

RECLAMATION

Managing Water in the West

St. Mary River and Milk River Basins Study Summary Report

Milk River Project, Montana
Great Plains Region



U.S. Department of the Interior
Bureau of Reclamation



State of Montana
Department of Natural Resources
and Conservation

March 2012

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

St. Mary River and Milk River Basins Study Summary Report

Milk River Project, Montana
Great Plains Region



U.S. Department of the Interior
Bureau of Reclamation

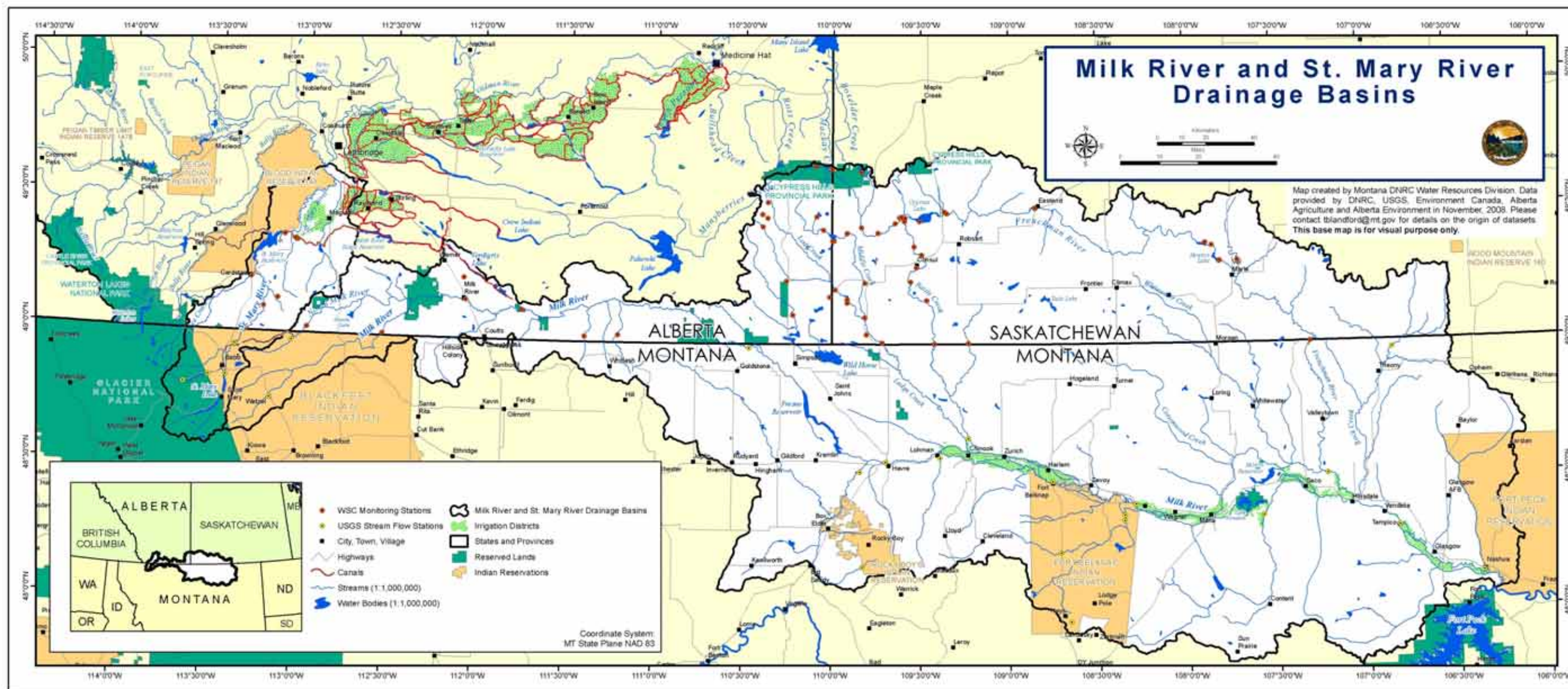


State of Montana
Department of Natural Resources
and Conservation

March 2012

Acronyms and Abbreviations

AF	acre-feet
CFS	cubic feet per second
DEQ	Montana Department of Environmental Quality
DNRC	Montana Department of Natural Resources and Conservation
Eastern Crossing	Milk River at the Eastern Crossing of the International Boundary
ESA	Endangered Species Act
FW&P	Montana Department of Fish, Wildlife & Parks
GCM	General Circulation Model
IJC	International Joint Commission
JBOC	Milk River Joint Board of Control
NRCS	U.S. Natural Resources Conservation Service
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
SMRWG	St. Mary Rehabilitation Working Group
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
Western Crossing	Milk River at the Western Crossing of the International Boundary



Frontispiece: Location map.

Report and Contacts

This Basin Study report provides an overview of the problems and needs, present and future water supplies and demands, models, potential alternatives, and basin study requirements. This report is accompanied by a technical report (Montana Department of Natural Resources and Conservation [DNRC] et al., 2012) with further details on the setting, water supplies, present and future water demands, models, analyses, and potential alternatives.

The Bureau of Reclamation's (Reclamation) Technical Service Center peer reviewed this Basin Study and determined that it was technically sound. Hydros Consulting, Inc., worked with the DNRC to refine and calibrate the river system model.

Reclamation and DNRC have jointly developed the St. Mary River and Milk River basins study reports and river system model. Please contact Reclamation at 406-247-7300 or DNRC at 406-444-6627 for information on how to obtain a copy of the river system model and associated documentation.

Abstract

Water shortages in the St. Mary River and Milk River basins in north-central Montana have been well documented. Existing irrigation water shortages average about 71,000 acre-feet (AF) per year, which is about 36 percent of the amount of water needed for optimal crop growth. Aging, under-designed infrastructure in the Milk River Project is not able to supply enough water to irrigators even when an adequate water supply is available. The Tribes of the Blackfeet Reservation may develop federally reserved water rights for St. Mary River flow in the future, and the Fort Belknap Community and Blackfeet Tribes may develop more of their federally reserved water rights for Milk River natural flows in the future. Canada surpluses about 33,000 AF of its share of Milk River natural flow on average annually to the U.S.. Canada is investigating alternatives to provide storage facilities on the Milk River to capture and use most of their allocation.

The U.S. Department of Interior’s Bureau of Reclamation (Reclamation) and the Montana Department of Natural Resources and Conservation (DNRC) conducted a basin study under Reclamation’s WaterSMART Program. To address present and future water needs in the St. Mary River and Milk River basins, this Basin Study created and tested a river system model or “tool” to help analyze a range of potential alternatives. This Basin Study also provides a first look into what future water supplies and demands might be and how the existing infrastructure performs when trying to meet these future demands.

In this Basin Study, Reclamation and DNRC examined:

- **River system processes.** Reclamation and DNRC created and tested a “daily time step” river system model that would be acceptable to stakeholders as a planning tool. The model was developed and calibrated for historic water supply and demand conditions. The model was then run for the five future climate scenarios to assess how the existing infrastructure would perform when attempting to meet future demands. This river system model, with its new capabilities, will allow decisionmakers and technical users to help evaluate issues and potential solutions to basin needs.
- **Historic and future water supplies and demands.** Reclamation and DNRC determined water supplies and demands for the river basin for historic conditions. To analyze how climate change may affect future water supplies, demands, and shortages, Reclamation and DNRC developed five climate scenarios and ran models to translate potential changes in temperature and precipitation into projections for streamflows, evaporation rates, and crop irrigation requirements.

- **Potential alternatives.** To evaluate how changes to the St. Mary River and Milk River system might bridge the gap between supply and demand, Reclamation and DNRC developed a range of alternatives and modeled their performance in reducing future water shortages. The single-most effective alternative might be to increase irrigation efficiencies, which might reduce average irrigation water shortages by about 20,000 AF.

This Basin Study recommends using and enhancing the new river system model to further analyze alternatives and combinations of alternatives to address supply and demand issues in the basins, including Tribal and international issues.

