4	48,300
Median (Q_{50})	61.6	163	172	122	39.0	10.3	11.0	20.8	43,800
Lower Quartile (Q_{25})	35.8	90.5	79.0	48.3	12.1	1.73	2.47	10.7	22,200

Table 3 lists precipitation during the study period at the Del Bonita National Weather Service Cooperative station. The station is located near the eastern portion of the study area. The data for this station may not give a good indication of the precipitation in the higher elevations of the watershed, but the data do indicate how dry it was at the lower elevation during the growing season. Unfortunately, data were missing for some months during 2006 and 2007, so annual and seasonal totals could not be computed for those years. Precipitation during 2008 was slightly below the long-term mean, while during 2009 it was substantially lower. It appears that summer precipitation during 2006 and 2007 was generally below average, which likely contributed to the low flows or absence of flow during the late summer of these years.

Table 3. Precipitation at the Del Bonita weather station during the study compared to the long-term average station precipitation.

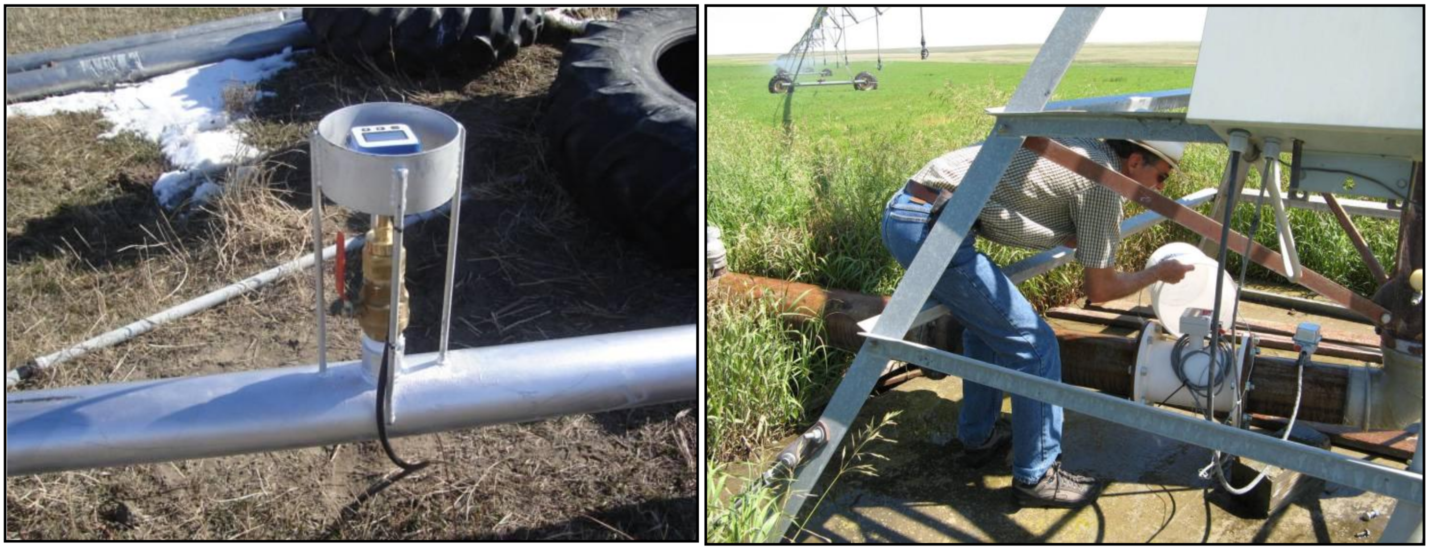
	Precipitation in Inches												
Study Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2006		0	NA	NA	1.35	3.5	0.52	0.95	NA	1.62	2.08	1.03	
2007	0.2	0	0.04	NA	0	NA	NA	0.85	1.56	0.4	0	0.22	
2008	0.21	0.14	0.07	0.14	3.64	2.58	1.37	0.9	2.39	0.09	0.06	0.92	12.51
2009	0.24	0.11	0.78	0.16	0.17	2.35	2.63	0.6	0.81	1.05	0.25	1.18	10.33
1951-2010 Average	0.43	0.34	0.60	1.10	2.37	3.35	1.43	1.65	1.39	0.58	0.52	0.43	14.18

Irrigation Water Use

In-line flow meters, installed on pump-to-sprinkler systems, and flumes (equipped with water level loggers) were used to estimate irrigation water use in the Upper Milk River watershed during this study. Landowners who were not irrigating at the time of this study but planned to do so in the future also were provided with measuring devices. The flow measuring devices all were installed in late 2007 and during 2008. Photos 1 through 4 illustrate several of the measuring devices installed and used during the study.

During the 2008 and 2009 seasons, meters were periodically read by DNRC staff and landowners were contacted to estimate irrigation water use. Estimated diversions, by month and by subbasin, are summarized in Table 4. These results include a combination of measured flows by meters and flumes, and estimates based on conversations with the irrigators. Sprinkler irrigation systems were assumed to consume the entire amount of flow diverted because most of the acres irrigated during the 2008-2009 season were by center-pivot systems which typically generate little return flow. Flood irrigation systems were assumed to deplete 50 percent of the diverted flow. Because the irrigated fields for these systems were close to the river, it was assumed that much of the water that was diverted would return to the stream relatively quickly. The 50 percent return flow used was a rough estimate and assumes a relatively high efficiency for flood irrigation. More thorough system-specific analyses would be required for more accurate estimation of return flow. Where diversions were reported but not measured, 8 inches of water was assumed consumed per acre irrigated. This is a rough estimated based on the following assumptions: (1) that there was only one irrigation early in the season, (2) that the irrigation entirely filled the soil to field capacity and that the soil profile was able to hold 8 inches of water and (3) that the irrigated crop later consumed this water. A medium loam soil might have a capacity to hold about 2 inches of water per foot of soil (NCAT, 2003); with the first-four feet of the loam soil, where most of the root zone would be located, having a water capacity of about 8 inches total. The earlier investigation by the U.S. Geological Survey also used an annual water consumption of 8 inches for flood irrigation in the Upper Milk River watershed (USGS 1986). Because measuring device installation lagged behind the stream gaging station installation, irrigation water use estimates are not included for the 2006 and 2007 seasons, although from conversations with landowners these uses were thought to be of a similar amount as those during 2008 and 2009.

Interviews with the landowners and on-site inspections indicated that about 1,400 acres of land in the upper Milk River watershed were being irrigated on a somewhat regular basis around the time of the study. There are other lands that are irrigated on a less regular basis, or that have water rights and have been irrigated in the past and could be brought back into production relatively quickly. There were no lands irrigated with water from the North Fork of the Milk River during the study period, although there are lands with water rights that have been irrigated at times during the past 10 years in this drainage.



Photos 1 and 2. Pipe flow meters on the Berkram and Smrcka Sprinkler Irrigation Systems.

Photos 3 and 4. Flumes on the Peterson and Reeverts surface irrigation systems.

Table 4. Upper Milk River Watershed estimated irrigation water use in acre-feet during 2008 and 2009.

	South Fork Watershed	Middle Fork Watershed	Milk River Proper	Total (acre-feet)
April	31			31
May	200	77	43	320
June			77	77
July	33		110	143
August			79	79
2008 total	**264**	**77**	**309**	**650**
April	8			8
May	43	30		73
June	17	18	192	227
July	138		164	302
August	38		62	100
2009 total	**244**	**48**	**418**	**710**

Streamflow Gains and Losses

Streamflow gains and losses in the Upper Milk River watershed also were investigated during this study. Figure 10 depicts the 2006-2009 average summer and fall flow for streams in the upper Milk River watershed. The blue line "Upper Watershed Inflow" is the summation of the flow for the upper South Fork of the Milk River (at USGS gage 06132200), Livermore Creek, and Middle Fork of Milk River. The "Total at Forks" is the combined flow of the lower South Fork of the Milk River at the DNRC gage and the Middle Fork of the Milk River. Progressing downstream, flow also is plotted for the Milk River at Del Bonita and for the Milk River at the Western Crossing of the International Boundary. The graph time-scale starts on June 15 because the DNRC gages were not started until mid-June during the 2006 and 2007 seasons. These are plots of the average flow for the four years, rather than flow during a particular year.

In general, the system gained water throughout until late June. This coincides with the runoff season, when flow is still being added to the surface-water system throughout the watershed. Later during the summer though, flow declined progressing downstream as flow rates dropped overall, and flow losses exceeded flow gains. Late-summer flow losses tended to be highest in the upper portions of the watershed, upstream of the Forks, and especially between the upper South Fork and lower South Fork of the Milk River gages. These losses could be due to the additive effects of several factors including irrigation depletions, channel evaporation, water use by riparian plants, and channel seepage.

Figure 10. Upper Milk River watershed streamflow comparison.

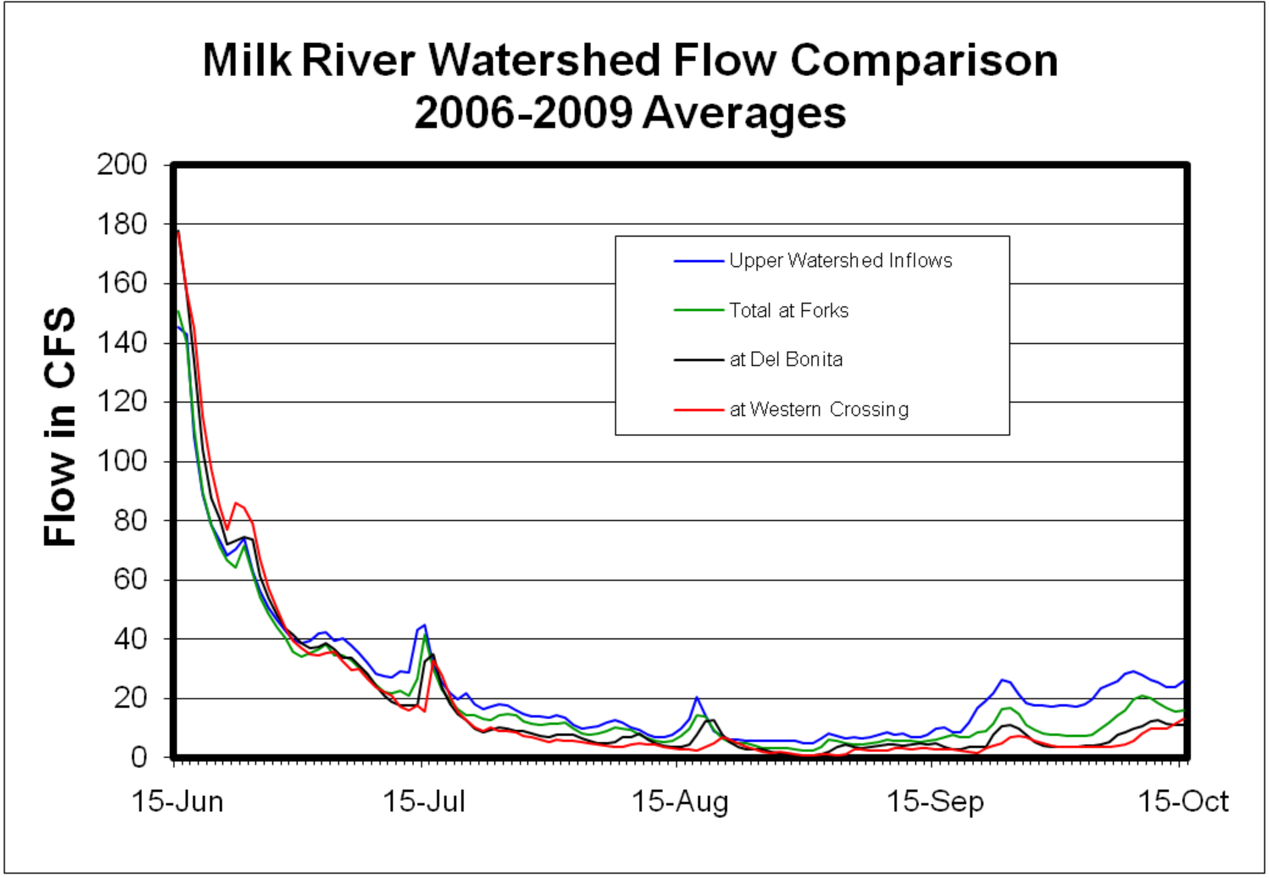
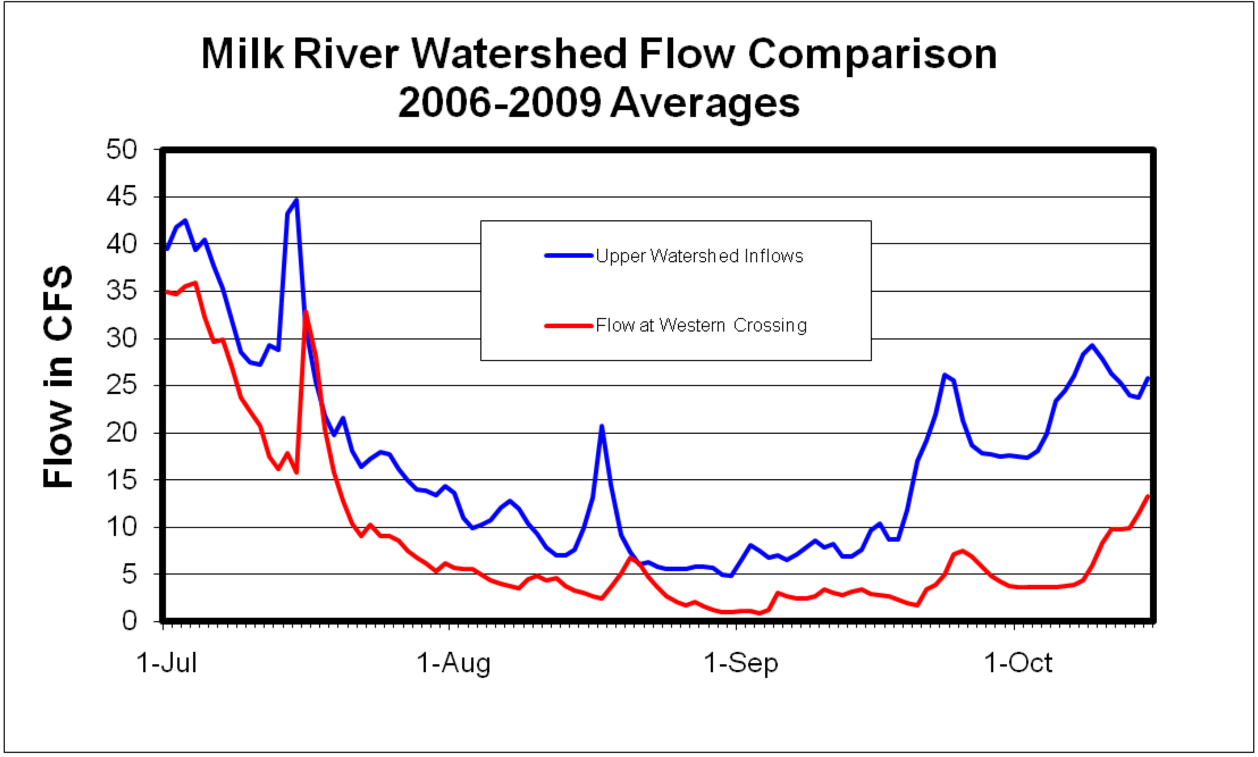


Figure 11 simplifies the information in the previous graph (Figure 10) by comparing only upper watershed inflow to the flow of the Milk River at the Western Crossing of the International Boundary, and by only including the period after July 1. During the later part of the summer and early fall, total losses from the system (which would include irrigation diversions) usually range between about 5 and 15 cfs, and averaged about 7.5 cfs. The minor peaks in the graph (the ones in mid-July and mid-August) probably are the result of rainfall events during one the years that raised the average flow for the period during those particular days. The shifting of these peaks, between the upper gages and the Milk River at the Western Crossing, reflects the 2-3 days it appears to take for water to flow through the system.

Figure 11. Upper Milk River watershed inflow-outflow comparison.



Average losses were presented in these graphs for simplicity and to show the overall trend. A more detailed year-by-year examination of the estimated channel losses for each month and river reach is presented in Table 5. These estimates are based on flow differences between the upstream and downstream gaging stations. The losses in this table only are those that would occur between the specified reaches; they would not include losses due to irrigation diversions in the South Fork watershed above the Highway 464 Bridge or in the Middle Fork watershed above the Forks.

Table 5. Upper Milk River watershed loss estimates by segment in acre-feet.

	South Fork Highway 464 to Forks including Livermore Creek inflow (17 river miles)	Milk River: Forks to Del Bonita (21 river miles)	Milk River: Del Bonita to Western Crossing (28 river miles)	Total (66 river miles)
July	305	48	133	486
August	314	214	71	599
September	214	124	154	492
2006 total	**833**	**386**	**358**	**<u>1,580</u>**
July	295	129	0*	424
August	213	0*	0*	213
September	252	340	0*	592
2007 total	**760**	**469**	**0**	**<u>1,230</u>**
July	177	179	32	388
August	0	255	66	321
September	448	119	191	758
2008 total	**625**	**553**	**289**	**<u>1,470</u>**
July	292	192	126	610
August	97	6	209	312
September	218	116	0*	334
2009 total	**607**	**314**	**335**	**<u>1,260</u>**

* Because there was little to no flow in these stream segments during these months, channel losses were zero or near-zero.

During the late summer of 2006 and 2007, the flow in the upper Milk River was very low in the headwaters and the streamflow ceased in the lower sections. Although the lack of flow might have been partially attributed to irrigation, the primary reason appears to be that the flow produced in the headwaters was not sufficient to overcome channel seepage and evaporation.

Channel losses generally were highest in the South Fork of the Milk River between the Highway 464 Bridge to where the stream joins with the Middle Fork. This could be due to higher seepage losses in this reach of river, and partially because late-summer flow generally was higher in this portion of the river……..that is, there was more water to lose to start with. From examining the data and speaking with local ranchers, it appears that, when the flow of the South Fork drops below about 5 cfs at the Highway 464 Bridge, flow does not make it to the lower portions of the South Fork, even when no water is being diverted for irrigation in the river reach between. Photo 5 is a September, 2003 aerial photograph of the lower South Fork of the Milk River (just upstream of the Forks) near where the lower South Fork of Milk River DNRC gage was installed during 2006. It shows the stream running out of water just downstream of the gage site, even though the gaged flow at the Highway 464 Bridge was a little over 5 cfs. Low to zero flow conditions also were recorded on the lower South Fork during this study. Photo 6 depicts the flow of the South Fork above the Forks during August, 2007, when there was just a trickle of flow through the riffles at the gage with mostly standing water in the pools. Figure 12 illustrates estimated July-September average total channel losses in acre-feet by stream segment.

Photo 5. Dewatered Lower South Fork of Milk River just above the confluence with the Middle Fork of Milk River, September 2003.

Photo 6. South Fork of the Milk River above Forks during August 6, 2007

Figure 12. Estimated July through September channel losses by river reach in the upper Milk River watershed.