Contents

	Page
Chapter 1: Introduction, Needs, and Setting.....	1
Problems and Needs.....	1
Authority	2
Setting	2
Climate	3
Water Quality	3
Plants, Wildlife, and Fish	3
Cultural Resources	4
Social and Economic Characteristics	4
Chapter 2: Water Supplies and Demands	7
Water Supply	7
Milk River Project.....	7
Present Water Supplies.....	7
Future Water Supplies.....	8
Water Demands	10
Present Water Demands	10
Future Water Demands.....	11
Chapter 3: Analysis Methods and Models.....	15
Climate Change Scenarios	15
River System Model	16
Description and Methodology	16
Model Findings and Recommendations	18
Chapter 4: Alternatives	21
Baseline Condition.....	21
Canal and On-Farm Water Use Efficiency Improvements Alternative	22
Rehabilitate St. Mary Canal for Increased Capacity Alternative	22
Increase Fresno Reservoir Storage Alternative	23
Expanded Frenchman Reservoir Alternative	24
New Storage on Milk River in Alberta Alternative.....	25
Combinations of Alternatives.....	26
Chapter 5: Consultation and Coordination.....	27
Partner and Stakeholder Involvement.....	27
Stakeholders	27
Consultation and Review	28
Milk River Project Joint Board of Control.....	28
St. Mary Rehabilitation Working Group.....	29
Indian Tribes.....	29
Federal and State Agencies	29

	Page
Professional Organizations	29
International Consultation	30
Chapter 6: WaterSMART Basin Study Requirements	31
Projections of Water Supply and Demand (Including Risks Posed by Climate Change)	31
Changes in Snowpack	31
Changes in Timing and Volume of Runoff	31
Changes in Groundwater Recharge and Discharge	32
Increase in Demands from Rising Temperatures or Reservoir Evaporation	32
How Water and Power Infrastructure and Operations Would do in Face of Future Population Growth and Climate Change (Including how Changes in Water Supply Will Affect Reclamation Operations and Facilities)	32
Reclamation’s Ability to Deliver Water.....	32
Hydropower Generation.....	33
Recreation at Reclamation Facilities.....	33
Fish and Wildlife Habitat	33
Threatened, Endangered, and Candidate Species under ESA	33
Water Quality Issues (Including Salinity).....	33
Water Flow and Water-Dependent Ecological Resiliency.....	34
Flood Control Management.....	34
Development of Options to Improve Infrastructure and Operations to Supply Water in the Future	34
Comparison of the Options, Findings, and Recommendations (Including Costs, Environmental Effects, Risks, Stakeholders’ Opinions, and Other Aspects).....	34
References Cited	37

Tables

Table	Page
1 Modeled Irrigation Depletion Shortages for all Milk River Irrigation Downstream from Fresno Reservoir Under <i>S0: Historic Climate Conditions</i>	10
2 Modeled Irrigation Depletion Shortages for all Milk River Irrigation Downstream from Fresno Reservoir Under <i>S5: Central Tendency</i>	12

Figures

Figure	Page
Frontispiece: Location map	
1 One of 16 documented slides on the St. Mary Canal.....	1
2 Shift in timing (days) of annual runoff volumes per subbasin.	9
3 Modeled Milk River irrigation depletion shortages under <i>S0: Historic Climate Conditions</i> and selected climate change scenarios.	16
4 St. Mary and Milk Rivers models and input files.	18
5 Example river system model calibration plot for Milk River at Harlem gauging station.....	19
6 Upper St. Mary River basin diversion and conveyance system.	36

Chapter 1: Introduction, Needs, and Setting

Problems and Needs

Water shortages in the St. Mary River and Milk River basins in north-central Montana have been well documented. Shortages are caused by periodic severe droughts and development of more irrigated lands than the available water supply can support in most years. During the spring, the Milk River Project irrigation districts met with the Bureau of Reclamation (Reclamation) to set water allotments for the upcoming season. In years where water shortages are anticipated, allotments for all project water users are reduced so that shortages are equitably shared.

Existing irrigation water shortages average about 71,000 acre-feet (AF) per year, which is about 36 percent of the amount of water needed for optimal crop growth. This unmet crop need is termed “irrigation depletion shortages.” These frequent irrigation depletion shortages affect the irrigators’ willingness to invest in necessary equipment and infrastructure to diversify crops. The lack of crop diversity then further contributes to water shortages, as project facilities were not designed to meet current peak irrigation demands (Reclamation, 2004a). See the “Present Water Demands” section for more information.

Aging, under-designed canals are not able to supply enough water to irrigators even when an adequate water supply is available. Diversions from the St. Mary Canal supply over one-half the Milk River Project’s water in an average year and up to 90 percent in extreme drought years. The St. Mary Canal System—through which St. Mary River water is transferred to the Milk River—is aging and needs rehabilitation to ensure an adequate water supply for the Milk River basin (Reclamation, 2004a). As figure 1 shows, most of the structures of the 90-year old St. Mary Canal have exceeded their design life and need major repairs or replacement.



Figure 1: One of 16 documented slides on the St. Mary Canal.

St. Mary River and Milk River Basins Study Summary Report

Sedimentation is decreasing the storage capacity of Fresno and Frenchman Reservoirs, further reducing the amount of water that can be delivered to irrigators and other users.

Moreover, future demands are projected to increase, particularly under various future climate change scenarios, leading to even more demands competing for a limited water resource. Warmer temperatures and a longer growing season would create more agricultural demands. Irrigation depletion shortages are predicted to increase substantially under all of the future climate scenarios.

Future development of reserved water by Tribes would increase demands on the water supply. Canada could develop more of its share of Milk River natural flow, which would decrease the amount of water available for U.S. water users. See the: “Future Water Demands” section for more information.

Authority

This study is authorized by Title IX, Subtitle F, of Public Law 111-11 (Secure Water Act).

Setting

The St. Mary River and Milk River basins straddle northern Montana and Canada (in the Alberta and Saskatchewan Provinces). The headwaters of the St. Mary River and Milk River basins run from the Rocky Mountains in the west to the Milk River confluence with the Missouri River below Fort Peck Dam in the east as shown on the frontispiece map. This Basin Study concentrates on the U.S. portion of the basins. Mainly rural and agricultural, the region contains three small cities (Havre, Malta, and Glasgow), with numerous small towns scattered throughout. The region also includes the Blackfeet Reservation in Glacier County, the Rocky Boy’s Indian Reservation in Hill County, and the Fort Belknap Reservation in western Phillips County and eastern Blaine County, Montana.

The St. Mary River rises in Glacier National Park, flowing northeast through the Blackfeet Reservation in Montana into Canada on its way to Hudson Bay and further to its confluence with Oldman River near Lethbridge, Alberta. Figure 6 (at the end of this summary report) shows the upper St. Mary River basin diversion and conveyance system for Reclamation’s Milk River Project.

The Milk River originates in the foothills of the Rocky Mountains on the Blackfeet Reservation, flowing northeasterly into Canada near the Del Bonita Border Station on the Blackfeet Reservation at the Western Crossing of the International Boundary (Western Crossing). Shortly after flowing into Canada, the North Fork of the Milk River, which conveys imported water from the St. Mary Canal, joins with the Milk River main stem. The Milk River then flows

through southern Alberta, Canada, before turning south and re-entering the US. at the Eastern Crossing of the International Boundary (Eastern Crossing) just upstream of Fresno Reservoir. Thereafter, the river flows in an easterly direction for 490 river miles until joining the Missouri River near Fort Peck, Montana.

Climate

The historic climate of the region is typical of the northern Great Plains, with wide variations in temperature from season to season. Summers are cooler and wetter in the higher elevations of the western part of the region near Glacier National Park where snow is reported in every month of the year. The average annual precipitation ranges from about 11 inches from the Glasgow, Montana, weather station to 18 inches from the Babb, Montana, weather station.

Water Quality

The St. Mary River outside Glacier National Park and from Glacier National Park to the Canadian border is suitable for drinking and food processing after conventional treatment as well as all other uses (classified B-1).¹ The St. Mary River in Glacier National Park is suitable for all water uses (classified A-1). From the Eastern Crossing to where the Milk River joins with the Missouri River, the Milk River is suitable for drinking and food processing after conventional treatment as well as for all uses except propagation of salmonid fish (classified B-3).