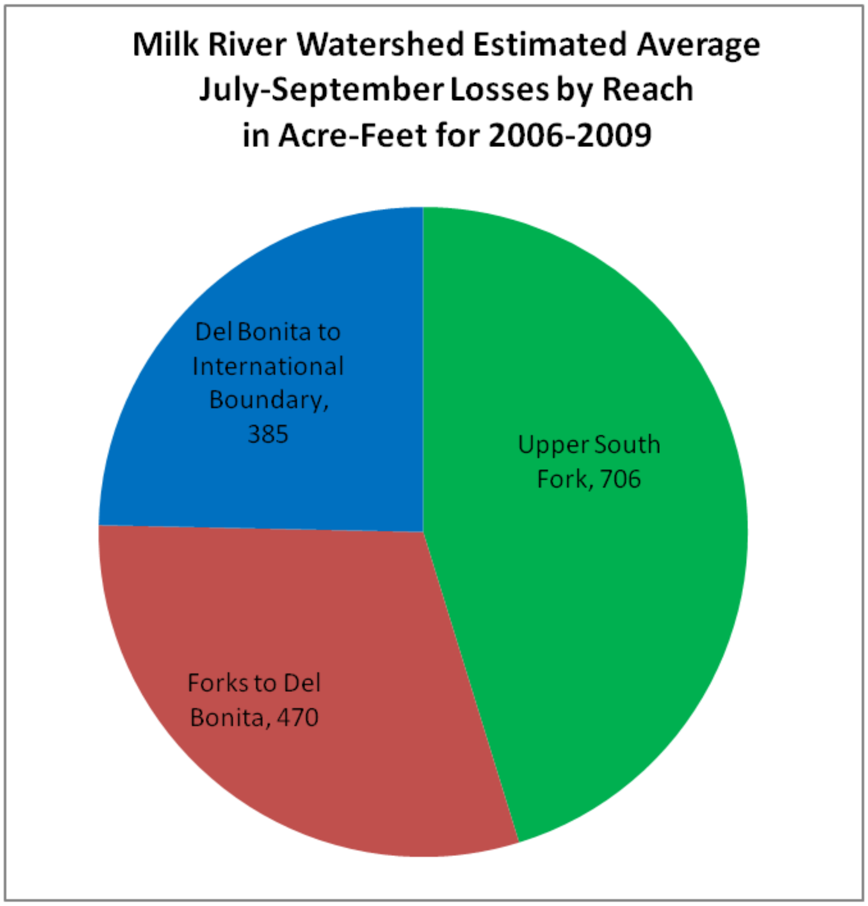


Table 6 summarizes average total flow losses by stream reach and how much of these losses might be attributed to irrigation depletions and evaporation. The irrigation depletions listed in the table are averages for the season by reach, but are based only on data collected during the 2008 and 2009 seasons, because there were no irrigation measuring devices installed before 2008. Evaporation was estimated by multiplying the average pan evaporation from the One-Four Agricultural Experiment Station in Alberta (adjusted by a 0.85 pan factor), by the estimated channel area for each reach. The area of the channel is the channel length times the width, with the widths based on those measured during discharge measurements at the gaging station.

From this analysis, it appears that most of the loss between the Forks and Del Bonita, and between Del Bonita and the Milk River at the Western Crossing of the International Boundary, can be attributed to a combination of channel evaporation and irrigation depletions. Irrigation depletions and evaporation though only explain a smaller portion of the losses that occur in the lower segment of the South Fork of the Milk River, with channel seepage likely accounting for the larger portion. Seepage losses may not be as high downstream of the Del Bonita gage, because the river channel here leaves the Quaternary fill deposits and flows over relatively impermeable mudstone bedrock to the east, before flowing north again through a much narrower alluvial valley (USGS 1996).

Table 6. Average July through September flow losses during the 2006-2009 period and estimated contributions to those losses in acre-feet.

	South Fork Milk River Highway 464 to Forks (17 river miles)	Milk River: Forks to Del Bonita (21 river miles)	Milk River: Del Bonita to Western Crossing (28 river miles)	Total (66 river miles)
Total July-September Losses	706	470	385	1,561
Irrigation Depletions	84	197	11	292
Evaporation	66	132	225	423
Remainder	**556**	**141**	**149**	**846**

* Note: All losses are based on 2006-2009 averages, except for irrigation depletions estimates, which are based only on 2008-2009 data. Irrigation depletions only include July through September estimates within the designated reaches; they do not include irrigation depletions in the South Fork and Middle Fork watersheds upstream of the Highway 464 crossings.

Seepage Investigations Using Streambed Temperatures

Temperature differences between the stream and the subsurface groundwater can be used to investigate the movement of water through the streambed. The USGS (2003b) has developed procedures for investigating water movement through the streambed using water temperature data.

To investigate potential seepage through the streambed in the Milk River watershed, submersible temperature loggers were installed at the gaging sites for the DNRC South Fork of Milk River above confluence with Middle Fork (SFMR), Milk River near Del Bonita (MRDB), and North Fork of Milk River at North Fork Ranch (NFMR) gaging stations. The loggers were placed in the gaging station stilling wells (a length of 2-inch pipe driven into the streambed) at intervals up to a depth of just over 3 feet: the maximum depth to which the stilling well pipe typically was driven into the streambed. Foam pipe insulation was used to isolate the individual temperature loggers in the stilling-well so that each logger measured and recorded the temperature of the adjacent groundwater (see photo in Appendix 3). For comparison, stream water temperatures were logged by the TruTrack Ltd. water level loggers which were used at the gaging sites.

For streams that are losing substantial amounts of water through the channel bed, the downward flow of water will transport heat from the stream into the streambed sediments. This downward flow of heat will result in significant daily fluctuations of temperature (like those that occur in the stream itself) in the streambed sediments and these daily fluctuations should be visible with depth. For streams where there is little flow of water into the streambed, or where there is groundwater flow from the streambed into the stream (gaining streams), temperatures in the streambed sediments will not show significant daily variations with depth.

For the gaging station temperature monitoring data, substantial daily fluctuations in water temperatures were not visible in the data for the streambed temperature loggers deeper than about 1.0 foot. This seems to indicate that, at least at the gaging station locations, streambed seepage rates were not overly high. Appendix C contains graphs depicting the stream and subsurface temperature data at the selected gaging sites for the 2008 and 2009 seasons.

Previous Upper Milk River Water Use and Flow Investigations

Early 1960s

During the early 1960s, several inspections were made to examine the extent of upper Milk River water use in the United States for the purposes of determining what might be causing the low summer and fall streamflow at the International Boundary at that time. These inspections were conducted jointly by the United States and Canada, except the 1962 inspection which was conducted by USGS personnel only. The following is the introductory paragraph for the first inspection from 1960:

> *"The flow of the South Fork of the Milk River within Canada was very low during the summer of 1960. The stream ceased to flow about September 8 and that condition prevailed until October 14. Concern was expressed by cattle raisers within the fifteen-mile meandering reach of Canada as pools were becoming low. Severe freezing weather under these conditions could result in a serious and prolonged stock-water shortage. Mr. Mar R. Stringham registered a complaint, evidently on his behalf and perhaps on the part of others. In his complaint to the Department of Agriculture, Edmonton, Canada, he stated that he observed a "fair stream" in the South Fork of the Milk River south of Del Bonita and a "good head" due north of Browning, Montana on October 6. Mr. Delano Jones who lives just north of the boundary verbally complained on the absence of flow."*

An excerpt from the field inspection that was conducted on October 26, 1960 discusses the extent of irrigation in the upper watershed that year.

> *"The inspection revealed that some private irrigation is practiced within the drainage basin particularly during the high-water period, but not restricted thereto. Approximately 250 acres of native hay land appear to be irrigated under fairly well attended works. A much larger acreage is poorly served by small ditches or sub-surface irrigation caused, to a considerable extent, by innumerable beaver dams."*

The 1960 report revealed that low flow had been a concern during prior years by referencing some early investigations as follows:

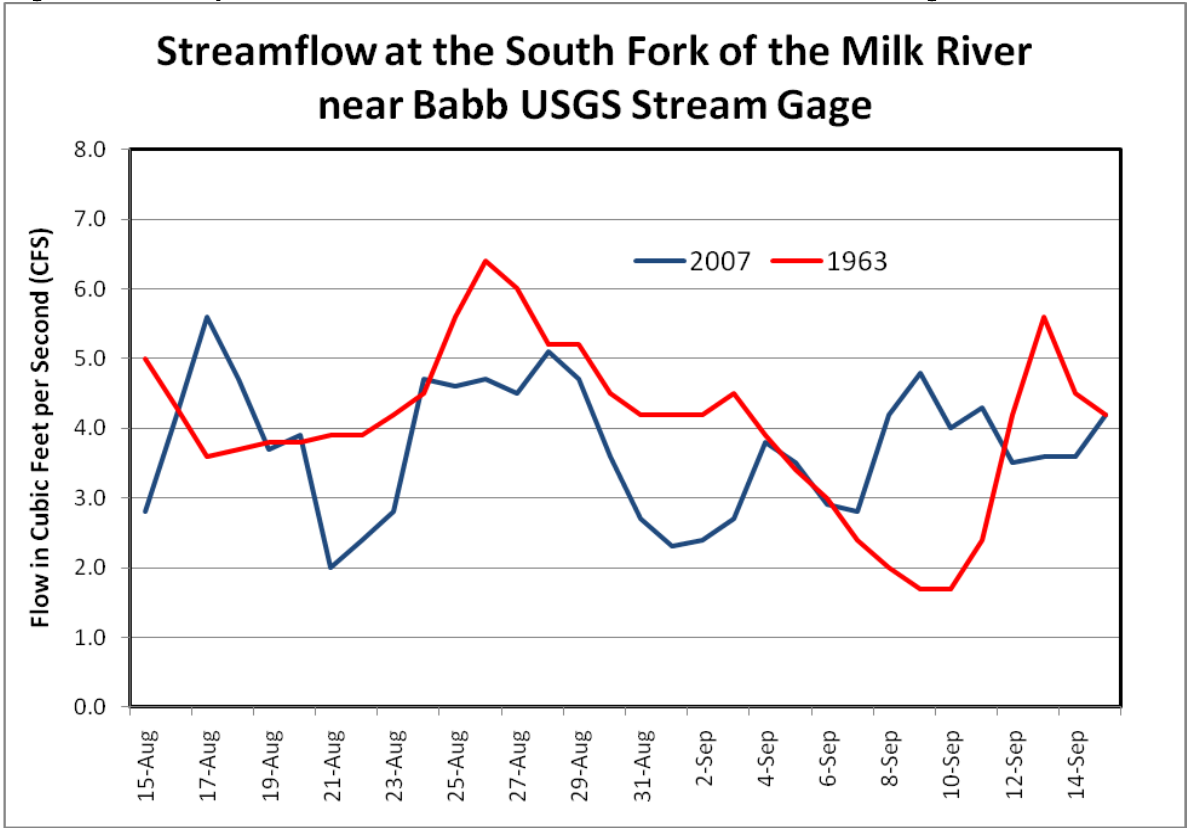
> *"The low flows of 1936 and 1944 prompted inspections of the Milk River drainage within the Blackfeet Indian Reservation. On July 28, 1936, it was noted that there was approximately 5 cubic feet per second near the headwater at the U.S. Highway 89. There was no flow at the junctions of the Middle and South Forks in T. 36 N., R.11 W. At a few points downstream very minor flow prevailed for short reaches. Facilities for the diversion of water to the hay land were noted at a number of points although no diversion was taking place or could be satisfactorily conducted except at medium or high stages. The report of August 6 and 8, 1944 discloses no irrigation was apparently conducted during the period of low flow."*

The 1961 report described that *"The U.S. Geological Survey began additional stream-flow record collection in 1961 to supplement discharge records regularly collected near the* *international boundary."* The 1961 report also stated that *"The Milk River ceased flowing at the western crossing of the international boundary on Aug. 21 and resumed flowing on Sept. 21."* It was the low-flow concerns and these inspections that led to the establishment of the South Fork Milk River near Babb gaging station (USGS station #06132200). Interviews with landowners during the investigations for the 1961 report indicated that the South Fork of the Milk River was dry for some time during that summer above the confluence with the Middle Fork, although there was always at least some flow at the upstream USGS gaging station during this time. There did not appear to be any irrigation between the newly established South Fork gage and the confluence with the Middle Fork during that year. The 1961 report also indicated that *" Observations of the stream-flow data indicates that there was an average gain of about 10 cfs in the reach from Secondary roads FAS 464 [South Fork of Milk River USGS gage] to FAS 483, south of Del Bonita, from early March to early May and a loss of about 7 cfs until late September"*.

Inspections during the 1962 season also showed *"appreciable downstream diminution during the summer season, in the streams which make up the Milk River at western crossing"* although the South Fork of the Milk River above the confluence of the Middle Fork did not appear to entirely cease flowing at any time during that year. The inspections during this and other years also cited beaver activity as appearing to contribute to flow losses and providing sub-irrigation of hay meadows. The beaver population does not appear to have declined in number since.

Streamflow conditions during the early 1960s were similar to what they were during this study. As an example, Figure 13 below compares late-August through early September streamflow for the USGS South Fork Milk River near Babb gage for the years 2007 and 1963. During both years, the flow of the upper South Fork was not sufficient enough to overcome channel losses, and no flow occurred in the Milk River at the Western Crossing of the International Boundary.

Figure 13. Comparison of South Fork of Milk River low flows during 1963 and 2007.



Glacier County Water Resources Survey

In 1969, the Montana Water Resources Board completed a survey of irrigated lands in Glacier County, Montana, which includes all the lands in the upper Milk River watershed. Purposes of the survey were to map irrigated lands and to inventory perfected water rights. The survey started with a comprehensive inventory of water rights filings at the Glacier County Courthouse. This was followed up with detailed examination of aerial photographs and an initial mapping of irrigated lands. All of these mapped irrigated lands where then field checked, which included landowner verification.

The survey identified 1,384 acres of irrigated lands in the upper Milk River watershed. The breakdowns of these acres by subbasin are summarized in Table 7.

Table 7. Irrigated acres in the Upper Milk River Watershed identified in the 1969 Water Resources Survey by subbasin.

South Fork of Milk River and Milk River proper: 580 acres
Arnold Creek: 64 acres
Livermore Creek: 171 acres
Middle Fork of Milk River: 418 acres
Davis Coulee: 24 acres
Dry Fork Milk River and tributaries: 107 acres
North Fork Milk River and Tributaries: 20 acres

The survey also found that there were another 701 acres that were irrigable under the facilities present, but not irrigated at the time.

USGS Thompson Report

During the 1980s, the U.S. Geological Survey conducted investigations to collect information needed to determine the natural flow for the Milk River where it reenters the United States at the Eastern Crossing of the International Boundary (USGS, 1986). This report, referred to as the Thompson Report, covered many topics but primarily was concerned with developing an interim method for computing the natural flow of the Milk River by accounting for the effects of irrigation depletions, and evaporation losses associated with transporting St. Mary Canal water through the Milk River in Canada. Most relevant to this study are discussions in the report concerning irrigation consumption in the headwaters of the Milk River and North Fork of the Milk River upstream of Canada. For the report, the extent of irrigation for 1982 was estimated based on review of earlier irrigation maps (Montana Water Resources Board, 1969), telephone conversations with local irrigators, aerial black and white videotaping (an exciting new technology at the time), and some onsite checks. The findings of the report were that there were about 2,700 acres total irrigated in the upper Milk River basin: 1,900 acres under flood irrigation and 800 acres under sprinkler irrigation. The report also estimated water use for 2,250 irrigated acres in the U.S. portion of the Sweet Grass Hills. The estimated mean daily water consumption due to this irrigation in the upper Milk River watershed (not including the Sweet Grass Hills) is summarized in Table 8.

Table 8. Estimated U.S. Irrigation Daily Depletions in the Upper Milk River Watershed based on Thompson's Report.

Period	Flood Irrigation Depletions (cfs)	Sprinkler Irrigation Depletions (cfs)	Total Depletions (cfs)
May 16-31	21	3	24
June 1-15	21	3	24
June 16-30	0	3	3
July	0	5	5
August	0	4	4
September 1-15	0	3	3
Seasonal Volumes (acre-feet)	1,290	915	2,200

The drafters of the report recognized the yearly variability of irrigation stating that: "*Even though some irrigators in the United States part of the study area irrigate relatively constant parcels of land, others may vary their areas yearly. The variation is mostly associated with the volume and duration of runoff. When runoff is substantially diminished during droughts, less land is irrigated because of water shortages.*" They also recognized the need for irrigation monitoring, especially during times of lower flow: *"The effects of irrigated agriculture currently can be estimated only from surveys that may or may not reflect conditions at any given time. Because irrigation is the single greatest man-induced consumer of streamflows, it needs to be* *monitored closely, particularly during periods of low natural flows when its effects are most significant."* Another observation that was made in the report was that, by adding an average irrigation usage that is greater than natural flow to recorded flows to compute natural flow, the computed natural flow would be inflated.

DNRC 2005 Field Investigations

During April 6-8 of 2005, Mike Dailey and Marv Cross of DNRC traveled to the upper Milk River basin to determine the extent of active irrigation. They used the Water Resources Survey irrigation maps, interviewed landowners and their neighbors, and field-checked lands that had been mapped as irrigated in the past or that were identified by landowners as being irrigated. They found a total of 3,073 acres that were being actively irrigated, and estimated the annual volume of water used during a normal year to be about 2,260 acre-feet. Both of these estimates are similar to what was found in the USGS Thompson Study.

Acres were categorized as being "active" if the land appeared to have been irrigated during recent years, or if the land-owner stated an intention to irrigate the land in the future. This does not necessarily mean that the land was going to be irrigated during 2005. For instance, one 510 acre-parcel that was included in the total had not been irrigated during the most recent years because the land was not being farmed and had been put into the Conservation Reserve Program (CRP). The land was included in the total active acres because the owner's intentions were to irrigate and hay the parcel again, once his CRP contract expired.