Water quality problems on the Milk River become more pronounced during droughts when dissolved chemical concentrations and water temperatures are highest, although suspended sediments are higher during high flow events such as spring runoff. Irrigation can contribute to water quality degradation. Problems typically occur when irrigation diversions result in low riverflows and when return flows from fields contain higher concentrations of salts, nutrients, suspended solids, and pesticides.

Plants, Wildlife, and Fish

For most of its distance, the Milk River runs through short grass prairie: vast, rolling, high plains grasslands, interrupted by island mountain ranges like the Bears Paw and Little Rocky Mountains, and valleys like the Milk River basin and Missouri River basin. Potholes—remnants of glaciers—pock the prairie,

¹ Under the Clean Water Act, the Montana Department of Environmental Quality classifies water quality by water use, with Montana standards equal to or exceeding United States Environmental Protection Agency water quality standards. Classes run from A-closed (the highest water quality) through A-1, B, C, to I (the lowest quality).

St. Mary River and Milk River Basins Study Summary Report

providing grassland-wetland habitat. Other important wetland habitat is provided by the river's oxbows and sloughs. Habitat diversity in the region allows for a great number of wildlife and bird species. The region is a haven for birds.

There are 10 Montana Wildlife Management Areas in the Milk River basin. Several of them are associated with Milk River Project facilities, including Fresno Reservoir, Dodson Diversion Dam, Dodson South Canal, Nelson Reservoir, and Vandalia Diversion Dam. Bowdoin National Wildlife Refuge is also located in the Milk River Basin near Malta, Montana.

Lakes in the St. Mary drainage also contain native populations of northern pike and sucker species as well as the only known population of trout-perch in Montana. This habitat is shared with non-native populations of Yellowstone cutthroat trout, rainbow trout, brook trout, kokanee, and lake whitefish.

A number of species listed under the Endangered Species Act (ESA) can be found in the St. Mary River and Milk River region. Endangered species include the black-footed ferret, whooping crane, pallid sturgeon, and interior least tern. Threatened species include the grizzly bear, piping plover, bull trout, and Canada lynx. Montana Department of Fish, Wildlife & Parks (FW&P) has identified 27 Species of Special Concern in the St. Mary River and Milk River region.

Cultural Resources

Humans have occupied northern Montana for at least 11,900 years, evidenced by finds of distinctive stone artifacts. Northern Montana is rich in prehistoric and historic resources. Cultural resources include prehistoric archeological sites, Indian sacred sites, and other traditional and historic sites important to Native Americans. Many of the facilities of the Milk River Project itself are considered eligible for the National Register of Historic Places.

Social and Economic Characteristics

The five-county region had a total population of 47,608 people, compared to 49,902 in 1990, an overall decrease of 4.8 percent. Native Americans make up a considerable part of the population. In 2010, the populations of the reservations were: Blackfeet Reservation: 10,405, Rocky Boy's Indian Reservation: 3,323, and Fort Belknap Indian Reservation: 2,851. (U.S. Census Bureau, 2010).

Average income per person in the region (in 2009 dollars) ranges from \$16,904 to \$23,246. Only one county exceeded the Montana per capita income, and none approached the national per capita income. Agriculture forms the underpinning of the region's economy (U.S. Census Bureau, 2012). Unemployment rates ranged from 4.7 percent to 10.8 percent. Unemployment rates in the region are skewed by the extremely high rates on the reservations, estimated to be over 60 percent (Montana State University, 2011). In two of the counties, despite

limited job opportunities, the unemployment rate is lower than the Montana rate of 5.6 percent. Except for Phillips County, with a poverty rate of 8.7 percent, all of the region's 2009 poverty rates² were higher than the Montana rate of 9.8 percent and the national rate of 9.9 percent. Poverty rates in the region ranged from 8.7 percent to 25.1 percent (Montana State University, 2011).

² Poverty level is \$22,050 for a family of four.

Chapter 2: Water Supplies and Demands

Water Supply

Milk River Project

Reclamation's Milk River Project facilities are in both the St. Mary basin and the Milk River basin. For part of its length, the St. Mary flows near the North Fork of the Milk River, offering the opportunity for a transbasin diversion. Thus, St. Mary River water is diverted to the Milk River through the St. Mary Canal to increase the reliable water supply for Milk River users.

Congress authorized construction of the St. Mary facilities in 1905. St. Mary Storage and Conveyance Facilities (constructed between 1907 and 1923) are entirely within the Blackfeet Reservation near the Canadian border in north-central Montana. Water is diverted by the St. Mary Diversion Dam just downstream from the outlet of Lower St. Mary Lake and is conveyed to the North Fork of the Milk River through a 29-mile canal, siphon, and drop system (figure 6).

Lake Sherburne on Swiftcurrent Creek, a tributary of the St. Mary River, stores winter and high spring flows for later release to keep the St. Mary Canal running near full longer in the irrigation season. When U.S. share is insufficient to meet St. Mary Canal diversion needs, stored U.S. share water is released from Lake Sherburne to make up the difference. When there is a U.S. share surplus, water from the Swiftcurrent drainage is stored in Lake Sherburne. Milk River water is stored in Fresno Reservoir, 14 miles west of Havre, Montana, and in Nelson Reservoir, 19 miles northeast of Malta, Montana.

These diversions provide most of the water supply for most of the irrigated land in the Milk River valley that comprise Reclamation's Milk River Project.

Present Water Supplies

Water supplies for the region come from the St. Mary River and Milk River basins. The median combined historic water supply above Fresno Reservoir from St. Mary River diversions and the Milk River flow is about 262,400 AF at the Eastern Crossing. This upstream supply is heavily managed by Reclamation facilities, and most of the U.S. share can be captured and put to beneficial use during low-to-median flow years. The median annual flow for the Milk River near its confluence with the Missouri River near Nashua during the study period (1959–2008) is 337,600 AF; the median streamflow at Nashua during the May through September irrigation season is 129,400 AF. Although some of this water

St. Mary River and Milk River Basins Study Summary Report

represents tributary inflows that cannot be captured with existing facilities, some of these flows could be made available through infrastructure and water management improvements.

St. Mary River

The St. Mary River is a predictable and relatively reliable water supply, typical of headwater, mountain streams with a large snowmelt component. The St. Mary River produces a relatively dependable flow in the summer due to its higher elevation snowmelt and rainfall in Glacier National Park. Streamflow is divided between Canada and the U.S., as per the Boundary Waters Treaty, with Canada receiving a larger allocation of water.

Milk River

The Milk River and its tributaries are less predictable and less reliable from year to year, typical of plains streams in the region. The Milk River is a foothills and prairie stream and produces less water because it has a far smaller high-elevation drainage area than the St. Mary River. Streamflow from the Milk River at the Eastern Crossing is divided between Canada and the U.S.

Because Canada does not have storage facilities on the Milk River, they are not able to capture and use their entire share of the Milk River's natural flow. Evaluation of gauging station records indicates that the median volume of Canada's share that flows into the U.S. is about 20,000 AF.

Future Water Supplies

Model results using climate change scenarios and river system models (discussed in the next section) indicated future changes in water supplies in the region. Overall, the water supply available for Milk River irrigation in the future might be similar to what it has been during the past, but with an earlier shift in the runoff peak.

Precipitation and Temperature

Changes in precipitation and temperature should produce modest streamflow increases in the basins under most scenarios, but with generally lower streamflow during the driest years under most scenarios. The centroid (or halfway date for total annual streamflow runoff volume) for most subwatersheds in the basins is expected to be earlier in the year, as much as 7 to 9 days earlier for snowmelt-dominated streams in the St. Mary River basin (figure 2).

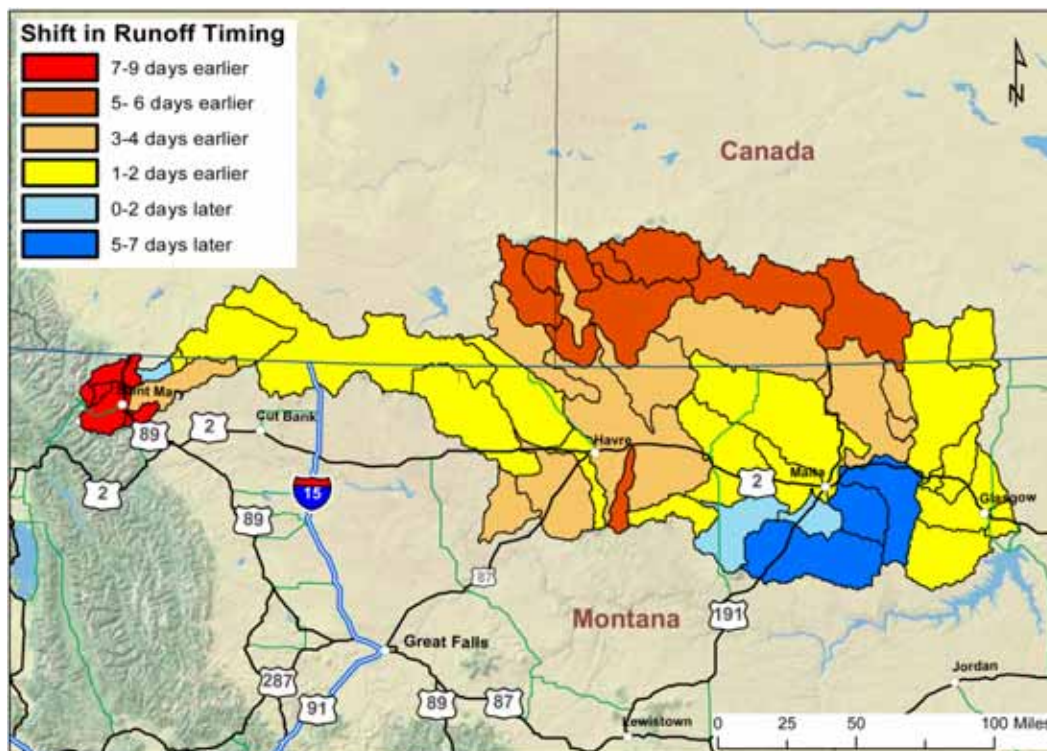


Figure 2: Shift in timing (days) of annual runoff volumes per subbasin.

Diversions and Flow

St. Mary Canal diversions in the future are expected to be 2 to 5 percent higher on average than what they have been during the past, with increased variability, which would result in 5 to 12 percent higher diversions during wetter years and 2 to 10 percent lower diversions during the driest years.

Flow contributions for the upper Milk River portion of the watershed are expected to decrease under all but one of the future scenarios, but not enough to substantially reduce the volume of water that flows into Fresno Reservoir during median years when considered in combination with St. Mary Canal diversions to the Milk River.

Below Fresno Reservoir, average lower Milk River tributary flow contributions are expected to increase somewhat under most future climate scenarios, but about one-half of the scenarios predict about 5 to 15 percent less flow during the irrigation season.

Groundwater

Changes in groundwater due to climate change have not been specifically studied in the St. Mary River basin or the Milk River basin. However, surface water is connected to alluvial aquifers, which includes alluvium of the ancestral Missouri

St. Mary River and Milk River Basins Study Summary Report

River throughout the basin. The Milk River is also a regional discharge area for bedrock aquifers such as the Judith River and Eagle formations. Therefore, effects of climate change on precipitation and surface water runoff could affect both recharge to and discharge from groundwater. Warmer climate conditions could reduce groundwater recharge. Increased evapotranspiration would result in more water consumed by plants, thereby reducing groundwater recharge through surface soils. Less precipitation and possibly fewer irrigation return flows due to direct evaporation from the soil also might reduce recharge to groundwater.

Water Demands

Securing an adequate supply of water to support the agricultural economy, along with municipalities, rural water users, fish, wildlife, and recreation is the primary challenge in this region.

Present Water Demands

Water demands in the Milk River basin are dominated by agricultural irrigation. Previous studies have indicated that significant irrigation shortages already occur in the basin.

Agricultural Use

The Geographic Information Systems analysis indicated that 140,200 acres of land are irrigated from the Milk River downstream from the Eastern Crossing with a present crop demand of 210,000 AF. Table 1 shows the current shortages as modeled under the historic climate conditions.

	Shortage Volume (AF)	Shortage as Percent of Demand
Average	71,000	36
Wettest Ten Years	53,000	29
Middle Ten Years	66,000	35
Driest Ten Years	91,000	44
Maximum	145,000	62
Minimum	18,000	13

Municipal Uses

The communities of Havre, Chinook, Harlem, Hill County, and North Havre Water District have water supply contracts with Reclamation for municipal water. The communities currently use an average of about 2,600 AF annually. The combined contracted amount of water is up to 4,600 AF annually, so they are presently using considerably less than the contracted volume. Municipal use represents less than 1 percent of total Milk River diversions. These demands generally are met.

Fish, Wildlife, and Recreation Demands

Non-consumptive water demands for recreation and fish and wildlife purposes are associated with the Milk River Project, but these generally are not quantified, and Reclamation has historically considered these to be incidental uses of project water. The Bowdoin National Wildlife Refuge provides food and habitat for migratory birds (including the endangered piping plover and interior least tern), upland birds, and many species of waterfowl. The refuge has a reserved water right from Beaver Creek and a contract with Reclamation for Milk River Project water. Under the contract, up to 3,500 AF of project water annually is diverted to the refuge from the Dodson South Canal. The refuge also receives return flow from the Malta Irrigation District.

Threatened and Endangered Species

Currently, water operations are coordinated in the area for bull trout, piping plover, and pallid sturgeon.

Future Water Demands

The ability of water supplies for the region to meet the demand is expected to change in the future. For the Milk River Project to remain viable, water users will likely have to incorporate new technologies, forge new partnerships, and improve overall water supply management.

Many factors, including unforeseen new uses, increased resource protection, and socioeconomic changes could also affect future water use. Other factors that could increase demands as a result of warmer climate conditions include evaporation, groundwater depletions, and fish, wildlife, and recreation demands.

Agricultural Use

Warmer temperatures and a long growing season would result in more crop growth and increased evapotranspiration. All of the climate change scenarios project a substantial increase in crop irrigation requirements for the irrigated lands.

St. Mary River and Milk River Basins Study Summary Report

Even if projected increases in runoff by 2050 under the wetter future scenarios could be captured and used, this would only make up for 33 to 37 percent of the expected increase in irrigation depletions. Because water supplies would not increase enough to meet demands, the river system model results show increased irrigation depletion shortages under all future climate scenarios, with the greatest relative increase during drier years. Irrigation depletion shortages would increase from the current annual average of 71,000 AF to 106,000 AF under future climate change scenario *S5: Central Tendency* as shown in table 2.

	Shortage Volume (AF)	Shortage as Percent of Demand	Increase in Future Shortages Volume (AF)¹
Average	106,000	43	35,000
Wettest Ten Years	77,000	34	24,000
Middle Ten Years	96,000	41	30,000
Driest Ten Years	140,000	54	49,000
Maximum	216,000	74	71,000
Minimum	37,000	21	19,000

¹ Calculated by subtracting current shortages (table 1) from projected shortage from climate change scenario *S5: Central Tendency*.

Municipal Uses

Future municipal water uses are expected to remain within the current contracted amount.

Fish, Wildlife, and Recreation Demands

Instream flow amounts and temperatures need to be considered for aquatic species. Climate change in northern Montana is generally projected to increase annual mean temperatures, modifying streamflow volumes both positively and negatively, and shifting the peak of the hydrograph both forward and backward. These effects are localized in different regions of the two basins and have the potential to affect ecological resiliency for aquatic species in these basins, primarily the ability of invertebrate and fish species to adapt to changing habitat conditions. With warming temperatures and higher evaporation rates in the future, lower overall water levels at the Bowdoin National Wildlife Refuge could be a concern. Recreational use of Fresno Reservoir, Nelson Reservoir, and Sherburne Lake, as well as Glacier National Park, is expected to increase, so water surface elevations might be a public concern.

Threatened and Endangered Species

Reclamation will be entering into ESA consultation with the U.S. Fish and Wildlife Service (USFWS) to continue to study bull trout needs. Bull trout flow requirements on Swiftcurrent Creek and the St. Mary River might be quantified in the future once more information has been obtained. Current water operations to benefit the piping plover are not expected to change in the foreseeable future. Pallid sturgeon flow requirements might be quantified in the future. Water demands for Species of Special Concern are not anticipated to change.