Implications: Computations of Milk River Natural Flow for International Apportionment

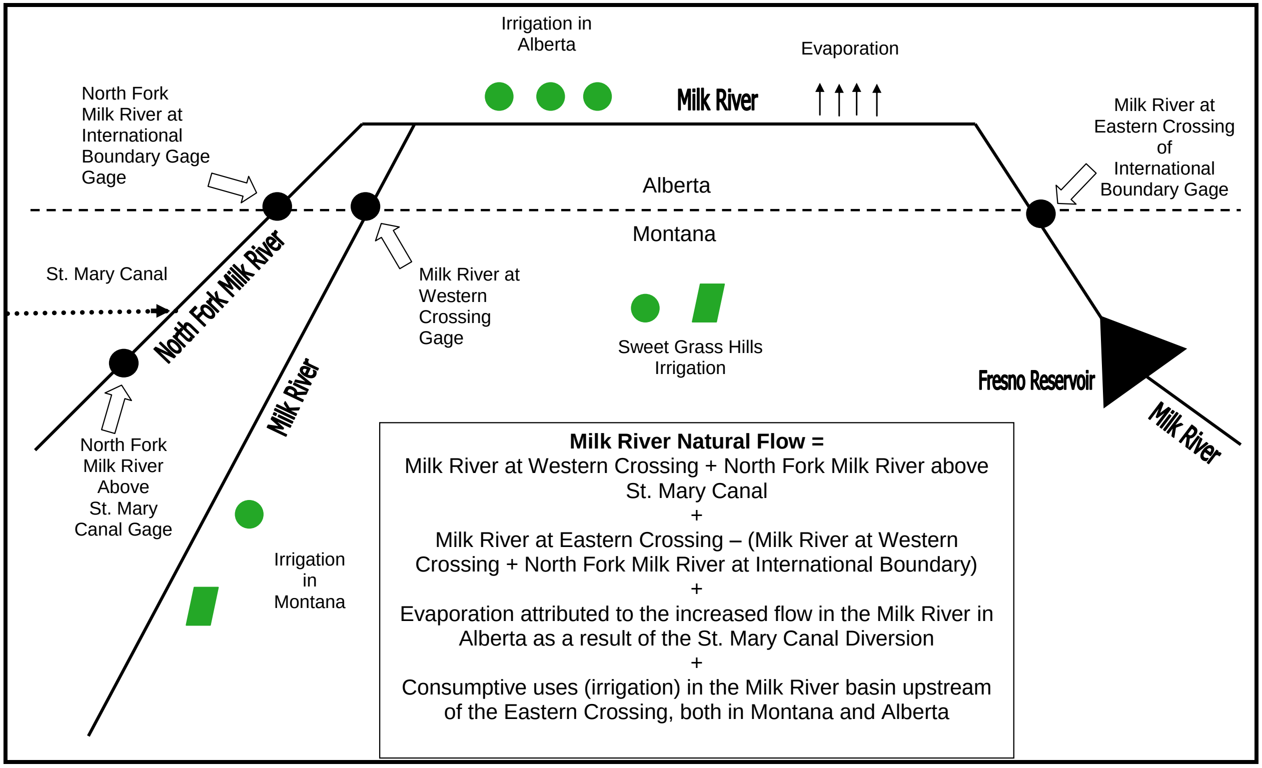
The 1921 Order of the International Joint Commission allocates Milk River natural flow to the United States as follows:

- During the non-irrigation season (November 1 to March 31) the United States is entitled to 50 percent of the natural flow of the Milk River
- During the irrigation season (April 1 through October 31) the United States is entitled to:
  - ➢ 75 percent of the first 666 cfs of natural flow
  - ➢ 50 percent of the natural flow above 666 cfs

Most of the time during the irrigation season, the natural flow of the Milk River is below 666 cfs, and the United States is entitled to 75 percent of the flow. Higher natural flow typically only occurs following rainfall events, or during the spring of years when runoff is higher than average.

Determination of the United States share (and the Canadian share) is dependent on accurate computation of the natural flow of the Milk River. Estimating Milk River natural flow is complicated by the effects of water uses in the U.S. and Canada, and diversions of St. Mary Canal water into the North Fork of the Milk River. During the irrigation season, the basic procedure for computing the natural flow of the Milk River at the Eastern Crossing of the International Boundary is described in Figure 14.

Figure 14. Milk River natural flow computation procedure and schematic.



Milk River Natural Flow =
Milk River at Western Crossing + North Fork Milk River above St. Mary Canal
+
Milk River at Eastern Crossing – (Milk River at Western Crossing + North Fork Milk River at International Boundary)
+
Evaporation attributed to the increased flow in the Milk River in Alberta as a result of the St. Mary Canal Diversion
+
Consumptive uses (irrigation) in the Milk River basin upstream of the Eastern Crossing, both in Montana and Alberta

Correctly computing the last term in the equation in Figure 14 (consumptive uses) requires an accurate accounting of irrigation depletions. If irrigation depletion estimates are too high, then the natural flow of the Milk River will be overestimated. Depletions estimates that are too low will result in an underestimation of natural flow. An inaccurate computation of natural flow could, in turn, lead to one country receiving more or less water than it should.

Consumptive use estimates from the 1986 USGS report by Thompson were developed for what was considered by the authors to be an interim procedure for the flow apportionment computations. The results of the study are still the basis for estimating consumptive-use depletions in the Procedures Manual for the Division of St. Mary and Milk River flow (USGS and Environment Canada, 2003), with one important refinement: during “dry years” the Thompson estimates are adjusted to reflect the effects that reduced water availability would have on irrigation depletions. During the early irrigation season of “dry years” adjustments are not made for the upper Milk River watershed depletions, because it is assumed that there still is adequate April through mid-June water--although the procedures do assume some reduction in U.S. Sweet Grass Hills area irrigation depletions for these years. After July 21, there are assumed to be no U.S. depletions during “dry years” in the upper Milk River watershed and the Sweet Grass Hills area.

But how large a factor might an inaccurate accounting of irrigation depletion in United States portion of the upper Milk River watershed have on the computed natural flow and the share of Milk River flow that each country receives? Table 9 compares the upper Milk River watershed irrigation depletions used in the current procedures for standard and dry years to the average estimated 2008-2009 depletions from this study. The depletions are categorized for the semi-monthly balancing periods used in the current apportionment computations.

Table 9. Current Upper Milk River Watershed flow apportionment depletions used during standard and dry years compared to 2008-2009 average estimated depletions (does not include Sweet Grass Hills).

Period	Standard Irrigation Depletion (cfs)	Dry-Year Irrigation Depletion (cfs)	Estimated 2008-2009 Depletion
April 1 – May 15	0	0	0.5
May 16-31	24	24	5.3
June 1-15	24	24	1.9
June 16-30	3	3	3.2
July 1-20	5	5	3.6
July 21-31	5	0	3.7
August 1-15	4	0	2.7
August 16-31	4	0	0.6
September 1-15	3	0	0
September 16-30	0	0	0
Total Volume (acre-feet)	2,200	1,760	680

Upper Milk River watershed early-season irrigation depletions during 2008-2009 were found to be much lower than the 24 cfs daily depletion used in the current flow apportionment procedures. During these times, the current flow apportionment procedures are likely overestimating U.S. irrigation depletions, thereby overestimating Milk River natural flow. From mid-June through mid-August, the standard irrigation depletions used were a little higher, but similar to the depletions estimated for this study. There was little irrigation during the study period in late August and none observed during early September, which is more similar to what the current procedures would assume during a dry year.

Making the adjustments for dry years, as shown in Table 9, should account for situations when there is no natural flow at the international boundary. It also should be noted that adding irrigation depletions during those years would result in computing a natural flow that wasn’t there. However, the years 2006, 2007, 2008, and 2009 were all considered to be in the standard category for flow apportionment computation purposes. At present, there is no defined process in the flow apportionment procedures to determine when “dry year” depletions are applied. The years to date that have had “dry” year depletions applied were 1987, 1988, 2000, 2001, 2005.

Concerning early-season U.S. depletions, an overestimation of natural flow will not necessarily result in the United States receiving any less Milk River water unless Canadian Milk River irrigators are able to divert and use their “share” of the over-estimated natural flow. The median Milk River share available to Canada, based just on gaged flow of the Milk River at the Western Crossing of the International Boundary and North Fork of Milk River above the St. Mary Canal, would be about 50 cfs during May and about 40 cfs during early June. Although assessing Alberta Milk River irrigation requirements was beyond the scope of this report, these rates of flow probably are sufficient to meet current Alberta irrigation demands during the early irrigation season. During very dry years, overestimating the Milk River natural flow could allow Canadian irrigators to divert a little more water than they are entitled too. The maximum potential effect on the computation would be 25% (or 6 cfs) of the 24 cfs assumed to be consumed by the U.S. irrigators in the Upper Milk River watershed during these periods. The corresponding volume would be about 370 acre-feet for the late May-early June period.

Summary and Conclusions

Most of the flow of the Milk River at the Eastern Crossing of the International Boundary comes from the upper watershed on the Blackfeet Indian Reservation, and most of that flow is generated from the relatively small foothills area west of Highway 464. During the 2006-2009 seasons, there were substantial flow losses in the lower South Fork of the Milk River, and on the Milk River main stem from the Forks to the Western Crossing of the International Boundary. Some of the flow losses can be attributed to irrigation. During the late summer and early fall though, channel evaporation and channel seepage losses probably are more significant, especially during dry years. The channel losses that were observed during recent years are similar to those observed during investigations in the early 1960s.

There are about 3,000 acres of land in the upper Milk River basin that could be irrigated with existing infrastructure or relatively modest improvements to existing infrastructure. However, during any given year it appears that less than half of this acreage is actually being irrigated. The use of the installed measuring devices and interviews with landowners on an annual basis will allow for a more accurate estimation of irrigation depletions in the upper watershed. About every 10 years, it would be beneficial to re-analyze irrigation in the watershed to determine if there are any other acres that have come into consistent production, for which measuring devices should be installed and used in the apportionment computations.

During times of zero or very low flow Milk River flow at the Western Crossing gage, it should be determined whether these low flows are due to natural or human causes. If the causes are natural, the apportionment computations should recognize this. Otherwise, a natural flow of 3-5 cfs might be computed, even when there is no natural flow. This problem seems to be recognized in the “dry year” criteria in the current flow apportionment procedures, but these criteria do not appear to be consistently applied.

In this report it was found that early-season irrigation depletions for U.S. irrigators in the upper Milk River watershed are being overestimated, and this likely leads to an overestimation of late May and early June natural flows. Given the current irrigation infrastructure in Alberta, this over-computation of natural flow would only have a small effect on the amount of Milk River water that the U.S. receives. If Alberta were to develop a reservoir where it could store almost its entire share of the natural flow, as has been proposed, then accurate computation of these early-season irrigation depletions would be more essential.

This report only describes the hydrology and water use of the Milk River watershed upstream of the Western Crossing, including the North Fork of the Milk River. The apportionment computations also account for U.S. irrigation depletions in the Sweet Grass Hills in Montana, as well as for irrigation water use from the Milk River in Alberta. A more thorough evaluation of irrigation depletions and the installation of some flow measuring devices in the Sweet Grass Hills in Montana could lead to more accurate irrigation consumption estimates and natural flow computations. Alberta has installed measuring devices on many Milk River irrigation diversions, and this information also could be used to more accurately estimate Canadian irrigation depletions for the flow apportionment computations.

References

Montana Water Resources Board, 1969. Water Resources Survey, Glacier County, Montana. Available from Montana Department of Natural Resources and Conservation, Helena.

Montana Department of Natural Resources and Conservation (DNRC), 2005. Field review of irrigated acres claimed above Western Crossing of the Milk River in Montana. April, 2005 Memorandum from Mike Dailey and Marv Cross to Bill Greiman and Rich Moy.

Montana Natural Resource Information System (NRIS), 2011. Montana annual average precipitation maps 1971-2000, and 1961-1990. http://nris.mt.gov/gis/gisdatalib/mtmaps.aspx.

National Center for Appropriate Technology (NCAT), 2003. The Montana Irrigator's Pocket Guide. Available from NCAT, Butte, MT.

U.S. Geological Survey, State Engineer of Montana, Alberta Water Resources Branch, and Canada Department of Northern Affairs and National Resources, 1960. The Utilization of Water in the Milk River Basin within the Blackfeet Indian Reservation, Montana; Inspection of October 26, 1960. Available from DNRC Helena.

U.S. Geological Survey, Alberta Water Resources Branch, and Canada Department of Northern Affairs and National Resources, 1961. The Utilization of Water in the Milk River Basin within the Blackfeet Indian Reservation, Montana; Inspection of October 5, 1961. Available from DNRC Helena.

U.S. Geological Survey, 1962. The Utilization of Water in the Milk River Basin within the Blackfeet Indian Reservation, Montana; Inspection of September 10 and October 1, 1962. Available from DNRC Helena.

U.S. Geological Survey, 1986. Natural Flow and Water Consumption in the Milk River Basin, Montana and Alberta, Canada. Water-Resources Investigation Report 86-4006. Prepared in Cooperation with Environment Canada (also referred to as the Thompson Report).

U.S. Geological Survey, 1996. Geology and Groundwater Resources of the Blackfeet Indian Reservation, Northwestern Montana. Hydrologic Atlas 737; prepared by Cannon, M.R.

U.S. Geological Survey, 1997. Water Resources of Browning-Starr Scholl area, Blackfeet Indian Reservation, Northwestern Montana. Water Resources Investigations Report 97-4134; prepared by Cannon, M.R.

U.S. Geological Survey and Environment Canada, 2003. Procedures for the Division of the Waters of the St. Mary and Milk Rivers. U.S. Geological Survey, Helena.

U.S. Geological Survey and Environment Canada, 2003b. Heat as a tool for studying the movement of ground water near streams. Circular 1260.

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This report is dedicated to Bill Smrcka, one of the irrigators, who farmed and ranched with his wife Irma on the Milk River near Del Bonita but passed away in 2010. Bill was the personification of the ranchers and farmers of the area: welcoming, helpful, knowledgeable, hard-working and self confident, with the can-do attitude that it takes to keep a cattle and grain operation going on this often harsh but beautiful land.

Appendix A
Discharge Measurement Summary
DNRC Upper Milk River Watershed gages: 2006-2009

Table A-1. Livermore Creek upstream of Highway 464 crossing (DNRC gage LVMC): discharge measurement summary

Date	Time	Flow (cfs)	Stage (feet)	Velocity Meter Used
06/09/06	12:00	5.60	0.74	Marsh-McBirney Electromagnetic
07/13/06	11:45	1.09	0.51	Marsh-McBirney Electromagnetic
10/26/06	12:45	3.04	0.63	Marsh-McBirney Electromagnetic
06/15/07	10:45	3.5	0.59	FlowTracker Acoustic Doppler
07/11/07	09:00	0	0	Channel was dry
08/06/07	11:00	0	0	Channel was dry
09/21/07	10:00	0	0	Channel was dry
10/23/07	12:15	2.23	0.56	FlowTracker Acoustic Doppler
04/15/08	13:45	57.0	1.33	FlowTracker Acoustic Doppler
05/05/08	16:30	59.2	1.28	FlowTracker Acoustic Doppler
06/04/08*	16:00	35.3	1.08	FlowTracker Acoustic Doppler
06/30/08	18:15	10.5	0.72	FlowTracker Acoustic Doppler
08/01/08	11:30	0.321	0.35	FlowTracker Acoustic Doppler
08/27/08	15:00	0	0	Channel was dry
10/7/08	11:30	0.731	0.41	FlowTracker Acoustic Doppler
04/21/09	16:45	59.9	1.37	FlowTracker Acoustic Doppler
05/21/09	11:15	31.2	1.05	FlowTracker Acoustic Doppler
06/30/09	11:15	1.58	0.49	FlowTracker Acoustic Doppler
07/26/09	10:15	0.307	0.34	FlowTracker Acoustic Doppler
08/27/09	17:30	0	0.20	Stream flowing just a trickle
10/21/09	10:00	2.76	0.55	FlowTracker Acoustic Doppler

* Downstream control shift noted following 2009 runoff peak.

Table A-2. Middle Fork of Milk River just upstream of confluence with South Fork (DNRC gage MFMR): discharge measurement summary

Date	Time	Flow (cfs)	Stage (feet)	Velocity Meter Used
06/08/06	19:00	3.55	1.08	Marsh-McBirney Electromagnetic
07/14/06	15:45	1.06	0.95	Marsh-McBirney Electromagnetic
10/26/06	15:30	6.63	1.10	Marsh-McBirney Electromagnetic
06/14/07	20:00	2.68	1.09	FlowTracker Acoustic Doppler
07/10/07	13:45	0	0.32	No flow; some standing water
08/06/07	15:00	0	0	No flow; channel dry
09/20/07	15:20	10.7	1.28	FlowTracker Acoustic Doppler
10/24/07	09:45	3.69	1.12	FlowTracker Acoustic Doppler
05/6/08	13:30	37.7	1.40	Marsh-McBirney Electromagnetic
06/03/08	12:15	24.0	1.25	FlowTracker Acoustic Doppler
06/30/08	13:15	7.26	0.99	FlowTracker Acoustic Doppler
07/28/08	17:30	2.56	0.83	FlowTracker Acoustic Doppler
08/27/08	09:00	1.74	0.80	FlowTracker Acoustic Doppler
10/8/08	12:00	3.66	0.90	FlowTracker Acoustic Doppler
04/20/09*	16:45	44.0	1.32	FlowTracker Acoustic Doppler
05/21/09*	14:30	30.0	1.05	FlowTracker Acoustic Doppler
06/29/09	18:00	3.92	0.54	FlowTracker Acoustic Doppler
07/25/09	14:45	4.90	0.60	FlowTracker Acoustic Doppler
08/28/09	10:00	1.28	0.41	FlowTracker Acoustic Doppler
10/20/09	16:15	6.65	0.65	FlowTracker Acoustic Doppler

* Instrument was damaged and channel changes occurred at ice break-up and high runoff during April and early May; rating adjustments were made.

Table A-3. South Fork of Milk River above Forks (DNRC gage SFMR): discharge measurement summary

Date	Time	Flow (cfs)	Stage (feet)	Velocity Meter Used
06/08/06	16:50	32.5	1.27	Marsh-McBirney Electromagnetic
07/14/06	14:45	13.5	1.00	Marsh-McBirney Electromagnetic
10/27/06	10:15	15.2	0.98	Marsh-McBirney Electromagnetic
06/14/07	18:00	28.4	1.23	FlowTracker Acoustic Doppler
07/10/07	12:30	4.35	0.76	FlowTracker Acoustic Doppler
08/06/07	13:45	0.0	0.26	Stream flowing just a trickle
09/20/07	16:00	0	0	Channel was dry
10/24/07	11:15	10.4	0.92	FlowTracker Acoustic Doppler
04/14/08*	17:30	163	1.73	FlowTracker Acoustic Doppler
05/06/08	14:45	131	1.54	Marsh-McBirney Electromagnetic
06/03/08	15:45	150	1.57	FlowTracker Acoustic Doppler
06/30/08	14:45	70.0	1.05	FlowTracker Acoustic Doppler
07/28/08	17:30	19.7	0.49	FlowTracker Acoustic Doppler
08/27/08**	11:45	2.97	-0.02	FlowTracker Acoustic Doppler
10/08/08	10:00	5.76	.08	FlowTracker Acoustic Doppler
04/20/09	17:00	113	1.27	FlowTracker Acoustic Doppler
05/21/09	16:45	108	1.27	FlowTracker Acoustic Doppler
06/29/09	16:30	16.1	0.41	FlowTracker Acoustic Doppler
07/25/09	17:10	11.6	0.32	FlowTracker Acoustic Doppler
08/28/09**	12:00	0.50	-0.25	FlowTracker Acoustic Doppler
10/20/09	14:30	21.1	0.50	FlowTracker Acoustic Doppler

* Gage was reset at an elevation of 0.49 feet higher at start of 2008 season; gage rating was adjusted.