Future International Uses

Because Canada does not have storage facilities on the Milk River, they are not able to capture and use their entire share of the Milk River's natural flow. Canada surpluses about 33,000 AF of its share of Milk River natural flow on average annually to the U.S.. The Province of Alberta has investigated constructing a reservoir on the Milk River to capture the remaining Canadian share of Milk River natural flow. This would increase shortages for U.S. Milk River irrigators.

Future Tribal Implementation of Federal Reserved Water Rights

The Tribes of the Blackfeet and Fort Belknap reservations may develop more of their federally reserved water rights for St. Mary River and Milk River flows in the future (the Tribes of the Fort Belknap Reservation only have rights to Milk River flow). Montana and the Blackfeet Tribe have conditionally approved a Water Rights Compact, and draft settlement legislation has been introduced in Congress. The Fort Belknap Community has conditionally approved a Water Rights Compact with Montana and is also planning to introduce legislation to Congress.

Chapter 3: Analysis Methods and Models

Climate Change Scenarios

This Basin Study considered future supplies under various climate change scenarios. Warming has been experienced over much of the U.S. during the 20th century and this general warming is likely to continue in the 21st century. Reclamation analyzed climate change for the St. Mary River and Milk River basins, producing hydrologic data sets centered on 2030 and 2050 using the Period Change Method. (The findings are summarized in the report *Climate Change Analysis for the St. Mary and Milk River Systems in Montana* [Reclamation, 2010].) There are 16 General Circulation Models (GCM), 3 emission scenarios, and multiple initial conditions, resulting in 112 projections. For the climate change analysis, Reclamation started with the future climate data sets produced by 112 projections that simulate future climate changes that affect weather patterns (by assuming various rates of some physical parameter such as greenhouse gas concentrations).

While reports (e.g., Reclamation 2010 and Reclamation 2011a) agree that temperatures in the St. Mary River and Milk River basins are likely to be warmer, the projected rate of warming varies. Thus, the study grouped projections into five future climate change scenarios as well as *S0: Historic Climate Conditions*.

- *S1: Less Warming/Dryer*
- *S2: Less Warming /Wetter*
- *S3: More Warming / Dryer*
- *S4: More Warming/ Wetter*
- *S5: Central Tendency*

Under all future scenarios, basin temperatures are predicted to warm, with the average rate of warming varying by projections from about 1.5 to 6 degrees Fahrenheit by the year 2050. A moderate increase in precipitation is predicted for most of the scenarios, with a trend towards greater variability between wet and dry years.

As part of the climate change analysis, models were also used to translate changes in temperature and precipitation from the climate change projections to changes in streamflow, evaporation rates, and crop irrigation requirements for each alternative.³ The river system model used these results to project potential impacts

³ Although streamflow changes in the basin were projected for both 2030 and 2050, only the 2050 climate model results are presented in this report.

St. Mary River and Milk River Basins Study Summary Report

of various climate scenarios with a focus on irrigation shortages (figure 3). Irrigation depletion shortages are predicted to increase substantially under all of the future climate scenarios. This was found to be due primarily to the increase in crop irrigation requirements under the future climate scenarios.

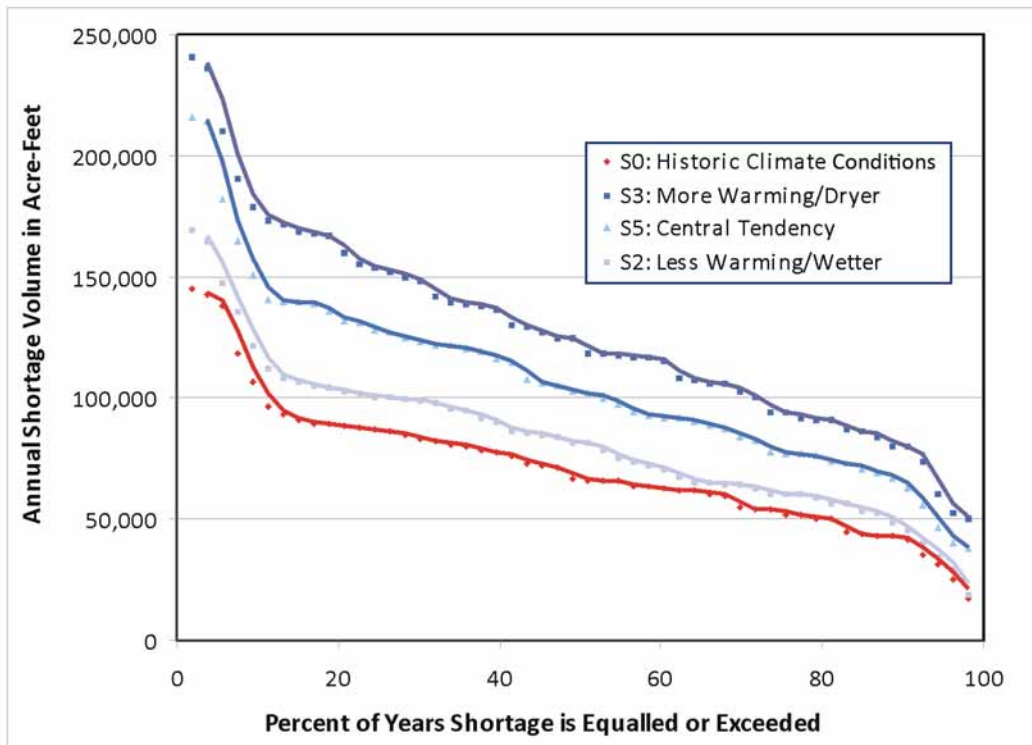


Figure 3: Modeled Milk River irrigation depletion shortages under *S0: Historic Climate Conditions* and selected climate change scenarios.⁴

River System Model

Description and Methodology

One of the main purposes of this Basin Study is to develop, refine, and test a river system model to be used to evaluate current and future activities and conditions in the St. Mary River and Milk River basins. RiverWare™, an advanced, generalized river basin modeling software, was used to construct the model that simulates the St. Mary River and Milk River system operations. This river system model, with its new capabilities, will allow decisionmakers and technical users to help evaluate issues and potential solutions to basin needs, including:

⁴ Please note that figure 3 does not show results for all of the future climate scenarios. Instead, data are plotted for the scenarios that show the maximum and minimum range (*S2: Less Warming/Wetter* and *S3: More Warming/Dryer*) as well as the medium condition, *S5: Central Tendency*.

- The effects of climate change on water supply and demands
- Alternatives for replacing and rehabilitating aging water infrastructure
- Administration of the Boundary Waters Treaty between the U.S. and Canada and proposed water apportionment/sharing alternatives being considered by Montana and Alberta through the St. Mary and Milk Rivers Joint Water Management Initiative
- Water development proposals for implementing the Water Rights Compacts of the Blackfeet Tribe and Fort Belknap Indian Community
- ESA compliance

Previous studies relied on older generation models that no longer have the robustness or resolution to evaluate complex river system issues faced by water managers, planners, decisionmakers, or users. However, knowledge gained from previous models developed for the basins was used to help develop the model for this study. Notable improvements and additions to this model are:

- **Daily Timesteps.** Performs calculations on a daily time step. Previous models used a monthly time step, while operations and flows change more frequently and (even daily) to meet apportionment requirements, irrigation demands, and other goals.
- **Recent Data.** Incorporates operations of the system and irrigation diversion data for more recent years, including data that have only recently been collected on irrigation district canal diversions and surface return flows.
- **Apportionment.** Incorporates procedures to apportion water according to the Boundary Waters Treaty and the International Joint Commission (IJC) 1921 Order. The apportionment procedure also includes the Letter of Intent allowing temporary deficit deliveries.
- **Storage Accounts.** Provides two storage accounts in Fresno Reservoir—one for the Fort Belknap Indian Irrigation Project and the other for Milk River Project users.

The outputs from the climate change analysis that predict future streamflows, crop irrigation requirements, and evaporation rates, along with the data for operational criteria, acres irrigated, and irrigation characteristics, were the final inputs into the river system model. The river system model simulated operations of the system under the future climate scenarios and evaluated the performance of the water

St. Mary River and Milk River Basins Study Summary Report

management alternatives. Output from the river system model included streamflow, irrigation diversions and depletions, and reservoir levels. Figure 4 is a flow diagram that describes this process.

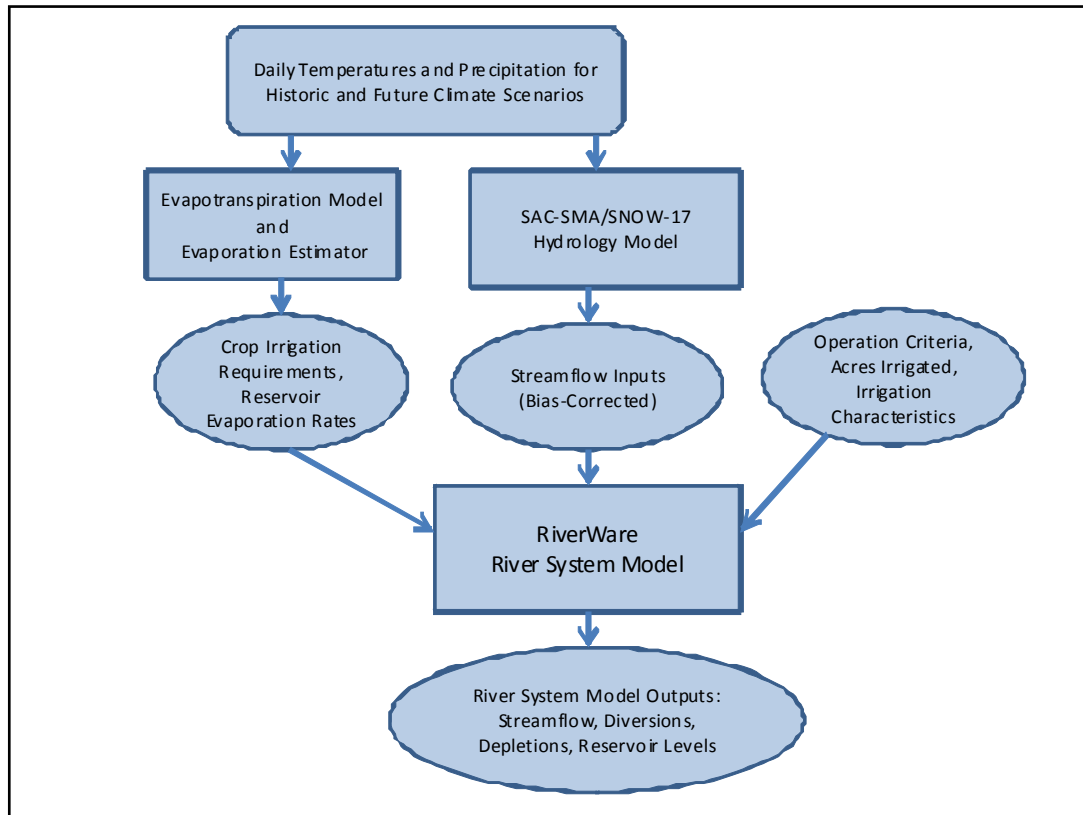


Figure 4: St. Mary and Milk Rivers models and input files.

Hydros Consulting, Inc., evaluated the river system model to quantify and improve the model's ability to simulate irrigation water use and to replicate historical riverflows (Hydros Consulting, Inc., 2011). The calibration focused on physical parameters such as irrigation efficiencies, surface and groundwater return flows, and water losses. Overall, the model appeared to be well calibrated, properly estimating river depletions and reasonably able to replicate historic conditions at the river gauges as shown on figure 5.

Model Findings and Recommendations

The model could be further improved as more irrigation diversion and return flow data become available. A better understanding of surface water and groundwater exchanges and losses in the Milk River valley would also allow for a better calibration. To keep the river system model up to date and to ensure that future stakeholders can use the model for evaluating water resource alternatives or plans,

the Montana Department of Natural Resources and Conservation (DNRC) and Reclamation recommend:

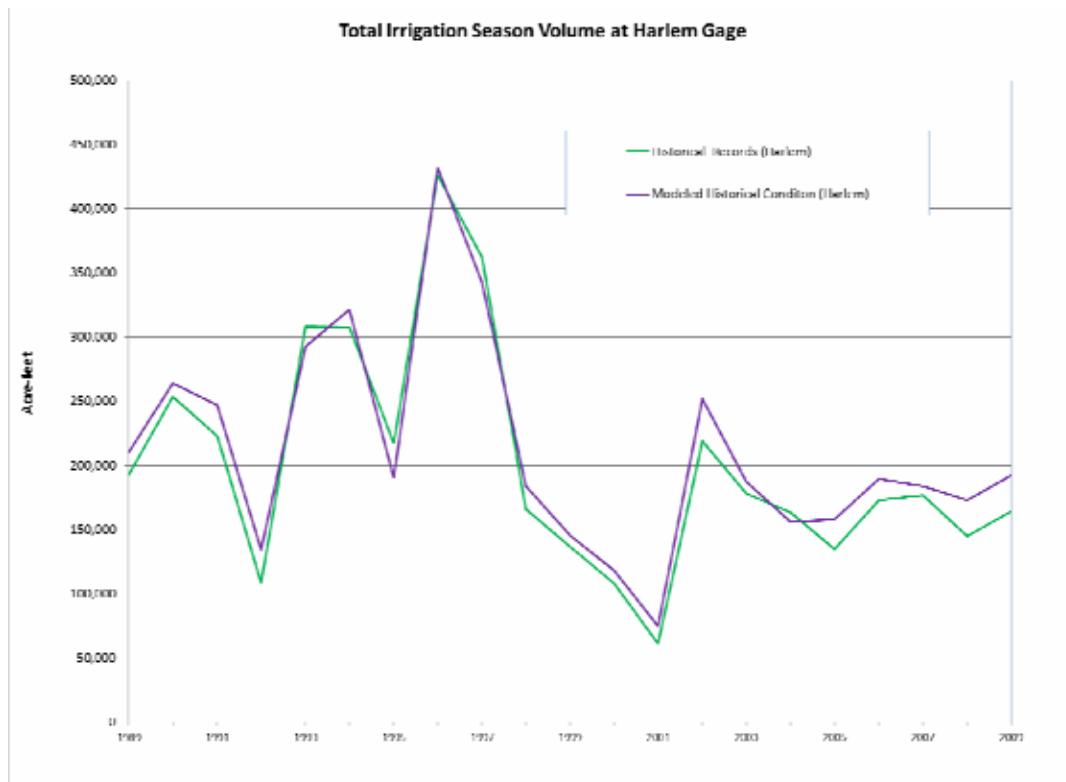


Figure 5: Example river system model calibration plot for Milk River at Harlem gauging station.

- Updating the model annually, including updates to streamflow and water use information, and keeping the model current with software updates.
- Exploring groundwater/surface water interaction in the Milk River valley and updating the model to better simulate groundwater return flow.
- Continuing joint efforts between the federal, Tribal, and state agencies, as well as water users on collecting and monitoring canal diversions. With this additional data, the model's calibration and predictive capabilities could be improved.
- Expanding the river system model to model and analyze water supplies and water uses on the larger Milk River tributaries.
- Expanding the model's capability to analyze irrigation system improvements by accounting for canal efficiencies and irrigation field efficiencies separately.

St. Mary River and Milk River Basins Study Summary Report

- Adding accounting capabilities to the model that track the current semimonthly balancing of the U.S. and Canadian shares of St. Mary and Milk Rivers' natural flow.
- Updating DNRC management and the Federal Negotiating Teams on the river system model status annually so they are informed of model's ability to simulate proposed projects by the Tribes to implement Water Rights Compacts.
- Exploring using the river system model to analyze water quality in the St. Mary and Milk Rivers.
- Updating the model input files to include any refinements in the climate change projections.

Chapter 4: Alternatives

Although it is not the intent of this Basin Study to make recommendations for specific alternatives or for future feasibility level studies, some alternatives for reducing future water shortages were examined. Note that this Basin Study does not include cost/benefit analysis of alternatives. However, the findings do provide some insights on the alternatives' potential benefits. The river system model could be used to further analyze these alternatives, combinations of these alternatives, or other alternatives.