** Water level dropped below zero reference point on staff gage but was still measurable by logging instrument.

Table A-4. Milk River near Del Bonita (DNRC gage MRDB): discharge measurement summary

Date	Time	Flow (cfs)	Stage (feet)	Velocity Meter Used
06/08/06	14:15	30.9	1.56	Marsh-McBirney Electromagnetic
07/14/06	16:45	9.44	1.33	Marsh-McBirney Electromagnetic
10/27/06	13:30	21.2	1.43	Marsh-McBirney Electromagnetic
06/15/07	16:00	27.6	1.45	FlowTracker Acoustic Doppler
07/10/07	15:30	0.997	0.93	FlowTracker Acoustic Doppler
08/06/07	16:00	.03	0	Standing water; a trickle of flow
09/20/07*	17:30	0	-.02	Standing water; a trickle of flow
10/24/07	15:00	11.8	1.21	FlowTracker Acoustic Doppler
04/15/08	16:45	335	2.87	FlowTracker Acoustic Doppler
05/06/08	10:45	187	2.24	FlowTracker Acoustic Doppler
06/3/08	19:00	185	2.26	FlowTracker Acoustic Doppler
07/01/08	14:30	83.9	1.74	FlowTracker Acoustic Doppler
07/28/08	13:00	19.8	1.22	FlowTracker Acoustic Doppler
08/26/08	16:30	4.39	0.97	FlowTracker Acoustic Doppler
10/08/08	14:00	8.79	1.08	FlowTracker Acoustic Doppler
04/21/09	10:45	187	2.25	FlowTracker Acoustic Doppler
05/22/09	12:45	134	1.99	FlowTracker Acoustic Doppler
06/29/09	14:15	26.1	1.31	FlowTracker Acoustic Doppler
07/25/09	11:00	4.54	0.94	FlowTracker Acoustic Doppler
08/28/09	14:00	1.09	0.83	FlowTracker Acoustic Doppler
10/22/09	12:00	20.2	1.28	FlowTracker Acoustic Doppler

*Water level dropped below zero reference point on staff gage but was still measurable by logging instrument.

Table A-5. North Fork of Milk River at North Fork Ranch (DNRC gage NFMR): discharge measurement summary*

Date	Time	Flow (cfs)	Stage (feet)	Velocity Meter Used
06/09/06	10:00	5.07	1.22	Marsh-McBirney Electromagnetic
07/13/06	18:00	3.75	1.39	Marsh-McBirney Electromagnetic
10/26/06	14:00	5.42	1.28	Marsh-McBirney Electromagnetic
06/15/07	13:00	3.10	0.98	FlowTracker Acoustic Doppler
07/11/07	10:00	2.88	0.94	FlowTracker Acoustic Doppler
08/06/07	12:00	2.55	0.98	Marsh-McBirney Electromagnetic
09/21/07	11:00	3.45	1.14	FlowTracker Acoustic Doppler
10/23/07	16:30	2.98	1.04	FlowTracker Acoustic Doppler
04/15/08**	12:00	6.74	1.05	Marsh-McBirney Electromagnetic
05/05/08	16:30	5.86	0.89	Marsh-McBirney Electromagnetic
06/04/08	13:45	7.28	1.08	Marsh-McBirney Electromagnetic
07/01/08	09:15	6.25	1.05	Marsh-McBirney Electromagnetic
07/30/08	19:15	3.98	0.76	FlowTracker Acoustic Doppler
08/27/08	13:45	3.69	0.80	FlowTracker Acoustic Doppler
10/07/08	09:00	4.52	0.80	FlowTracker Acoustic Doppler
04/21/09	15:15	9.34	1.07	FlowTracker Acoustic Doppler
05/21/09	10:00	8.82	1.00	FlowTracker Acoustic Doppler
06/30/09	09:30	4.17	0.64	FlowTracker Acoustic Doppler
07/26/09	10:15	3.09	0.65	FlowTracker Acoustic Doppler
08/27/09	17:00	2.71	0.61	FlowTracker Acoustic Doppler
10/21/09	11:30	3.18	0.67	FlowTracker Acoustic Doppler

* Gage is subject to shifts due to vegetation build up in channel and control during the summer.

** Gage was moved to a new location 50 yards upstream in 2008.

Appendix B

Daily Average Streamflow Data

Upper Milk River Watershed Gages: 2006-2009

Table B-1. Daily average streamflows for the Livermore Creek DNRC gage. (E = estimated)

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	**2006**	**2007**	**2008**	**2009**	**Day**	**2006**	**2007**	**2008**	**2009**
April 1					**June 1**			41.2	14.5
April 2					**June 2**			39.9	11.7
April 3					**June 3**			36.4	11.2
April 4					**June 4**			38.7	10.7
April 5					**June 5**			34.2	9.8
April 6					**June 6**			28.0	11.7
April 7					**June 7**			25.2	15.7
April 8					**June 8**			36.4	15.1
April 9					**June 9**	5.7		35.3	15.1
April 10					**June 10**	45.0		27.1	15.1
April 11					**June 11**	42.4		86.2	13.4
April 12					**June 12**	33.1		122 E	11.2
April 13					**June 13**	35.3		98.9	9.3
April 14					**June 14**	50.4		90.3	8.5
April 15			57.8		**June 15**	50.4	3.6	65.9	7.7
April 16			46.3		**June 16**	61.0	4.2	54.8	7.3
April 17			32.0		**June 17**	26.1	5.7	45.0	6.6
April 18			31.0		**June 18**	16.6	6.4	37.6	5.2
April 19			28.0		**June 19**	13.4	5.7	32.0	5.0
April 20			29.0		**June 20**	13.4	4.2	30.0	5.2
April 21			32.0	62.6	**June 21**	12.8	2.9	27.1	4.7
April 22			30.0	65.9	**June 22**	10.7	2.0	24.3	6.9
April 23			16.6	48.0	**June 23**	8.8	1.7	21.8	15.7
April 24			10.2	33.9	**June 24**	7.9	1.1	18.7	9.3
April 25			9.7	22.9	**June 25**	6.7	1.1	18.7	5.9
April 26			10.2	21.3	**June 26**	6.0	0.9	15.9	4.1
April 27			13.4	20.6	**June 27**	5.3	0.7	14.0	3.2
April 28			29.0	18.4	**June 28**	4.7	0.7	13.4	2.6
April 29			62.6	20.6	**June 29**	3.9	0.7	11.7	2.1
April 30			59.4	28.0	**June 30**	4.2	0.7	10.2	1.8
May 1			42.4	24.5	**July 1**	4.2	0.4	11.7	1.5
May 2			42.4	22.1	**July 2**	4.2	0.3	15.9	1.1
May 3			37.6	27.1	**July 3**	3.6	0.2	16.6	1.2
May 4			47.7	49.3	**July 4**	3.6	0.1	11.7	1.2
May 5			59.4	54.9	**July 5**	3.4	0.0	13.4	1.4
May 6			53.3	46.7	**July 6**	3.2	0.0	11.7	1.8
May 7			62.6	37.1	**July 7**	2.4	0.0	8.3	2.4
May 8			54.8	38.3	**July 8**	1.8	0.0	7.5	1.6
May 9			50.4	40.6	**July 9**	1.6	0.0	5.3	1.5
May 10			37.6	39.4	**July 10**	1.1	0.0	4.2	1.2
May 11			29.0	38.3	**July 11**	1.2	0.0	4.4	1.0
May 12			43.7	38.3	**July 12**	1.1	0.0	4.7	0.7
May 13			45.0	36.0	**July 13**	1.0	0.0	4.4	0.7
May 14			36.4	30.9	**July 14**	0.7	0.0	4.2	11.7
May 15			42.4	37.1	**July 15**	0.4	0.0	2.9	16.4
May 16			56.3	35.0	**July 16**	0.3	0.0	2.5	8.1
May 17			57.8	31.9	**July 17**	0.2	0.0	3.2	3.9
May 18			53.3	40.6	**July 18**	0.1	0.0	2.9	2.6
May 19			57.8	41.7	**July 19**	0.0	0.0	2.7	1.8
May 20			46.3	38.3	**July 20**	0.0	0.0	2.2	1.1
May 21			42.4	30.9	**July 21**	0.0	0.0	1.8	0.7
May 22			41.2	26.2	**July 22**	0.0	0.0	1.7	0.5
May 23			329 E	24.5	**July 23**	0.0	0.0	2.5	0.3
May 24			334 E	23.7	**July 24**	0.0	0.0	2.7	0.2
May 25			177 E	28.0	**July 25**	0.0	0.0	2.3	0.2
May 26			101 E	22.9	**July 26**	0.0	0.0	2.0	0.3
May 27			90.3	20.6	**July 27**	0.0	0.0	1.7	0.3
May 28			74.7	19.1	**July 28**	0.0	0.0	1.3	0.5
May 29			61.0	17.7	**July 29**	0.0	0.0	1.1	0.6
May 30			51.9	15.7	**July 30**	0.0	0.0	0.7	1.2
May 31			46.3	14.5	**July 31**	0.0	0.0	0.4	2.6

Table B-1. Daily average streamflows for the Livermore Creek DNRC gage (Continued).

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	**2006**	**2007**	**2008**	**2009**	**Day**	**2006**	**2007**	**2008**	**2009**
Aug 1	0.0	0.0	0.3	2.6	Oct 1	0.7	0.3	0.6	0.0
Aug 2	0.0	0.0	0.2	2.1	Oct 2	0.7	0.4	0.7	0.0
Aug 3	0.0	0.0	0.3	1.2	Oct 3	0.7	0.6	0.7	0.0
Aug 4	0.0	0.0	0.4	0.9	Oct 4	0.7	1.1	0.7	0.0
Aug 5	0.0	0.0	0.4	0.7	Oct 5	0.8	3.0	1.1	0.0
Aug 6	0.0	0.0	0.4	1.4	Oct 6	1.0	3.6	0.9	0.0
Aug 7	0.0	0.0	0.4	1.8	Oct 7	1.2	4.2	0.7	0.0
Aug 8	0.0	0.0	0.3	1.5	Oct 8	1.4	3.6		0.0
Aug 9	0.0	0.0	0.3	1.2	Oct 9	1.5	3.9		0.0
Aug 10	0.0	0.0	0.3	0.8	Oct 10	1.9	3.9		0.0
Aug 11	0.0	0.0	0.3	0.5	Oct 11	2.2	3.0		0.0
Aug 12	0.0	0.0	0.2	0.3	Oct 12	2.2	2.4		1.6
Aug 13	0.0	0.0	0.2	0.2	Oct 13	2.1	2.2		0.3
Aug 14	0.0	0.0	0.2	0.2	Oct 14	1.9	2.0		0.5
Aug 15	0.0	0.0	0.3	0.2	Oct 15	1.8	2.0		2.1
Aug 16	0.0	0.0	0.1	1.0	Oct 16	1.9	2.0		4.7
Aug 17	0.0	0.0	0.0	3.4	Oct 17	2.4	1.7		5.0
Aug 18	0.0	0.0	0.0	3.0	Oct 18	2.8	1.6		4.4
Aug 19	0.0	0.0	0.0	1.8	Oct 19	2.8	1.7		3.6
Aug 20	0.0	0.0	0.0	1.1	Oct 20	3.2	2.0		3.0
Aug 21	0.0	0.0	0.0	0.7	Oct 21	4.7	2.4		2.8
Aug 22	0.0	0.0	0.0	0.5	Oct 22	4.7	3.0		
Aug 23	0.0	0.0	0.0	0.3	Oct 23	3.6	2.4		
Aug 24	0.0	0.0	0.0	0.2	Oct 24	3.2			
Aug 25	0.0	0.0	0.0	0.1	Oct 25	3.0			
Aug 26	0.0	0.0	0.0	0.0	Oct 26	2.8			
Aug 27	0.0	0.0	0.0	0.0	Oct 27				
Aug 28	0.0	0.0	0.0	0.0	Oct 28				
Aug 29	0.0	0.0	0.0	0.0	Oct 29				
Aug 30	0.0	0.0	0.0	0.0	Oct 30				
Aug 31	0.0	0.0	0.0	0.0	Oct 31				
Sept 1	0.0	0.0	0.0	0.0					
Sept 2	0.0	0.0	0.0	0.0					
Sept 3	0.0	0.0	0.4	0.0					
Sept 4	0.0	0.0	0.6	0.0					
Sept 5	0.0	0.0	0.7	0.0					
Sept 6	0.0	0.0	0.7	0.0					
Sept 7	0.0	0.0	0.8	0.0					
Sept 8	0.0	0.0	0.9	0.0					
Sept 9	0.0	0.0	0.9	0.0					
Sept 10	0.0	0.0	1.1	0.0					
Sept 11	0.0	0.0	0.9	0.0					
Sept 12	0.0	0.0	0.7	0.0					
Sept 13	0.0	0.0	1.1	0.0					
Sept 14	0.0	0.0	0.9	0.0					
Sept 15	0.0	0.0	0.8	0.0					
Sept 16	0.0	0.0	0.7	0.0					
Sept 17	0.0	0.0	0.4	0.0					
Sept 18	0.0	0.0	0.3	0.0					
Sept 19	0.0	0.0	0.2	0.0					
Sept 20	0.0	0.0	0.1	0.0					
Sept 21	0.1	0.0	0.1	0.0					
Sept 22	3.6	0.0	0.2	0.0					
Sept 23	6.7	0.0	0.3	0.0					
Sept 24	4.7	0.0	0.3	0.0					
Sept 25	2.6	0.0	0.5	0.0					
Sept 26	1.6	0.0	0.5	0.0					
Sept 27	1.4	0.0	0.5	0.0					
Sept 28	1.1	0.0	0.5	0.0					
Sept 29	0.9	0.0	0.5	0.0					
Sept 30	1.0	0.3	0.5	0.0					

Table B-2. Daily average streamflows for the South Fork of Milk River near Babb USGS gage #06132200.

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	***2006***	***2007***	***2008***	***2009***	***Day***	***2006***	***2007***	***2008***	***2009***
April 1	101	44		10	***June 1***	37	37	107	47
April 2	90	45		11	***June 2***	32	35	109	47
April 3	63	40		12	***June 3***	28	33	102	45
April 4	90	39		12	***June 4***	27	32	101	41
April 5	148	37		13	***June 5***	32	30	99	38
April 6	117	34		18	***June 6***	33	32	90	45
April 7	141	31		28	***June 7***	29	41	85	56
April 8	140	36		41	***June 8***	28	42	93	53
April 9	114	49		53	***June 9***	35	36	89	55
April 10	106	46		56	***June 10***	90	33	85	57
April 11	85	41		61	***June 11***	127	33	212	53
April 12	72	38		72	***June 12***	119	30	362	46
April 13	72	37		52	***June 13***	124	28	211	41
April 14	65	36		45	***June 14***	134	27	170	37
April 15	67	36		29	***June 15***	119	27	140	35
April 16	62	37		22	***June 16***	128	28	118	35
April 17	54	36		22	***June 17***	84	41	106	31
April 18	47	38		31	***June 18***	63	38	99	31
April 19	43	44		34	***June 19***	55	30		29
April 20	42	49		51	***June 20***	54	26		27
April 21	43	50		79	***June 21***	52	22	88	26
April 22	48	44		88	***June 22***	46	20	85	49
April 23	56	41		71	***June 23***	42	18	85	60
April 24	48	40		57	***June 24***	41	16	83	40
April 25	43	40		49	***June 25***	39	16	81	30
April 26	41	41		46	***June 26***	36	16	77	24
April 27	40	41		43	***June 27***	33	16	73	21
April 28	40	40		35	***June 28***	30	14	70	19
April 29	41	39		31	***June 29***	27	15	68	16
April 30	42	40		38	***June 30***	31	14	65	14
May 1	48	40	74	37	***July 1***	32	13	66	13
May 2	49	40	61	47	***July 2***	26	13	78	13
May 3	51	54	53	73	***July 3***	25	12	81	13
May 4	48	73	57	107	***July 4***	31	10	70	13
May 5	43	54	69	114	***July 5***	34	10	66	16
May 6	39	46	72	95	***July 6***	28	9.7	61	20
May 7	37	41	82	81	***July 7***	24	8.8	58	23
May 8	37	38	78	77	***July 8***	22	9	54	19
May 9	37	37	69	81	***July 9***	19	9.6	51	16
May 10	35	36	61	80	***July 10***	17	9.8	47	21
May 11	31	36	49	74	***July 11***	19	8.3	46	19
May 12	30	35	58	76	***July 12***	21	7.5	47	22
May 13	28	36	66	74	***July 13***	18	6.8	43	29
May 14	27	46	56	68	***July 14***	16	9.1	39	72
May 15	27	43	60	77	***July 15***	14	8	37	66
May 16	26	39	75	74	***July 16***	12	7.1	36	38
May 17	25	36	81	71	***July 17***	13	6.1	39	24
May 18	24	36	75	82	***July 18***	12	4.4	38	18
May 19	24	35	82	88	***July 19***	11	7.7	34	14
May 20	26	35	73	85	***July 20***	12	20	32	13
May 21	26	35	72	72	***July 21***	12	12	29	12
May 22	27	40	73	63	***July 22***	11	9.8	28	10
May 23	28	42	403	60	***July 23***	11	7.1	32	9.9
May 24	26	40	642	60	***July 24***	12	6.1	31	8.3
May 25	26	47	465	60	***July 25***	13	5.5	30	10
May 26	32	52	266	60	***July 26***	13	5	26	8.8
May 27	41	46	228	56	***July 27***	11	5.1	22	11
May 28	70	48	178	51	***July 28***	9.9	4.7	20	12
May 29	72	61	141	48	***July 29***	9.7	3.1	20	14
May 30	54	52	120	47	***July 30***	8.8	2.4	19	14
May 31	44	43	112	46	***July 31***	8	1.9	18	18

Table B-2. Daily average streamflow for South Fork of Milk River near Babb USGS gage 06132200 (Continued)

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	**2006**	**2007**	**2008**	**2009**	**Day**	**2006**	**2007**	**2008**	**2009**
Aug 1	7.9	1.5	16	17	**Oct 1**	6.8	7.1	32	8.2
Aug 2	8.2	2.1	15	10	**Oct 2**	6.5	6.2	32	8.8
Aug 3	8.8	2.6	15	6.7	**Oct 3**	7.2	6.4	33	9
Aug 4	8.8	2.7	15	9.3	**Oct 4**	7.8	11	33	9.9
Aug 5	8.7	2.6	13	13	**Oct 5**	8.2	17	35	11
Aug 6	8.3	2.7	11	18	**Oct 6**	8.1	18	34	12
Aug 7	8.5	3	9.8	20	**Oct 7**	7.9	21	34	13
Aug 8	8.3	3.4	9.9	17	**Oct 8**	8.2	25	34	14
Aug 9	8.4	3.3	9	13	**Oct 9**	10	23	37	12
Aug 10	8.9	3.6	8	9.5	**Oct 10**	12	18	38	10
Aug 11	9.3	3.5	6.2	7.3	**Oct 11**	12	15	38	9.7
Aug 12	10	3.7	4.8	4.3	**Oct 12**	12	13	38	8
Aug 13	10	3.1	4.4	4.9	**Oct 13**	11	11	39	8.2
Aug 14	9.4	2.9	5.2	7.2	**Oct 14**	10	10	39	8.8
Aug 15	9.5	2.8	4.5	15	**Oct 15**	10	9.9	41	11
Aug 16	11	4.2	4.1	21	**Oct 16**	11	9.2	41	17
Aug 17	27	5.6	3.4	24	**Oct 17**	14	8.6	41	19
Aug 18	21	4.7	3.4	9.9	**Oct 18**	13	8.1	41	19
Aug 19	13	3.7	2.5	6.3	**Oct 19**	14	8.1	41	15
Aug 20	10	3.9	2.6	5.1	**Oct 20**	15	8.8	39	13
Aug 21	9.1	2	3.1	3.3	**Oct 21**	19	11	39	12
Aug 22	8.6	2.4	4.5	3.4	**Oct 22**	18	11	38	11
Aug 23	7.7	2.8	3.4	2.5	**Oct 23**	15	9.1	38	11
Aug 24	7.1	4.7	2	2.4	**Oct 24**	14	8.7	37	11
Aug 25	8.8	4.6	1.1	2.9	**Oct 25**	13	10	35	13
Aug 26	9.9	4.7	0.44	1.9	**Oct 26**	12	10	34	14
Aug 27	9.8	4.5	2.1	2	**Oct 27**	12	11	33	18
Aug 28	8.1	5.1	3	2	**Oct 28**	11	10	35	20
Aug 29	7.2	4.7	4	2.5	**Oct 29**	11	9.2	35	17
Aug 30	6.4	3.6	3.3	2.8	**Oct 30**	11	9	36	17
Aug 31	6.8	2.7	3.5	1.7	**Oct 31**	11	8.5	36	20
Sept 1	7	2.3	8.5	1.9					
Sept 2	6.7	2.4	11	2.4					
Sept 3	6.4	2.7	9	2.1					
Sept 4	6.1	3.8	7.6	1.8					
Sept 5	5.8	3.5	8.8	2.5					
Sept 6	5.3	2.9	8.6	2.2					
Sept 7	5.5	2.8	10	2.3					
Sept 8	6	4.2	10	2.9					
Sept 9	6	4.8	8.5	2.3					
Sept 10	5.3	4	8.7	1.8					
Sept 11	4.9	4.3	11	1.7					
Sept 12	4.6	3.5	8.2	1.6					
Sept 13	4.5	3.6	7.8	1.9					
Sept 14	6.7	3.6	7.3	2.2					
Sept 15	11	4.2	8.4	1.8					
Sept 16	14	4.1	6.8	2.6					
Sept 17	12	3.6	6	1.5					
Sept 18	10	3.4	7.8	2.2					
Sept 19	9.5	9.2	13	2.3					
Sept 20	13	14	18	3.2					
Sept 21	14	14	25	4.1					
Sept 22	16	10	29	6.4					
Sept 23	21	14	27	6.7					
Sept 24	15	23	28	6.5					
Sept 25	11	15	29	6.4					
Sept 26	9.5	11	29	7.3					
Sept 27	9.2	8.3	30	7.8					
Sept 28	9	6.7	33	7.6					
Sept 29	8.6	6.3	33	7.6					
Sept 30	7.7	6.4	33	7.5					

Table B-3. Daily average streamflows for the Middle Fork of Milk River DNRC gage.

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	**2006**	**2007**	**2008**	**2009**	**Day**	**2006**	**2007**	**2008**	**2009**
April 1					June 1			25.3	13.8
April 2					June 2			26.2	13.4
April 3					June 3			24.4	12.5
April 4					June 4			20.9	11.6
April 5					June 5			20.9	10.8
April 6					June 6			17.1	12.0
April 7					June 7			14.3	18.0
April 8					June 8	4.0		15.0	19.1
April 9					June 9	4.6		24.4	17.4
April 10					June 10	25.7		20.1	16.3
April 11					June 11	59.0		116 E	14.3
April 12					June 12	33.6		378 E	12.0
April 13					June 13	33.6		194 E	11.2
April 14					June 14	32.3	2.2	112 E	10.0
April 15					June 15	47.4	2.7	73.2	10.0
April 16					June 16	76.4	3.9	45.9	9.6
April 17					June 17	40.1	5.3	33.4	9.2
April 18					June 18	16.6	8.6	26.2	7.8
April 19					June 19	11.7	8.1	20.9	8.2
April 20				47.1	June 20	10.0	5.7	18.6	7.5
April 21				59.1	June 21	10.0	3.9	17.1	6.9
April 22				65.1	June 22	9.4	2.7	15.7	9.2
April 23				56.8	June 23	7.4	1.8	13.7	20.9
April 24				38.6	June 24	6.1	1.3	11.9	15.8
April 25				38.6	June 25	5.0	1.0	10.8	10.0
April 26				36.0	June 26	4.3	0.8	9.8	7.2
April 27				40.4	June 27	3.7	1.0	8.8	6.0
April 28				51.2	June 28	3.1	1.1	7.9	5.2
April 29				406 E	June 29	2.4	1.1	7.5	4.3
April 30				745 E	June 30	2.4	1.3	6.7	3.6
May 1				688 E	July 1	2.4	1.4	9.3	3.3
May 2				508 E	July 2	2.4	1.0	9.3	3.1
May 3				285 E	July 3	2.2	0.5	11.4	3.3
May 4				91.6	July 4	2.2	0.4	10.8	3.4
May 5				109 E	July 5	2.9	0.2	10.3	4.3
May 6			38.1	85.5	July 6	1.5	0.0	8.8	5.2
May 7			42.4	55.6	July 7	1.5	0.0	6.7	6.0
May 8			39.5	53.4	July 8	1.3	0.0	5.5	6.0
May 9			35.3	54.5	July 9	0.9	0.0	4.6	4.5
May 10			32.8	50.2	July 10	0.8	0.0	3.7	4.1
May 11			24.7	44.1	July 11	1.5	0.0	4.0	4.3
May 12			23.7	39.4	July 12	2.2	0.0	6.7	4.1
May 13			30.3	36.8	July 13	1.8	0.0	6.7	3.6
May 14			32.8	34.3	July 14	1.0	0.0	4.3	14.8
May 15			31.5	40.4	July 15	0.6	0.0	3.2	30.4
May 16			40.9	43.2	July 16	0.3	0.0	2.5	18.0
May 17			52.0	33.5	July 17	0.0	0.0	2.5	10.0
May 18			47.0	33.5	July 18	0.0	0.0	2.7	6.6
May 19			47.0	35.1	July 19	0.0	0.0	2.7	5.0
May 20			42.4	32.7	July 20	0.0	0.0	2.3	3.8
May 21			29.2	28.1	July 21	0.0	0.0	1.8	2.9
May 22			31.3	25.4	July 22	0.0	0.4	1.6	2.7
May 23			132 E	24.0	July 23	0.0	0.0	3.7	2.3
May 24			346 E	24.0	July 24	0.0	0.0	7.5	3.8
May 25			238 E	24.7	July 25	0.0	0.0	5.5	4.5
May 26			119 E	28.1	July 26	0.0	0.0	4.3	5.2
May 27			75.1	23.4	July 27	0.8	0.0	3.2	4.5
May 28			53.1	20.3	July 28	0.6	0.0	2.3	4.5
May 29			40.6	18.5	July 29	0.2	0.0	2.1	4.5
May 30			34.6	16.3	July 30	0.0	0.0	1.8	5.7
May 31			28.2	14.8	July 31	0.0	0.0	1.5	6.9

Table B-3. Daily average streamflows for the Middle Fork of Milk River DNRC gage (Continued).

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	***2006***	***2007***	***2008***	***2009***	***Day***	***2006***	***2007***	***2008***	***2009***
Aug 1	0.0	0.0	1.3	8.2	***Oct 1***	3.2	4.2	3.4	3.4
Aug 2	0.0	0.0	0.6	5.7	***Oct 2***	3.2	3.6	3.4	3.8
Aug 3	0.0	0.0	0.9	4.1	***Oct 3***	3.5	3.6	3.4	4.3
Aug 4	0.0	0.0	0.9	3.1	***Oct 4***	3.8	3.6	3.7	4.5
Aug 5	0.0	0.0	1.3	3.4	***Oct 5***	4.4	3.6	3.7	5.7
Aug 6	0.0	0.0	1.8	4.7	***Oct 6***	4.4	5.3	4.0	6.6
Aug 7	0.0	0.0	1.3	6.3	***Oct 7***	4.4	6.6	3.7	7.5
Aug 8	0.0	0.0	1.5	5.7	***Oct 8***	4.7	7.6	3.7	9.2
Aug 9	0.0	0.0	1.9	4.5	***Oct 9***	5.4	7.6		7.8
Aug 10	0.0	0.0	2.3	3.6	***Oct 10***	6.1	6.6		6.6
Aug 11	0.0	0.0	1.9	2.6	***Oct 11***	6.1	5.3		6.0
Aug 12	0.8	0.0	1.8	2.1	***Oct 12***	6.1	4.9		5.5
Aug 13	1.6	0.0	1.6	1.9	***Oct 13***	5.4	4.6		5.5
Aug 14	1.6	0.0	1.6	2.3	***Oct 14***	5.4	4.2		6.3
Aug 15	1.5	0.0	1.6	4.3	***Oct 15***	5.0	4.2		8.5
Aug 16	2.1	0.0	1.8	7.2	***Oct 16***	5.4	4.2		12.9
Aug 17	9.8	0.0	1.6	8.2	***Oct 17***	6.5	3.9		12.0
Aug 18	7.4	0.0	1.3	7.2	***Oct 18***	6.9	3.9		10.8
Aug 19	3.5	0.0	1.0	5.0	***Oct 19***	6.9	3.9		8.5
Aug 20	2.3	0.0	0.9	3.6	***Oct 20***	7.8	3.9		7.5
Aug 21	1.8	0.0	1.6	2.7	***Oct 21***	10.3	6.2		
Aug 22	1.5	0.0	2.1	2.4	***Oct 22***	10.3	4.9		
Aug 23	1.3	0.0	3.4	1.9	***Oct 23***	7.8	4.2		
Aug 24	1.0	0.0	3.4	1.6	***Oct 24***	6.9	3.9		
Aug 25	1.2	0.0	2.3	1.3	***Oct 25***	6.5			
Aug 26	1.8	0.0	2.3	1.5	***Oct 26***	6.5			
Aug 27	1.8	0.0	1.8	1.3	***Oct 27***				
Aug 28	2.3	0.0	1.6	1.3	***Oct 28***				
Aug 29	1.5	0.0	1.8	1.2	***Oct 29***				
Aug 30	1.0	0.0	1.8	1.2	***Oct 30***				
Aug 31	1.2	0.0	1.9	1.5	***Oct 31***				
Sept 1	1.5	0.0	3.0	2.1					
Sept 2	1.3	0.0	5.5	3.3					
Sept 3	1.8	0.0	5.2	2.4					
Sept 4	1.3	0.0	4.3	1.5					
Sept 5	1.2	0.0	4.0	1.5					
Sept 6	1.2	0.0	4.3	1.2					
Sept 7	1.2	0.0	4.9	0.8					
Sept 8	1.0	0.0	5.2	1.0					
Sept 9	1.3	4.6	4.6	1.2					
Sept 10	1.3	3.9	4.3	1.3					
Sept 11	1.3	2.5	4.9	1.3					
Sept 12	1.0	1.6	5.5	0.9					
Sept 13	1.0	1.6	4.9	1.0					
Sept 14	1.5	1.8	5.2	1.5					
Sept 15	3.2	1.8	4.6	2.9					
Sept 16	5.7	1.4	3.4	2.6					
Sept 17	6.1	1.3	2.7	1.2					
Sept 18	5.7	1.4	2.5	1.3					
Sept 19	4.7	4.2	2.3	1.8					
Sept 20	5.0	10.4	2.3	1.8					
Sept 21	6.1	7.6	2.7	2.9					
Sept 22	10.3	5.7	3.0	3.6					
Sept 23	15.3	6.2	4.0	3.6					
Sept 24	8.8	9.2	3.7	2.9					
Sept 25	5.7	9.2	3.4	2.4					
Sept 26	4.4	5.7	3.4	2.3					
Sept 27	4.1	4.6	3.4	2.1					
Sept 28	4.1	3.6	3.4	2.1					
Sept 29	3.8	3.6	3.4	2.1					
Sept 30	3.5	4.2	3.4	2.7					

Table B-4. Daily average streamflows for the South Fork of Milk River above Forks DNRC gage.

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	**2006**	**2007**	**2008**	**2009**	**Day**	**2006**	**2007**	**2008**	**2009**
April 1					**June 1**			160	58.9
April 2					**June 2**			158	57.8
April 3					**June 3**			145	54.6
April 4					**June 4**			138	50.6
April 5					**June 5**			136	47.6
April 6					**June 6**			119	50.6
April 7					**June 7**			109	68.0
April 8					**June 8**	31.9		113	70.0
April 9					**June 9**	34.4		124	70.0
April 10					**June 10**	61.5		107	70.0
April 11					**June 11**	150		221	70.0
April 12					**June 12**	131		710 E	59.2
April 13					**June 13**	141		478 E	51.4
April 14			209.4		**June 14**	1445	27.6	332 E	46.0
April 15			306 E		**June 15**	158	29.2	240	42.6
April 16			211.6		**June 16**	167	30.8	183	42.6
April 17			133		**June 17**	123	42.9	152	38.5
April 18			121		**June 18**	83.7	49.4	131	35.5
April 19			106		**June 19**	69.3	40.9	119	35.5
April 20			75.1	118	**June 20**	64.1	33.4	113	32.6
April 21			73.9	175	**June 21**	62.8	28.3	106	31.9
April 22			65.9	228	**June 22**	55.2	23.8	99.9	40.9
April 23			57.5	194	**June 23**	48.3	20.4	95.7	78.2
April 24			42.0	128	**June 24**	44.0	17.9	91.6	60.3
April 25			45.4	112	**June 25**	40.9	17.3	88.9	43.4
April 26			43.6	99.6	**June 26**	38.0	16.2	85.0	33.3
April 27			49.8	98.0	**June 27**	34.3	15.6	78.7	27.8
April 28			82.4	71.5	**June 28**	30.8	14.0	75.1	24.2
April 29			169	56.3	**June 29**	27.6	12.5	70.4	17.7
April 30			183	72.8	**June 30**	28.3	12.5	68.2	14.1
May 1			148	71.5	**July 1**	30.0	11.2	71.6	12.1
May 2			119	76.7	**July 2**	28.3	10.3	81.2	10.6
May 3			106	116	**July 3**	24.5	9.5	90.2	11.0
May 4			109	226	**July 4**	23.8	7.6	79.9	11.0
May 5			134	306 E	**July 5**	30.0	5.7	72.7	12.1
May 6			138	248	**July 6**	28.3	5.1	69.3	14.1
May 7			150	173	**July 7**	23.1	4.3	62.7	18.2
May 8			152	159	**July 8**	19.8	4.1	57.5	18.2
May 9			138	161	**July 9**	17.3	3.6	53.6	13.7
May 10			123	155	**July 10**	15.1	4.3	48.0	12.9
May 11			95.7	145	**July 11**	14.6	4.3	46.2	12.9
May 12			101	141	**July 12**	15.6	3.4	47.1	11.7
May 13			129	143	**July 13**	15.1	2.3	44.5	10.6
May 14			110	126	**July 14**	13.0	1.6	40.3	32.6
May 15			106	137	**July 15**	10.7	1.2	38.0	81.9
May 16			134	123	**July 16**	9.1	2.3	36.4	51.4
May 17			156	108	**July 17**	7.6	1.3	37.2	33.3
May 18			145	115	**July 18**	6.9	1.1	38.7	21.9
May 19			150	137	**July 19**	6.6	0.8	35.7	15.8
May 20			143	133	**July 20**	6.0	0.6	32.8	11.3
May 21			134	116	**July 21**	6.3	7.9	29.3	8.9
May 22			134	95.8	**July 22**	6.3	6.0	28.0	7.4
May 23			324	85.9	**July 23**	4.8	3.4	31.4	6.1
May 24			1094 E	83.2	**July 24**	5.7	1.8	32.8	6.1
May 25			821 E	87.3	**July 25**	7.6	0.8	32.1	8.3
May 26			517 E	84.5	**July 26**	7.2	0.5	29.3	10.3
May 27			383 E	77.9	**July 27**	6.3	0.0	24.9	10.3
May 28			318 E	70.4	**July 28**	5.4	0.0	21.5	11.3
May 29			242.5	65.6	**July 29**	4.3	0.0	18.9	14.1
May 30			196.1	62.2	**July 30**	3.6	0.0	18.4	15.8
May 31			169.2	58.9	**July 31**	3.0	0.0	17.4	17.2

Table B-4. Daily average streamflows for the South Fork of Milk River above Forks DNRC gage (Continued).

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	**2006**	**2007**	**2008**	**2009**	**Day**	**2006**	**2007**	**2008**	**2009**
Aug 1	2.6	0.0	15.6	19.2	**Oct 1**	5.1	4.3	6.4	0.00
Aug 2	2.0	0.0	14.7	16.8	**Oct 2**	4.6	4.6	6.6	0.00
Aug 3	2.0	0.0	14.7	11.7	**Oct 3**	4.1	4.1	6.4	0.00
Aug 4	2.1	0.0	16.0	8.3	**Oct 4**	4.1	4.1	6.9	0.00
Aug 5	4.1	0.0	16.0	8.3	**Oct 5**	5.1	9.5	7.4	0.00
Aug 6	3.4	0.0	14.7	11.0	**Oct 6**	6.0	15.1	7.1	0.00
Aug 7	2.3	0.0	13.0	17.7	**Oct 7**	5.7	18.5	7.1	4.8
Aug 8	2.5	0.0	12.6	17.7	**Oct 8**	6.6	21.7	6.2	5.2
Aug 9	3.0	0.0	14.3	13.7	**Oct 9**	7.2	24.5		6.7
Aug 10	3.0	0.0	13.4	9.6	**Oct 10**	9.9	23.8		10.1
Aug 11	3.4	0.0	11.9	6.3	**Oct 11**	13.0	20.4		9.7
Aug 12	3.8	0.0	10.1	4.7	**Oct 12**	13.0	17.3		8.1
Aug 13	4.8	0.0	8.8	3.3	**Oct 13**	14.0	14.6		6.4
Aug 14	4.8	0.0	8.8	4.7	**Oct 14**	11.2	13.0		6.7
Aug 15	4.1	0.0	8.8	9.6	**Oct 15**	10.7	11.6		7.5
Aug 16	6.0	0.0	7.3	15.4	**Oct 16**	10.7	11.2		14.3
Aug 17	10.7	0.0	6.3	21.3	**Oct 17**	12.1	10.7		22.2
Aug 18	19.1	0.0	5.3	16.1	**Oct 18**	15.1	9.9		24.5
Aug 19	13.5	0.0	4.4	9.7	**Oct 19**	15.1	9.5		23.3
Aug 20	8.7	0.0	4.0	6.2	**Oct 20**	16.7	9.5		19.0
Aug 21	6.3	0.0	4.6	3.9	**Oct 21**	19.8	9.5		
Aug 22	4.8	0.0	6.5	2.6	**Oct 22**	22.4	12.1		
Aug 23	4.1	0.0	7.6	1.8	**Oct 23**	19.8	12.1		
Aug 24	3.0	0.0	6.5	1.2	**Oct 24**	17.3	11.2		
Aug 25	2.6	0.0	4.9	0.68	**Oct 25**	15.6			
Aug 26	3.2	0.0	3.8	0.56	**Oct 26**	14.6			
Aug 27	4.6	0.0	2.8	0.50	**Oct 27**	14.0			
Aug 28	4.8	0.0	3.0	0.50	**Oct 28**				
Aug 29	3.2	0.0	2.8	0.45	**Oct 29**				
Aug 30	2.1	0.0	2.7	0.29	**Oct 30**				
Aug 31	1.7	0.0	3.7	0.18	**Oct 31**				
Sept 1	1.4	0.0	6.0	0.18					
Sept 2	1.5	0.0	12.3	0.18					
Sept 3	1.5	0.0	12.7	0.13					
Sept 4	1.2	0.0	10.7	0.09					
Sept 5	1.0	0.0	9.8	0.06					
Sept 6	0.9	0.0	11.0	0.06					
Sept 7	0.7	0.0	11.7	0.04					
Sept 8	0.6	0.0	13.7	0.02					
Sept 9	0.6	0.0	12.7	0.01					
Sept 10	0.5	0.0	11.7	0.01					
Sept 11	0.5	0.0	13.0	0.00					
Sept 12	0.5	0.0	13.0	0.00					
Sept 13	0.4	0.0	12.0	0.00					
Sept 14	0.4	0.0	12.3	0.00					
Sept 15	0.4	0.0	11.0	0.00					
Sept 16	6.3	0.0	8.9	0.00					
Sept 17	12.5	0.0	7.6	0.00					
Sept 18	10.7	0.0	6.6	0.00					
Sept 19	8.7	0.0	6.0	0.00					
Sept 20	8.7	0.0	5.5	0.00					
Sept 21	11.6	0.0	5.5	0.00					
Sept 22	18.5	0.0	5.1	0.00					
Sept 23	18.5	10.7	6.9	0.00					
Sept 24	21.7	14.0	6.9	0.00					
Sept 25	16.2	16.2	6.6	0.00					
Sept 26	11.6	10.7	6.2	0.00					
Sept 27	9.1	7.9	6.0	0.00					
Sept 28	7.9	6.3	5.8	0.00					
Sept 29	6.9	4.8	6.9	0.00					
Sept 30	6.3	4.6	6.9	0.00					

Table B-5. Daily average streamflows for the Milk River at Del Bonita DNRC gage.