Alternatives that might help bridge the gap between water supplies and projected irrigation depletion shortages were simulated with the river system model under historic baseline conditions and the future climate scenarios. Although none of the alternatives alone would reduce future shortages to below historic climate baseline levels, several had the potential to make significant improvements. The single-most effective alternative might be to increase the efficiencies of irrigation on the Milk River Project, which might reduce average irrigation depletion shortages by about 20,000 AF. Raising the full pool elevation of Fresno Reservoir by 5 feet would result in an average shortage reduction of about 5,000 AF. Increasing the capacity of the St. Mary Canal would reduce average shortages by about 5,000 AF. Rebuilding DNRC's Frenchman Creek Reservoir to a much larger reservoir with 50,000 AF of storage could almost eliminate shortages for lower Frenchman Creek irrigators during all but the driest years and might reduce shortages for lower Milk River irrigators by about 4,000 AF per year on average.

Baseline Condition

A baseline condition was established to provide the data from which to measure impacts from climate change, operational and/or facilities modifications, and changes in water use. For this report, the baseline condition was defined as the water supply, water facilities, water use, and irrigated land base in the St. Mary River and Milk River basins as they currently exist, but with adjustments made to recognize continual losses in Fresno Reservoir storage. The baseline condition is described in detail in the technical report, Chapter 4: Baseline Condition and the Ability to Meet Future Water Demands (DNRC et al., 2012) and summarized in the sections on present and future water supplies and demands.

Canal and On-Farm Water Use Efficiency Improvements Alternative

This alternative would improve water delivery to farms and on-farm irrigation systems. For this alternative, irrigation district total efficiencies were assumed to increase by 17 percent (10 percent conveyance and 7 percent on-farm), for an overall efficiency ranging from 37 to 57 percent. This alternative provided the single-most potential for decreasing shortages and is projected to reduce the irrigation depletion shortages by 20,000 AF in an average year and 15,000 AF in a dry year.

Improving efficiency in the canals would mean more water would be available to district irrigators, but would possibly reduce return flow available for other users. The Milk River Project area has traditionally relied heavily on the reuse of return flows to meet downstream demands. Improving efficiency in the canals would mean that water users would divert less water overall and that less return flow would be recycled. Although this would not decrease the amount of water that crops ultimately receive, it would change the way flow and water are distributed throughout the system. To adjust, water managers would have to restructure the way that they divert and deliver water to users, particularly when it comes to sharing shortages.

Reduced return flows also could impact other resources that have benefited from these flows in the past. Less water would return to the river from canal spills and groundwater returns with potential impacts on the river fishery, wildlife along some river reaches, and riparian and wetland wildlife habitat. This might affect waterfowl habitat, piping plover nesting, water temperatures, and pollutant concentrations. Return flows to the Bowdoin National Wildlife Refuge are projected to be reduced by 45 percent on average under climate change scenario *S5: Central Tendency*.

Rehabilitate St. Mary Canal for Increased Capacity Alternative

This alternative would upgrade the St. Mary Canal to the original 850 cubic foot per second (CFS) capacity. Canal capacity has dropped from to 650 CFS at the St. Mary's Siphon, as most of the structures of the century-old St. Mary Canal have exceeded their design life and need major repairs or replacement. On average, irrigation depletion shortages are projected to be reduced by about 5,000 AF per year with an 850-CFS canal.

Increasing the capacity of the St. Mary Canal would allow the U.S. to use more of its allocation of St. Mary River water and reduce shortages for Milk River irrigators. While this would result in substantial diversion increases during average to wetter years, only relatively small increases in diversions would occur

in drier years. During dry years, there is only a very short period of time when the U.S. allocation of St. Mary River natural flow is higher than what can be captured through a combination of diverting water through the canal at existing capacity and storing water in Lake Sherburne.

On an annual basis, the St. Mary River basin flows are projected to be reduced under this alternative, as more water would be able to be diverted during wetter and median flow years. At this time, it is unknown what the bull trout flow needs are; therefore, the impacts cannot be quantified.

In the Milk River basin, the overall higher water deliveries with an enlarged St. Mary Canal would increase benefits to fish and wildlife, municipal and industrial water supplies, and water quality. The increase in flows may positively impact water quality, such as sustaining or decreasing water temperatures and pollutant concentrations in the Milk River. Assuming irrigation efficiencies remained the same, water available for the Bowdoin National Wildlife Refuge from return flows could increase, which would benefit migratory waterfowl habitat and piping plover nesting.

Increased flow in Milk River channel in Alberta could result in increased channel and bank erosion, contributing to sediment loads.

Increase Fresno Reservoir Storage Alternative

This alternative would raise the spillway crest elevation to increase storage in the Fresno Reservoir. Fresno Reservoir has been steadily losing storage capacity due to sedimentation and is expected to continue to lose more capacity into the future. By 2050, the estimated storage available is projected to be only 62,000 AF, less than one-half of the original capacity of about 130,000 AF in 1939. Continued storage loss to sedimentation is a long-term problem that threatens to diminish all of the benefits of Fresno Reservoir. The decrease in storage capacity will lead to additional water shortages in the Milk River Project—beyond those that could be attributed to a warmer climate.

During median years, this extra storage from this alternative is projected to decrease irrigation depletion shortages by about 4,000 AF. Projected reductions in irrigation depletion shortages were about 7,000 AF during wet years and 2,000 AF during dry years. Benefits of the increased storage are greater during wetter years because there is extra water available to store during wet years.

The increase in Fresno Reservoir elevation also would help to maintain the existing reservoir fisheries and recreational values. However, even if the reservoir elevation were raised 5 feet to recapture lost storage, increased irrigation demands associated with warmer temperatures would result in greater fluctuations in pool elevation than in the past. Even though this alternative allows for more frequently meeting FW&P minimum pool recommendations to benefit the fishery and

St. Mary River and Milk River Basins Study Summary Report

recreation, the higher fluctuations would result in less fish production. This alternative would also result in more frequent inundation of surrounding reservoir lands, which decreases the historic wildlife habitat areas.

Water available for the Bowdoin National Wildlife Refuge might increase through higher return flows, which would benefit migratory and nesting waterfowl habitat. The increase in water available for storage may positively impact water quality, such as sustaining water temperatures in the Milk River.

Other benefits include safeguarding water supplies for municipal users. The increase in water surface elevation also would help to maintain the existing reservoir fisheries and recreational values. Water quality along the Milk River would likely remain the same. The increase in storage would not impact the flood storage space and will, therefore, continue to preserve the benefits associated with flood control.

Expanded Frenchman Reservoir Alternative

This alternative would expand Frenchman Reservoir from its current capacity of 3,000 AF. Frenchman Dam, a state-owned project on Frenchman Creek, a tributary to the Milk River, has experienced severe deterioration and has lost 60 percent of its design storage capacity to accumulated sediment and now only effectively stores about 3,000 acre-feet.

DNRC is currently considering options for Frenchman Dam to improve the water supply for users on Frenchman Creek and possibly mitigate impacts from Fort Belknap Compact implementation on Milk River irrigators. Because of the enormous year-to-year variability of the flow of Frenchman Creek, a rather large reservoir would need to be constructed to provide a reliable water supply to both of these groups of users.

The river system model was operated for various sizes of a reservoir. This study modeled a 50,000-AF reservoir on Frenchman Creek, with the increased storage used both for reducing shortages for Frenchman Creek irrigators and Milk River irrigators downstream. Overall, Milk River shortages would be higher with a warmer climate, the need for the stored water would be greater, and Frenchman Creek basin would yield more water under most of the future climate change scenarios due to projected higher average precipitation. A 50,000-AF reservoir is projected to significantly reduce shortages for Frenchman Creek water users in all but the driest years. This size reservoir is also projected to reduce irrigation depletion shortages by about 3,000 to 8,000 AF per year for downstream water users on the Milk River, with the higher range benefits during dry years.

If water users were willing to accept some shortages during dry years, then the 50,000-AF reservoir could be used to meet most of the needs of irrigators on Frenchman Creek and to provide some additional water for downstream users.

After most of the needs of Frenchman Creek water users are met, additional water could be released to reduce irrigation depletion shortages for downstream Milk River irrigators under this alternative.