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	***2006***	***2007***	***2008***	***2009***	***Day***	***2006***	***2007***	***2008***	***2009***
April 1					***June 1***			209	73.3
April 2					***June 2***			187	71.7
April 3					***June 3***			197	68.7
April 4					***June 4***			181	64.3
April 5					***June 5***			176	60.1
April 6					***June 6***			158	65.7
April 7					***June 7***			138	76.4
April 8					***June 8***	31.6		138	93.1
April 9					***June 9***	33.5		158	91.4
April 10					***June 10***	49.4		148	91.4
April 11					***June 11***	171		286	91.4
April 12					***June 12***	175		1420 E	82.9
April 13					***June 13***	168		1109 E	68.7
April 14					***June 14***	175		601 E	61.5
April 15					***June 15***	208	29.1	417	57.3
April 16					***June 16***	239	29.1	300	57.3
April 17					***June 17***	208	39.0	237	52.1
April 18					***June 18***	125	53.9	190	47.1
April 19					***June 19***	93.2	49.1	165	43.5
April 20					***June 20***	82.5	46.7	150	43.5
April 21				200.2	***June 21***	81.0	26.6	140	40.2
April 22				271.1	***June 22***	78.1	22.7	130	62.9
April 23				280.8	***June 23***	66.9	19.8	120	91.3
April 24				179.2	***June 24***	60.4	17.1	115	102.4
April 25				152.4	***June 25***	56.6	15.8	107	65.6
April 26				141.0	***June 26***	51.7	14.6	102	46.8
April 27				145.5	***June 27***	47.1	14.0	95.4	35.5
April 28				106.0	***June 28***	42.7	13.4	90.4	28.6
April 29				73.3	***June 29***	39.5	14.0	87.1	25.1
April 30				52.1	***June 30***	40.5	12.3	82.4	19.4
May 1				96.7	***July 1***	39.5	11.2	80.8	16.6
May 2				117.7	***July 2***	39.5	10.2	87.1	13.4
May 3				186.9	***July 3***	37.4	6.9	98.7	11.1
May 4				376.8	***July 4***	32.5	5.0	98.7	11.1
May 5				594 E	***July 5***	31.6	3.1	87.1	13.4
May 6			156	478.8	***July 6***	37.4	2.0	80.8	14.6
May 7			191	304.2	***July 7***	33.5	1.2	73.3	18.0
May 8			205	261.6	***July 8***	28.8	0.9	64.7	19.4
May 9			193	261.6	***July 9***	17.1	1.3	59.2	20.2
May 10			179	240.1	***July 10***	13.0	1.0	52.8	17.3
May 11			143	214.0	***July 11***	13.0	0.7	50.3	12.2
May 12			127	192.2	***July 12***	12.1	0.4	47.8	10.5
May 13			163	189.5	***July 13***	12.1	0.0	46.6	11.6
May 14			166	181.7	***July 14***	9.4	0.0	42.0	18.7
May 15			136	181.7	***July 15***	7.7	0.0	36.6	86.3
May 16			134	211.2	***July 16***	6.5	0.0	34.5	98.7
May 17			172	176.7	***July 17***	5.1	0.0	32.5	57.1
May 18			174	157.1	***July 18***	4.1	0.0	33.5	34.5
May 19			165	184.3	***July 19***	3.6	0.0	32.5	23.4
May 20			176	186.9	***July 20***	3.8	0.0	29.5	17.3
May 21			167	169.2	***July 21***	2.4	0.0	25.8	11.6
May 22			165	141.0	***July 22***	2.0	0.0	23.2	8.5
May 23			431	128.0	***July 23***	1.8	0.0	29.5	6.3
May 24			1211 E	119.7	***July 24***	3.6	0.0	32.5	4.9
May 25				121.8	***July 25***	2.7	0.0	32.5	4.9
May 26				128.0	***July 26***	1.5	0.0	28.6	5.9
May 27				115.7	***July 27***	1.5	0.0	25.0	9.0
May 28				102.2	***July 28***	2.3	0.0	20.8	9.0
May 29				93.1	***July 29***	1.5	0.0	17.7	10.5
May 30				82.9	***July 30***	0.9	0.0	13.5	12.8
May 31			269	76.4	***July 31***	0.5	0.0	12.2	18.7

Table B-5. Daily average streamflows for the Milk River at Del Bonita DNRC gage (Continued).

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	***2006***	***2007***	***2008***	***2009***	***Day***	***2006***	***2007***	***2008***	***2009***
Aug 1	0.4	0.0	11.0	20.2	**Oct 1**	6.8	0.0	8.3	0.1
Aug 2	0.7	0.0	9.3	21.0	**Oct 2**	6.5	0.0	7.8	0.1
Aug 3	0.5	0.0	8.2	17.3	**Oct 3**	6.2	2.1	8.3	0.2
Aug 4	0.0	0.0	10.4	12.8	**Oct 4**	6.2	2.2	8.3	0.3
Aug 5	0.0	0.0	9.8	10.0	**Oct 5**	5.9	3.1	8.3	0.4
Aug 6	0.0	0.0	9.3	10.5	**Oct 6**	6.5	5.8	9.3	0.4
Aug 7	0.0	0.0	8.2	12.8	**Oct 7**	7.7	13.2	9.3	0.6
Aug 8	0.0	0.0	7.2	21.0	**Oct 8**	7.7	17.3	8.8	0.7
Aug 9	0.0	0.0	6.8	21.0	**Oct 9**	8.4	21.0		0.3
Aug 10	0.0	0.0	15.5	16.6	**Oct 10**	9.4	22.6		0.3
Aug 11	0.0	0.0	14.1	11.1	**Oct 11**	15.0	21.0		0.5
Aug 12	0.0	0.0	11.0	8.1	**Oct 12**	19.3	18.0		0.5
Aug 13	0.0	0.0	9.3	7.2	**Oct 13**	18.2	15.9		0.7
Aug 14	0.0	0.0	8.2	7.2	**Oct 14**	18.2	13.9		0.8
Aug 15	0.0	0.0	6.8	7.2	**Oct 15**	16.0	12.6		5.2
Aug 16	0.0	0.0	6.3	12.2	**Oct 16**	16.0	12.0		13.7
Aug 17	3.4	0.0	5.4	22.5	**Oct 17**	17.1	11.4		23.8
Aug 18	17.1	0.0	3.9	27.7	**Oct 18**	20.5	10.3		30.5
Aug 19	23.0	0.0	2.3	25.9	**Oct 19**	24.2	9.7		30.5
Aug 20	11.2	0.0	1.3	18.0	**Oct 20**	30.0	9.7		27.1
Aug 21	6.8	0.0	1.1	12.8	**Oct 21**	33.9	9.2		23.8
Aug 22	4.8	0.0	1.8	8.5	**Oct 22**	35.9	9.7		20.1
Aug 23	3.3	0.0	2.6	5.9	**Oct 23**	34.9	11.4		
Aug 24	2.6	0.0	5.0	4.5	**Oct 24**	30.0	12.0		
Aug 25	2.3	0.0	5.4	3.3	**Oct 25**	26.4			
Aug 26	2.2	0.0	4.6	2.1	**Oct 26**	24.2			
Aug 27	1.8	0.0	3.5	1.6	**Oct 27**	21.7			
Aug 28	1.3	0.0	2.6	1.3	**Oct 28**				
Aug 29	1.0	0.0	1.3	1.3	**Oct 29**				
Aug 30	1.5	0.0	0.8	0.9	**Oct 30**				
Aug 31	1.6	0.0	0.9	0.7	**Oct 31**				
Sept 1	1.6	0.0	2.0	0.4					
Sept 2	1.3	0.0	5.9	0.3					
Sept 3	0.9	0.0	14.1	0.3					
Sept 4	0.7	0.0	16.9	0.1					
Sept 5	0.6	0.0	14.1	0.0					
Sept 6	0.5	0.0	12.8	0.0					
Sept 7	0.4	0.0	14.8	0.0					
Sept 8	0.0	0.0	16.2	0.0					
Sept 9	0.0	0.0	18.4	0.0					
Sept 10	0.0	0.0	17.7	0.0					
Sept 11	0.0	0.0	16.9	0.0					
Sept 12	0.0	0.0	18.4	0.0					
Sept 13	0.0	0.0	20.0	0.0					
Sept 14	0.5	0.0	16.9	0.0					
Sept 15	1.3	0.0	17.7	0.0					
Sept 16	1.6	0.0	12.8	0.0					
Sept 17	1.5	0.0	9.9	0.0					
Sept 18	3.0	0.0	7.8	0.0					
Sept 19	9.1	0.0	6.0	0.0					
Sept 20	9.1	0.0	5.2	0.0					
Sept 21	9.4	0.0	4.8	0.0					
Sept 22	26.4	0.0	4.8	0.0					
Sept 23	36.9	0.0	5.6	0.1					
Sept 24	37.9	0.0	6.0	0.0					
Sept 25	31.9	0.0	7.8	0.0					
Sept 26	23.0	0.0	7.8	0.0					
Sept 27	15.0	0.0	6.9	0.0					
Sept 28	10.3	0.0	6.4	0.0					
Sept 29	8.4	0.0	6.4	0.0					
Sept 30	7.4	0.0	7.3	0.0					

Table B-6. Daily streamflow Milk River Western Crossing of International Boundary USGS gage 06133000.

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	***2006***	***2007***	***2008***	***2009***	***Day***	***2006***	***2007***	***2008***	***2009***
April 1	341	93	43	60	***June 1***	86	85	219	69
April 2	353	99	49	63	***June 2***	68	66	210	67
April 3	347	92	54	57	***June 3***	56	56	206	67
April 4	268	90	62	61	***June 4***	50	53	192	67
April 5	360	84	65	60	***June 5***	45	46	182	62
April 6	593	78	57	55	***June 6***	41	56	176	63
April 7	682	69	58	84	***June 7***	37	50	158	62
April 8	491	73	58	119	***June 8***	41	55	148	81
April 9	413	78	58	118	***June 9***	40	63	154	90
April 10	325	96	64	126	***June 10***	53	55	168	85
April 11	288	113	71	136	***June 11***	109	45	219	84
April 12	249	105	85	182	***June 12***	216	40	1,060	83
April 13	212	102	113	258	***June 13***	189	38	1,290	71
April 14	202	97	155	263	***June 14***	211	38	579	61
April 15	186	93	208	171	***June 15***	225	35	396	53
April 16	183	85	280	131	***June 16***	252	32	292	53
April 17	175	84	187	100	***June 17***	267	32	232	49
April 18	152	85	138	90	***June 18***	182	43	191	44
April 19	136	91	141	112	***June 19***	130	56	165	41
April 20	123	105	58	121	***June 20***	109	45	149	37
April 21	105	115	58	148	***June 21***	97	35	139	37
April 22	108	120	69	230	***June 22***	96	28	130	90
April 23	120	113	74	280	***June 23***	84	23	119	111
April 24	136	104	78	227	***June 24***	71	20	111	114
April 25	122	97	82	168	***June 25***	60	18	105	86
April 26	107	91	82	168	***June 26***	54	15	100	60
April 27	99	91	79	156	***June 27***	47	13	95	46
April 28	98	88	95	150	***June 28***	41	12.0	88	35
April 29	98	82	158	100	***June 29***	36	11.0	83	28
April 30	102	78	240	81	***June 30***	35	10.0	79	25
May 1	105	76	238	99	***July 1***	33	10.0	77	20
May 2	121	78	195	133	***July 2***	31	7.9	83	17
May 3	131	83	168	179	***July 3***	31	7.1	90	14
May 4	139	113	149	299	***July 4***	27	5.9	100	11
May 5	130	151	155	448	***July 5***	23	4.2	93	9.7
May 6	112	120	185	406	***July 6***	22	2.8	82	12
May 7	98	96	189	304	***July 7***	25	2.5	77	15
May 8	89	82	203	241	***July 8***	21	2.2	69	16
May 9	89	73	195	239	***July 9***	17	1.9	60	17
May 10	91	67	182	231	***July 10***	15	1.4	54	19
May 11	87	64	165	211	***July 11***	13	1.2	54	15
May 12	79	60	139	193	***July 12***	12.0	0.81	47	9.7
May 13	75	61	144	187	***July 13***	11.0	0.49	44	9.1
May 14	71	62	169	183	***July 14***	9.4	0.39	42	19
May 15	70	68	149	176	***July 15***	9.1	0.32	37	17
May 16	71	78	145	193	***July 16***	7.6	0.18	33	91
May 17	70	70	176	189	***July 17***	6.3	0.18	31	75
May 18	66	64	195	156	***July 18***	4.7	0.14	29	48
May 19	61	58	179	159	***July 19***	3.8	0.07	29	30
May 20	57	54	191	171	***July 20***	2.9	0.04	28	20
May 21	54	51	200	164	***July 21***	2.3	0	24	15
May 22	51	50	194	140	***July 22***	1.9	0	22	12
May 23	51	52	304	118	***July 23***	1.9	0	31	8
May 24	50	68	1,010	113	***July 24***	1.5	0	29	5.8
May 25	44	72	1,660	110	***July 25***	1.9	0	30	4.7
May 26	43	69	1,130	116	***July 26***	1.7	0	29	3.5
May 27	48	73	600	112	***July 27***	1.5	0	25	3.3
May 28	66	75	445	100	***July 28***	2	0	22	3.7
May 29	99	81	364	90	***July 29***	1.4	0	18	5.6
May 30	134	119	291	81	***July 30***	0.95	0	15	5.4
May 31	111	110	244	73	***July 31***	0.53	0	12	12

Table B-6. Daily streamflows for the Milk River at Western Crossing of International Boundary (Continued).

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	**2006**	**2007**	**2008**	**2009**	**Day**	**2006**	**2007**	**2008**	**2009**
Aug 1	0.35	0	10	12	**Oct 1**	8.2	0.53	5.7	0
Aug 2	0.25	0	9.2	13	**Oct 2**	7.8	0.74	6	0
Aug 3	0.14	0	8.9	13	**Oct 3**	7.3	0.67	6.7	0
Aug 4	0.21	0	7.9	12	**Oct 4**	7	0.49	7	0
Aug 5	0.18	0	7.3	9.8	**Oct 5**	6.9	0.64	7.2	0
Aug 6	0.11	0	7.7	8.4	**Oct 6**	6.5	1.1	7.4	0
Aug 7	0.07	0	7.1	7.8	**Oct 7**	6.7	1.1	7.8	0
Aug 8	0.04	0	6.9	7.3	**Oct 8**	7.7	1.4	8.2	0
Aug 9	0	0	6.8	11	**Oct 9**	8.5	9.2	8.1	0.04
Aug 10	0	0	6.4	13	**Oct 10**	8.8	16	8.4	0.04
Aug 11	0.04	0	6.5	11	**Oct 11**	10	19	8.5	0.04
Aug 12	0	0	9.9	8.3	**Oct 12**	12	18	8.5	0.04
Aug 13	0	0	8.2	7	**Oct 13**	14	16	9.8	0.07
Aug 14	0	0	7	6.2	**Oct 14**	14	14	11	6.4
Aug 15	0	0	5.9	6.3	**Oct 15**	15	12	15	13
Aug 16	0	0	4.7	6	**Oct 16**	15	11	14	14
Aug 17	0	0	4.3	5.4	**Oct 17**	15	11	16	19
Aug 18	0	0	3.6	11	**Oct 18**	15	10	17	27
Aug 19	0	0	3.4	17	**Oct 19**	15	9.4	17	34
Aug 20	8.3	0	3	16	**Oct 20**	19	9.3	18	35
Aug 21	9.9	0	2.8	12	**Oct 21**	20	8.9	19	30
Aug 22	7.7	0	2.5	8.9	**Oct 22**	23	9	19	26
Aug 23	5.9	0	2.1	6.6	**Oct 23**	25	8.8	17	22
Aug 24	4.1	0	1.7	4.9	**Oct 24**	23	9.6	17	20
Aug 25	3.2	0	1.4	3.6	**Oct 25**	20	11	16	19
Aug 26	2.6	0	1.9	2.6	**Oct 26**	18	10	16	17
Aug 27	2	0	3.8	2.3	**Oct 27**	16	8.9	14	21
Aug 28	1.5	0	3.1	1.9	**Oct 28**	15	10	15	28
Aug 29	1.2	0	2.5	1.3	**Oct 29**	13	10	16	37
Aug 30	0.99	0	1.9	1	**Oct 30**	12	11	16	47
Aug 31	0.78	0	2.2	0.81	**Oct 31**	11	11	16	45
Sept 1	0.71	0	3	0.74					
Sept 2	0.57	0	3.2	0.57					
Sept 3	0.42	0	2.6	0.42					
Sept 4	0.35	0	4.2	0.35					
Sept 5	0.25	0	11	0.32					
Sept 6	0.21	0	10	0.32					
Sept 7	0.42	0	9	0.25					
Sept 8	0.39	0	9.2	0.21					
Sept 9	0.32	0	10	0.11					
Sept 10	0.28	0	13	0.04					
Sept 11	0.18	0	12	0					
Sept 12	0.07	0	11	0					
Sept 13	0.04	0	13	0					
Sept 14	0.11	0	13	0					
Sept 15	0.28	0	12	0					
Sept 16	0.42	0	11	0					
Sept 17	0.46	0	10	0					
Sept 18	0.39	0	8.7	0					
Sept 19	0.74	0	7	0					
Sept 20	1.1	0	5.9	0					
Sept 21	8.2	0	5.4	0					
Sept 22	11.0	0	4.7	0					
Sept 23	15	0	4.6	0					
Sept 24	24	0	4.9	0					
Sept 25	25	0.32	4.9	0					
Sept 26	21	1.1	5.3	0					
Sept 27	17	0.67	6	0					
Sept 28	13	0.46	5.9	0					
Sept 29	11.0	0.74	5.5	0					
Sept 30	9.1	0.6	5.5	0					

Table B-7. Daily average streamflows for the North Fork Milk River and North Fork Ranch DNRC gage.

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	***2006***	***2007***	***2008***	***2009***	***Day***	***2006***	***2007***	***2008***	***2009***
April 1					***June 1***			7.0	7.7
April 2					***June 2***			7.2	7.3
April 3					***June 3***			6.4	7.0
April 4					***June 4***			6.8	6.7
April 5					***June 5***			5.8	6.6
April 6					***June 6***			5.1	8.7
April 7					***June 7***			5.3	8.6
April 8					***June 8***			6.7	7.7
April 9					***June 9***	6.0		5.1	7.0
April 10					***June 10***	12.9		5.8	6.6
April 11					***June 11***	6.3		17 E	6.2
April 12					***June 12***	6.9		16 E	6.0
April 13					***June 13***	6.4		12.5	6.2
April 14					***June 14***	7.3		10.9	6.3
April 15			6.6		***June 15***	12.4	3.0	9.9	6.2
April 16			4.5		***June 16***	8.8	2.9	8.8	5.9
April 17			4.1		***June 17***	6.4	3.3	8.2	5.3
April 18			4.9		***June 18***	5.8	3.9	7.7	5.5
April 19			4.1		***June 19***	5.8	3.1	7.6	5.3
April 20			3.5		***June 20***	5.8	2.9	7.4	4.9
April 21			3.4	10.7	***June 21***	5.7	2.8	7.3	5.0
April 22			3.2	9.8	***June 22***	5.5	2.7	7.2	9.8
April 23			2.5	9.1	***June 23***	5.4	2.7	6.9	6.7
April 24			2.5	7.8	***June 24***	5.5	2.6	6.9	5.2
April 25			2.4	6.9	***June 25***	5.3	2.8	6.8	4.6
April 26			2.9	7.6	***June 26***	5.2	2.8	6.7	4.3
April 27			5.4	7.7	***June 27***	5.1	2.6	6.7	4.3
April 28			8.3	8.2	***June 28***	5.0	2.7	6.7	3.9
April 29			7.9	9.6	***June 29***	4.9	2.8	6.5	3.9
April 30			6.5	8.5	***June 30***	5.2	2.8	6.5	4.1
May 1			4.7	7.5	***July 1***	4.6	2.7	7.4	3.9
May 2			4.1	8.4	***July 2***	4.5	2.7	7.4	4.1
May 3			3.7	10.3	***July 3***	4.4	2.8	7.0	4.2
May 4			4.4	12.3	***July 4***	4.3	2.6	6.7	4.3
May 5			5.3	12.9	***July 5***	4.2	2.6	6.6	4.2
May 6			5.3	11.8	***July 6***	4.1	2.6	6.4	5.3
May 7			5.6	11.1	***July 7***	4.0	2.5	6.4	4.8
May 8			5.3	11.7	***July 8***	3.9	2.8	6.5	4.1
May 9			5.4	11.1	***July 9***	3.7	2.8	6.2	4.3
May 10			4.5	10.7	***July 10***	3.9	2.9	6.3	4.6
May 11			3.7	10.3	***July 11***	4.3	2.8	8.1	4.3
May 12			5.8	10.3	***July 12***	3.9	2.6	6.8	4.2
May 13			5.2	10.4	***July 13***	3.7	2.6	6.3	5.0
May 14			5.7	10.1	***July 14***	3.7	2.7	6.1	11.9
May 15			6.4	10.9	***July 15***	3.6	2.8	6.2	8.5
May 16			7.5	9.9	***July 16***	3.7	2.6	6.2	3.5
May 17			7.2	10.5	***July 17***	3.7	2.7	6.3	3.1
May 18			8.2	11.0	***July 18***	3.7	2.8	6.1	2.9
May 19			7.9	10.9	***July 19***	3.9	3.3	6.0	2.7
May 20			6.7	10.0	***July 20***	4.0	2.9	6.0	2.9
May 21			8.2	9.0	***July 21***	3.9	2.8	5.7	2.8
May 22			9.3	8.8	***July 22***	3.7	2.8	5.9	2.7
May 23			15.8 E	8.8	***July 23***	3.9	2.6	7.6	2.7
May 24			15.3 E	9.1	***July 24***	4.5	2.6	6.5	3.3
May 25			13.4	9.4	***July 25***	4.8	2.6	6.3	3.2
May 26			11.6	9.7	***July 26***	4.2	2.3	6.1	3.2
May 27			9.6	9.0	***July 27***	4.2	2.3	5.9	3.5
May 28			8.6	8.9	***July 28***	4.2	2.2	5.8	3.2
May 29			8.1	8.7	***July 29***	4.3	2.1	5.7	4.1
May 30			7.7	8.5	***July 30***	4.0	2.1	5.5	3.4
May 31			7.1	8.5	***July 31***	4.0	2.2	5.5	5.6

Table B-7. Daily average streamflows North Fork of Milk River at North Fork Ranch DNRC gage (Continued).

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	***2006***	***2007***	***2008***	***2009***	***Day***	***2006***	***2007***	***2008***	***2009***
Aug 1	4.2	2.2	5.4	3.4	***Oct 1***	5.8	3.5	5.4	2.9
Aug 2	4.2	2.3	5.5	3.1	***Oct 2***	6.0	3.4	5.4	2.9
Aug 3	4.3	2.3	5.8	3.1	***Oct 3***	6.1	3.3	5.5	2.9
Aug 4	4.5	2.2	6.0	3.3	***Oct 4***	6.1	3.4	5.6	3.6
Aug 5	4.5	2.3	5.6	3.8	***Oct 5***	6.1	3.5	5.6	3.8
Aug 6	4.5	2.5	5.6	3.9	***Oct 6***	6.0	3.9	5.4	4.1
Aug 7	4.3	2.3	5.4	3.8	***Oct 7***	6.3	4.2	5.5	4.4
Aug 8	4.3	2.3	5.4	3.4	***Oct 8***	6.3	4.7		3.7
Aug 9	4.6	2.3	5.6	3.2	***Oct 9***	6.4	3.9		3.7
Aug 10	4.6	2.5	6.3	3.0	***Oct 10***	6.3	3.7		3.4
Aug 11	4.9	2.5	5.6	2.9	***Oct 11***	6.1	3.6		3.4
Aug 12	4.8	2.5	5.5	2.9	***Oct 12***	6.0	3.5		3.4
Aug 13	4.9	2.3	5.5	3.2	***Oct 13***	5.9	3.6		3.5
Aug 14	4.7	2.6	5.6	3.8	***Oct 14***	5.9	3.4		3.6
Aug 15	4.6	2.4	5.5	4.4	***Oct 15***	5.8	3.2		4.9
Aug 16	6.7	2.5	5.2	4.2	***Oct 16***	6.3	3.1		4.8
Aug 17	6.5	2.6	5.2	3.6	***Oct 17***	6.3	3.0		4.5
Aug 18	5.1	2.5	5.1	3.2	***Oct 18***	6.3	3.3		3.5
Aug 19	4.8	2.4	5.0	3.0	***Oct 19***	6.6	3.4		3.3
Aug 20	4.7	2.5	5.3	2.9	***Oct 20***	7.3	3.5		3.5
Aug 21	4.7	2.5	5.5	2.9	***Oct 21***	6.8	3.4		3.3
Aug 22	4.6	2.5	6.5	2.7	***Oct 22***	6.4	3.3		
Aug 23	4.5	2.7	5.6	2.7	***Oct 23***	6.2	2.9		
Aug 24	4.6	3.1	5.3	2.7	***Oct 24***	6.0			
Aug 25	4.9	2.8	5.2	2.7	***Oct 25***	5.9			
Aug 26	4.8	2.5	5.5	2.7	***Oct 26***	5.7			
Aug 27	4.6	2.6	5.5	2.7	***Oct 27***				
Aug 28	4.3	2.8	5.3	2.7	***Oct 28***				
Aug 29	4.2	2.8	5.2	2.7	***Oct 29***				
Aug 30	4.2	2.6	5.1	2.7	***Oct 30***				
Aug 31	4.8	2.6	6.0	2.7	***Oct 31***				
Sept 1	4.8	2.6	7.1	2.7					
Sept 2	4.5	2.6	6.2	2.7					
Sept 3	4.2	2.5	5.8	2.6					
Sept 4	4.2	2.5	6.0	2.4					
Sept 5	4.0	2.5	5.8	2.7					
Sept 6	4.0	2.5	6.3	2.7					
Sept 7	4.0	2.8	6.1	2.6					
Sept 8	4.0	4.5	5.8	2.6					
Sept 9	3.7	3.0	5.6	2.5					
Sept 10	3.7	2.8	7.2	2.5					
Sept 11	3.7	2.8	6.0	2.6					
Sept 12	3.6	2.7	5.6	2.7					
Sept 13	3.6	3.0	6.7	2.4					
Sept 14	4.8	2.9	5.8	2.6					
Sept 15	4.9	2.7	5.4	2.5					
Sept 16	5.5	2.6	5.2	2.5					
Sept 17	4.9	2.6	5.3	2.4					
Sept 18	4.6	2.8	5.2	2.4					
Sept 19	4.8	5.2	5.2	2.4					
Sept 20	5.0	3.8	5.3	3.2					
Sept 21	5.0	3.8	5.7	3.1					
Sept 22	8.0	3.1	5.6	2.7					
Sept 23	7.2	3.7	5.6	2.7					
Sept 24	6.6	4.6	5.6	2.4					
Sept 25	6.4	4.3	5.5	2.5					
Sept 26	6.4	3.8	5.5	2.4					
Sept 27	6.6	3.6	5.5	2.4					
Sept 28	6.3	3.6	5.5	2.7					
Sept 29	6.2	4.3	5.5	2.7					
Sept 30	5.9	3.8	5.5	2.9					

Table B-8. Daily average streamflows North Fork Milk River above St. Mary Canal USGS gage #06133500.

Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	**2006**	**2007**	**2008**	**2009**	**Day**	**2006**	**2007**	**2008**	**2009**
April 1	67	16	11	9.0	June 1	17	16	21	19
April 2	48	16	11	9.0	June 2	16	15	25	18
April 3	31	16	12	9.0	June 3	15	14	21	17
April 4	36	16	12	9.5	June 4	15	14	21	17
April 5	52	16	12	11	June 5	16	14	20	17
April 6	76	16	12	13	June 6	15	16	18	20
April 7	62	16	13	18	June 7	15	22	18	23
April 8	42	17	13	27	June 8	16	17	21	20
April 9	35	19	14	28	June 9	19	14	18	19
April 10	32	17	20	27	June 10	40	14	18	18
April 11	29	18	24	27	June 11	31	13	94	17
April 12	27	18	27	27	June 12	25	13	137	16
April 13	27	21	38	23	June 13	26	12	53	16
April 14	26	21	55	20	June 14	27	12	35	16
April 15	26	19	40	18	June 15	34	12	30	17
April 16	24	18	22	18	June 16	43	13	26 1	21
April 17	23	17	17	21	June 17	26	15	24	16
April 18	22	18	18	21	June 18	22	15	22	15
April 19	22	21	16	24	June 19	21	14	22	15
April 20	22	22	16	30	June 20	21	12	21	15
April 21	22	23	15	31	June 21	21	11	20	15
April 22	23	26	14	29	June 22	20	11	20	27
April 23	26	26	14	22	June 23	19	10	19	24
April 24	24	22	13	22	June 24	19	10	19	16
April 25	22	19	14	25	June 25	19	10	19	15
April 26	21	18	13	25	June 26	18	10	18	14
April 27	20	17	16	21	June 27	18	10	18	14
April 28	20	16	21	20	June 28	17	10	18	13
April 29	20	16	25	20	June 29	17	10	17	13
April 30	21	16	21	22	June 30	18	10	16	13
May 1	23	16	18	25	July 1	17	10	17	13
May 2	23	15	17	35	July 2	18	10	18	13
May 3	26	27	16	51	July 3	18	10	17	13
May 4	23	27	17	54	July 4	16	9.6	16	13
May 5	21	18	18	50	July 5	16	9.3	16	13
May 6	19	16	18	37	July 6	16	9.1	15	13
May 7	19	15	19	42	July 7	15	8.9	15	15
May 8	19	15	18	36	July 8	14	9.2	15	13
May 9	19	15	18	32	July 9	14	9.4	14	12
May 10	18	15	18	30	July 10	15	9.4	14	13
May 11	18	15	16	29	July 11	16	9.3	17	13
May 12	18	15	19	31	July 12	15	9	16	12
May 13	18	15	19	32	July 13	15	9	14	13
May 14	18	17	18	35	July 14	14	9.3	14	30
May 15	18	17	19	32	July 15	15	9.8	13	22
May 16	17	15	20	29	July 16	15	9.4	14	15
May 17	17	14	20	30	July 17	16	9.2	14	13
May 18	17	14	20	29	July 18	15	9.3	14	13
May 19	17	14	21	28	July 19	15	9.2	13	12
May 20	17	14	19	24	July 20	15	9.4	13	12
May 21	17	15	23	23	July 21	15	9.1	13	12
May 22	16	21	26	23	July 22	14	8.9	12	12
May 23	16	18	88	23	July 23	14	8.7	17	11
May 24	15	19	94	23	July 24	15	8.6	15	12
May 25	15	21	66	24	July 25	16	8.7	14	13
May 26	17	19	42	22	July 26	15	9	13	12
May 27	18	16	31	21	July 27	14	9	13	13
May 28	34	25	27	21	July 28	13	8.7	12	13
May 29	26	31	24	20	July 29	13	8.4	12	13
May 30	22	20	22	19	July 30	12	8.3	11	14
May 31	18	17	21		July 31	12	8.2	11	16

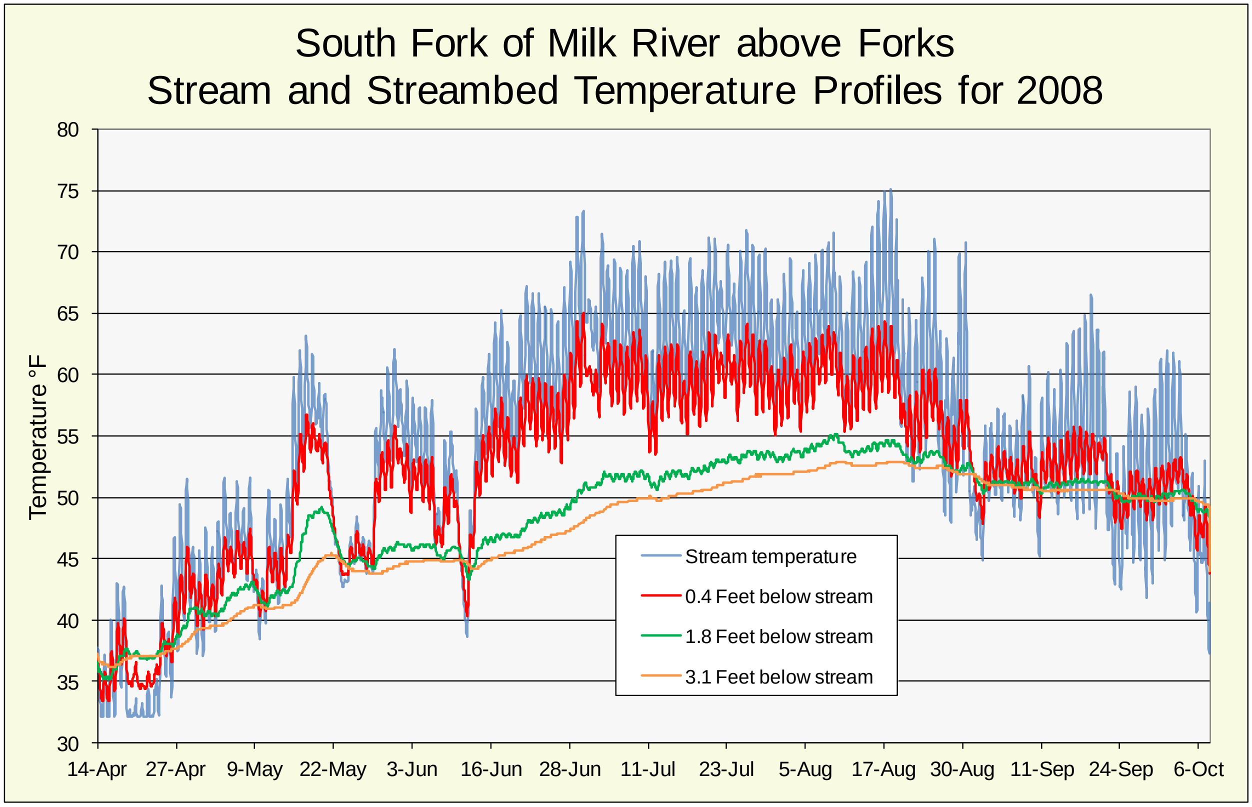
Table B-8. Daily average streamflows North Fork of Milk River above St. Mary Canal USGS gage (Continued).

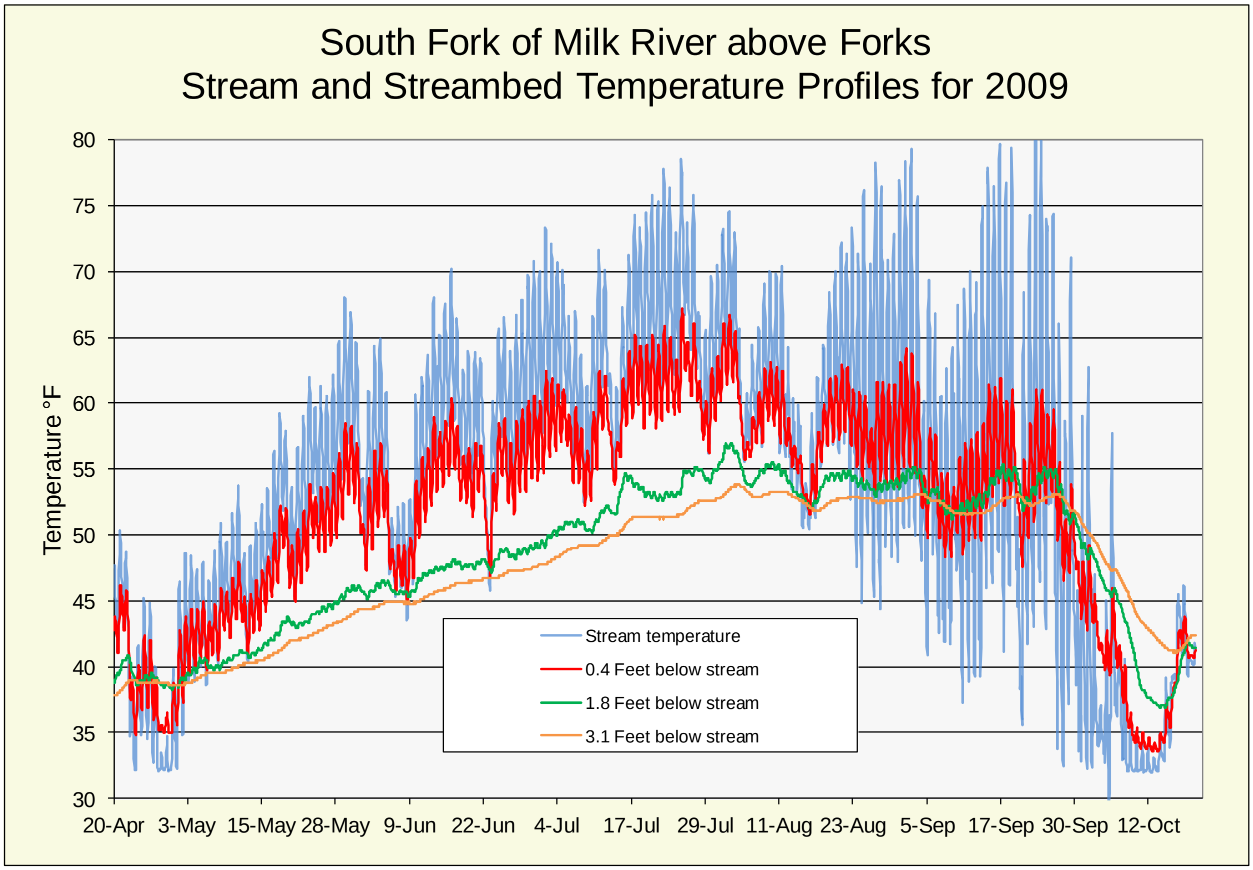
Daily Average Streamflows in Cubic Feet Per Second (CFS) by year									
Day	**2006**	**2007**	**2008**	**2009**	**Day**	**2006**	**2007**	**2008**	**2009**
Aug 1	12	8.2	12	15	**Oct 1**	13	9.3	12	13
Aug 2	12	8.5	12	12	**Oct 2**	15	8.9	12	13
Aug 3	11	8.5	13	12	**Oct 3**	14	8.4	12	14
Aug 4	12	8.1	14	12	**Oct 4**	14	9	13	14
Aug 5	11	8.2	13	13	**Oct 5**	16	9.9	13	16
Aug 6	11	9.3	13	14	**Oct 6**	16	11	12	15
Aug 7	11	8.8	13	14	**Oct 7**	17	11	13	17
Aug 8	11	8.4	13	13	**Oct 8**	19	12	13	15
Aug 9	11	8.2	13	12	**Oct 9**	19	10	13	13
Aug 10	11	8.4	14	12	**Oct 10**	19	9.6	13	13
Aug 11	11	8.5	13	12	**Oct 11**	20	9.4	13	12
Aug 12	11	8.5	13	12	**Oct 12**	19	9.3	13	13
Aug 13	11	8.3	13	12	**Oct 13**	19	9.5	13	15
Aug 14	11	8.5	13	13	**Oct 14**	18	9.3	13	15
Aug 15	11	8.3	13	14	**Oct 15**	18	9.3	13	16
Aug 16	14	7.9	13	15	**Oct 16**	20	9.3	13	18
Aug 17	24	8.2	13	14	**Oct 17**	21	10	13	16
Aug 18	12	8.2	12	13	**Oct 18**	21	9	13	14
Aug 19	12	7.9	11	12	**Oct 19**	23	9	13	13
Aug 20	12	8	12	12	**Oct 20**	28	9.4	13	13
Aug 21	12	7.9	12	12	**Oct 21**	27	9.3	13	13
Aug 22	13	7.8	14	12	**Oct 22**	22	9.4	13	13
Aug 23	12	8.3	13	12	**Oct 23**	20	9.5	13	13
Aug 24	13	9.3	13	12	**Oct 24**	19	9.5	13	14
Aug 25	13	9	13	12	**Oct 25**	19	9.3	13	14
Aug 26	14	8.2	13	12	**Oct 26**	18	9.4	13	13
Aug 27	13	8.2	13	12	**Oct 27**	17	10	13	15
Aug 28	12	8.5	13	12	**Oct 28**	17	11	13	14
Aug 29	12	8.6	12	12	**Oct 29**	16	11	13	14
Aug 30	11	8.2	12	12	**Oct 30**	15	11	13	15
Aug 31	11	7.9	13	12	**Oct 31**	15	11	13	19
Sept 1	12	7.8	14	12					
Sept 2	13	7.8	15	13					
Sept 3	12	7.8	14	12					
Sept 4	12	7.8	14	12					
Sept 5	11	8	14	12					
Sept 6	10	7.8	14	12					
Sept 7	10	9	14	12					
Sept 8	10	12	14	12					
Sept 9	8.5	10	14	12					
Sept 10	8.2	10	15	12					
Sept 11	7.3	9	14	12					
Sept 12	8	10	13	12					
Sept 13	9.6	10	14	11					
Sept 14	15	10	13	11					
Sept 15	19	9.9	13	11					
Sept 16	24	9.1	12	12					
Sept 17	20	9.4	12	12					
Sept 18	17	9.5	12	12					
Sept 19	17	15	12	11					
Sept 20	18	14	12	13					
Sept 21	17	12	13	14					
Sept 22	33	9	13	13					
Sept 23	17	14	13	12					
Sept 24	12	16	13	12					
Sept 25	11	13	13	12					
Sept 26	11	12	12	11					
Sept 27	12	12	12	11					
Sept 28	12	12	12	12					
Sept 29	11	10	12	12					
Sept 30	13	9.8	12	13					

Appendix C
Stream and Streambed Temperature Profiles
2008-2009

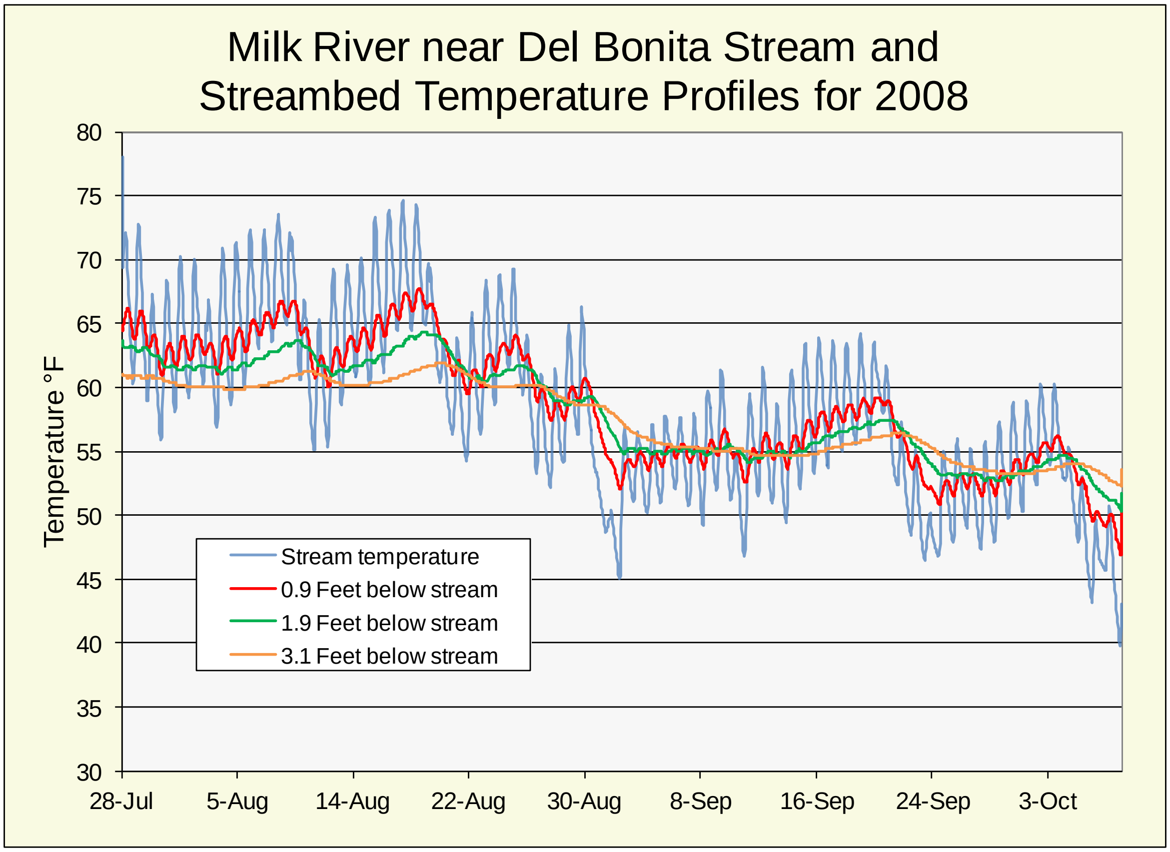
Photo of submersible temperature loggers mounted at depth intervals in PVC pipe and isolated by foam baffles. Apparatus was pushed into the steel stilling-well pipe that was driven into the streambed and also housed the water-level loggers

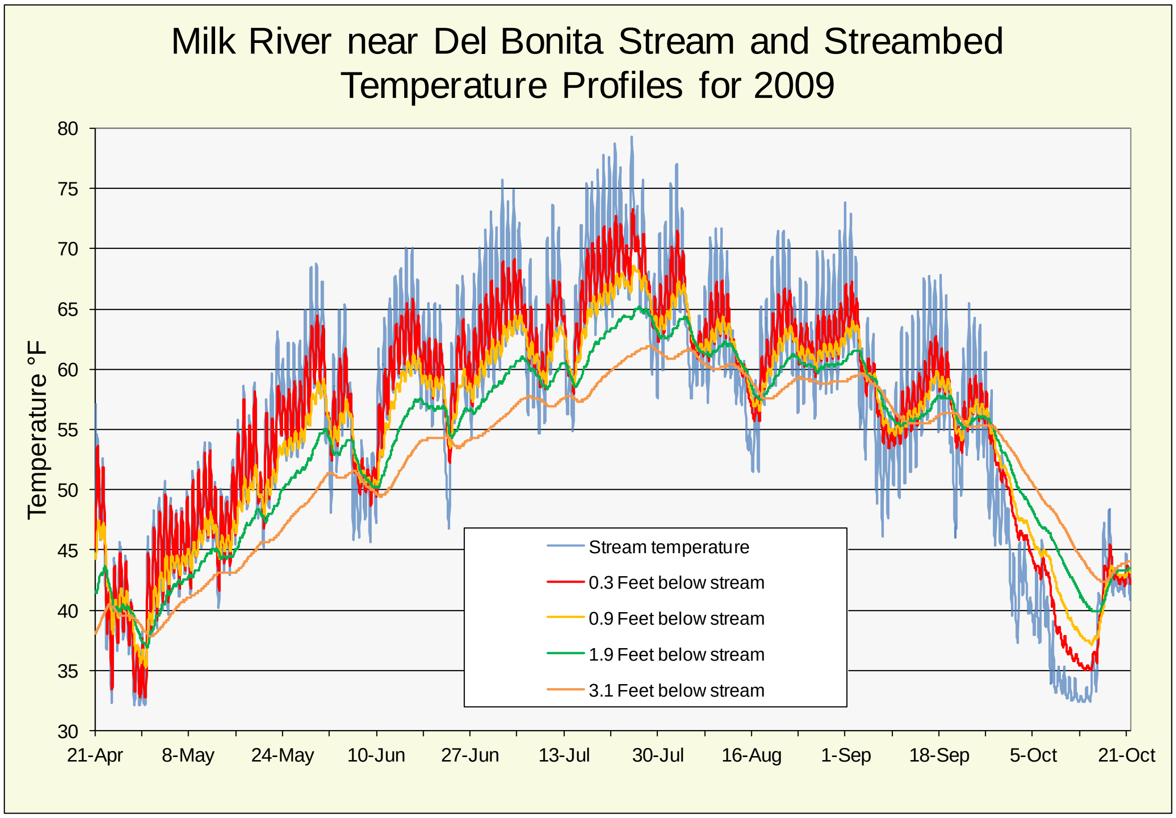
Figures C-1 and C-2. Temperature graphs for South Fork of Milk River above Forks (SFMR) for 2008 and 2009.





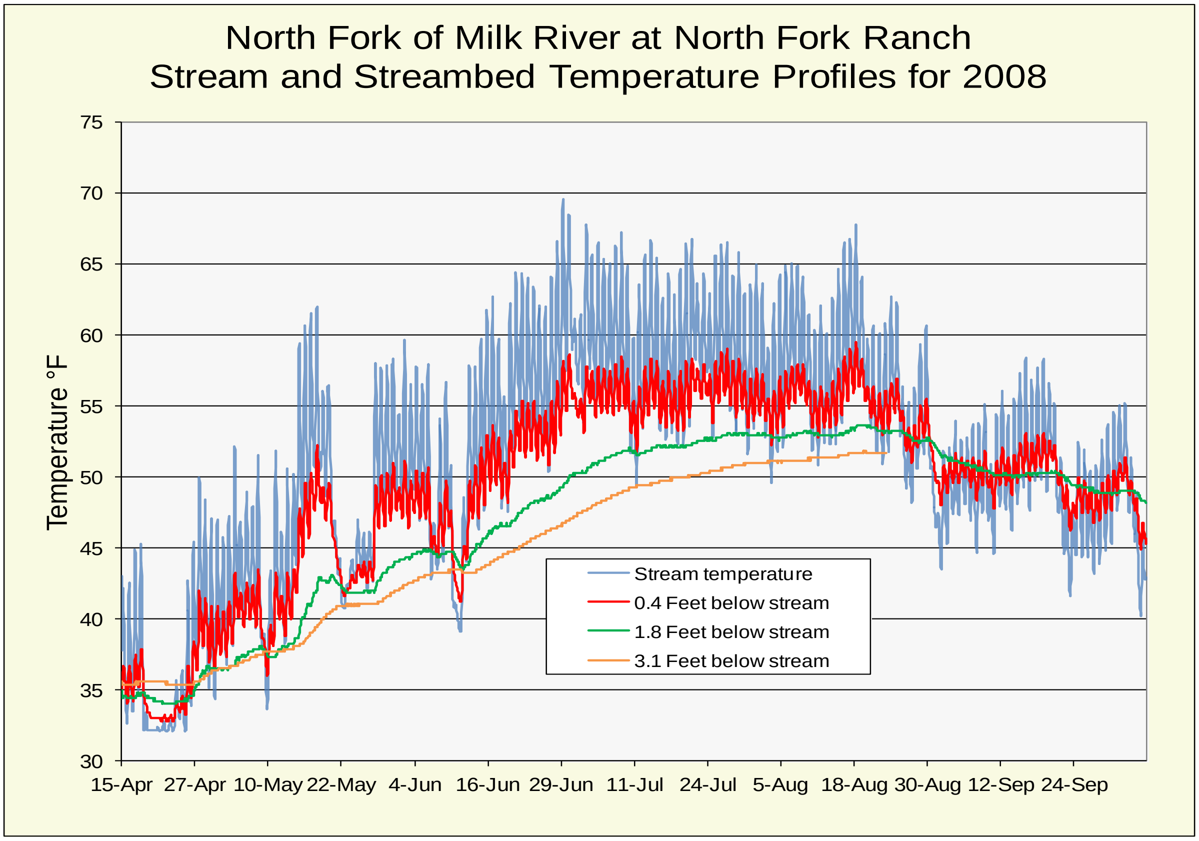
Figures C3 and C4. Temperature Graphs for Milk River near Del Bonita (MRDB) for 2008 and 2009.

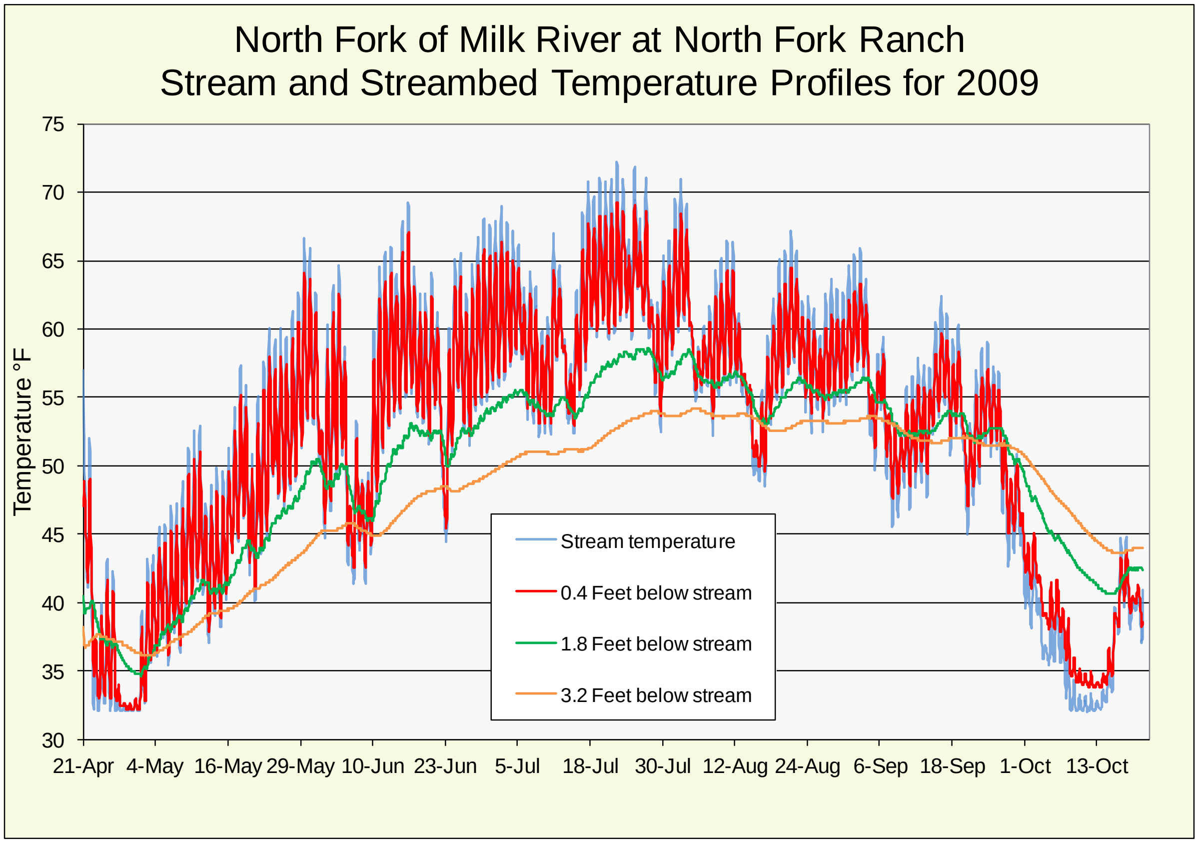




Note: an additional temperature logger was added at 0.3 feet during 2009.

Figure C-5 and C-6. Temperature graphs for North Fork of Milk River at North Fork Ranch (NFMR) for 2008 and 2009.





Note: Baffle between stream and 0.4 feet logger may have been damaged during 2009.