In the past, DNRC employees inspecting reservoir facilities at low pool levels observed a healthy gamefish population despite the reservoir's overall shallow depth and low storage capacity. A larger, deeper reservoir would have the potential to support a good fishery along with an associated increase in recreational opportunities. The reservoir could also provide habitat for other wildlife such as migratory waterfowl.

Negative impacts associated with a larger reservoir would be inundated riparian and upland habitat used by existing wildlife populations. Downstream from the reservoir, riparian areas could be affected due to the loss of peak flows that overtop the riverbanks and scour the channel.

Reduced high flows from Frenchman Creek tributary also would lower peak flows downstream, which could have an adverse effect on native fish that spawn in the lower Milk River.

New Storage on Milk River in Alberta Alternative

This alternative evaluates a 237,000-AF new reservoir in Alberta, Canada, just below the confluence of the North Fork on the Milk River main stem. If Canada were to construct such a reservoir, the amount of water available to U.S. irrigators would decrease, and irrigation depletion shortages are projected to increase by 2,000 to 4,000 AF per year. Past discussions and investigations with the Province of Alberta have indicated that a shared reservoir in Canada could provide joint benefits. If this alternative is investigated further, then the river system model could be used to investigate potential benefits of shared Milk River storage to U.S. Milk River water users.

Because the natural flow of the Milk River is usually far below 666 CFS during the peak summer irrigation season (and often near zero), and because Canada is only entitled to 25 percent of the natural flow below 666 CFS, the flow available for Alberta irrigators typically is less than the irrigation demand. In addition to providing a more reliable water supply to existing Alberta irrigation, a reservoir might allow Alberta to expand its total irrigated land base in the Milk River watershed by about 18,000 acres to a total of 26,000 acres.

Reservoir operations were simulated to store only the Canadian share of Milk River natural flow to meet Alberta irrigation demands using the historic climate baseline and future climate change scenarios. The flow of the Milk River at the Eastern Crossing is projected to be reduced by about 24,000 to 30,000 AF on average; during middle to dry years, flow reductions are projected to be 3,000 to 18,000 AF. Because a reservoir primarily would capture and store higher peak

St. Mary River and Milk River Basins Study Summary Report

flows, irrigation shortage depletions for the U.S. irrigators are projected to be increased by about 2,000 to 4,000 AF per year rather than by the full amount that the flow is reduced at the Eastern Crossing.

Combinations of Alternatives

Combining alternatives could increase benefits to water users. Because each alternative's benefits likely overlap to some degree, the combined benefits would not simply be additive. If combinations of alternatives are investigated further, then the river system model could be used to analyze these combinations and to determine combinations that optimize benefits.

Chapter 5: Consultation and Coordination

Partner and Stakeholder Involvement

Public involvement is an important part of study processes. It serves as the public's opportunity to provide input on different interests and assists in defining issues, brainstorming potential scenarios, identifying constraints, and reviewing results. In 2010, Reclamation and DNRC began a public involvement process to help the public, organizations, stakeholders, and government agencies learn about the *St. Mary River and Milk River Basins Study Report* and provide comments. Reclamation and DNRC developed a public involvement strategy, including:

- Meetings for information sharing and evaluating level of interest
- Meetings with stakeholders to define issues, modeling scenarios, and constraints
- Regular status meetings with stakeholders to report progress and review interim results
- A draft *St. Mary River and Milk River Basins Study Report* for review and comment
- Distribution of this final report and model

Stakeholders

- *Milk River Joint Board of Control*: The JBOC consists of representatives from the eight irrigation districts that comprise the Milk River Project. It works with Reclamation to develop annual operations and maintenance plans and in setting annual water allotments.
- *St. Mary Rehabilitation Working Group (SMRWG)*: The SMRWG is a group of stakeholders that seeks rehabilitation of the St. Mary Canal. It includes representatives from irrigation districts, Indian Tribes, municipalities, counties, recreational groups, and local economic development groups.

St. Mary River and Milk River Basins Study Summary Report

- *Blackfeet Tribe:* Administers Blackfeet Reservation in the headwaters of the St. Mary and Milk River watersheds. The Tribe has substantial federally reserved water rights in both watersheds.
- *Fort Belknap Indian Community of the Fort Belknap Indian Reservation:* The Gros Ventre and Assiniboine Tribes of the Fort Belknap Indian Reservation have substantial federally reserved water rights to the natural flow of the Milk River and some tributaries.
- *Montana Department of Fish, Wildlife & Parks:* FW&P is responsible for managing fish and wildlife resources in Montana, including interests in the lower Milk River watershed.
- *International Joint Commission:* The IJC, established by the Boundary Waters Treaty of 1909, has six members appointed by the governments of Canada and the U.S..
- *U.S. Fish and Wildlife Service:* The USFWS is responsible for administering compliance with the ESA and manages Bowdoin National Wildlife Refuge in the Milk River basin.

Other agencies include:

- Province of Alberta, Canada
- State of Montana
- Montana Department of Environmental Quality (DEQ)
- U.S. Geological Survey (USGS)
- Bureau of Indian Affairs
- Bureau of Land Management
- National Park Service
- U.S. Natural Resources Conservation Service (NRCS)

Consultation and Review

Reclamation and DNRC informed stakeholders of the study goals and timelines by attending regularly scheduled meetings of stakeholder groups. As the study progressed and model results became available, specific meetings were held with stakeholders to solicit input for developing alternatives to simulate using the model. See the technical report, Chapter 5: Alternative to Meet Water Demands.

Milk River Project Joint Board of Control

In March 2010, Study Team members met with the JBOC at a regular board meeting. The plan of study was presented and discussed. Board members were

invited to contribute options and ideas for the model. DNRC and Reclamation staff presented an update at the board meeting in October 2011, providing an overview of the river system model, climate change analysis, and preliminary model results.

St. Mary Rehabilitation Working Group

Members of the Study Team met with the SMRWG in May 2010 to introduce this Basin Study and to invite its members to participate. Updates were provided at meetings on August, 2010. The SMRWG was updated in October 2011, with an overview of the river system model, climate change analysis, and presentation of preliminary model results.

Indian Tribes

Blackfeet Tribe

Members of the Study Team met with the Blackfeet Tribe in March 2010 to introduce the Basin Study and to invite Tribal participation. Updates were provided during subsequent meetings in April and August of 2011.

Fort Belknap Indian Community

No formal meetings with the Fort Belknap Indian Community have been held. However, members of the Study Team have had informal meetings with Tribal staff. Members of the Tribal Council have been unavailable to meet.

Federal and State Agencies

DNRC and Reclamation met with other state and federal agencies in May 2010 to inform the agencies of the study plan and to seek their initial input. Those in attendance included DEQ, FW&P, USGS, National Park Service, USFWS, Bureau of Land Management, and NRCS.

Reclamation held a meeting with state and federal agencies in September 2011. Those in attendance included the USGS, DEQ, and USFWS. Reclamation presented the river system model, climate change analysis, and preliminary model results.

Professional Organizations

DNRC presented an overview of the Basin Study and discussed some preliminary findings to the Montana Chapter of the American Water Resources Association at their annual meeting in Great Falls, Montana, on October 7, 2011.

St. Mary River and Milk River Basins Study Summary Report

International Consultation

As part of the Montana/Alberta Joint Initiative Team, DNRC has informed their Canadian counterparts of the Basin Study and invited their participation.

Representatives from the University of Lethbridge expressed interest in the climate change work included in the study. Copies of all climate change studies and investigations have been shared with interested Canadian parties.

Representatives of the IJC, USGS, Environment Canada, Alberta Environment, and Saskatchewan Watershed Authority were updated on the Basin Study and results at the St. Mary – Milk River International Records Meeting in Helena, Montana, on February 16, 2012.

Chapter 6: WaterSMART Basin Study Requirements

Basin studies supports basin-wide efforts to evaluate and address the impacts of climate change. Each study includes four key elements, listed below, along with the results for this Basin Study. This section reports on the results of the Basin Study by the requirements in the WaterSmart Program Basin Study Framework Study (§ 4.4.5). References are to DNRC et al., 2012, *St. Mary River and Milk River Basins Study Technical Report*.

Projections of Water Supply and Demand (Including Risks Posed by Climate Change)

Runoff is projected to increase by 2050 under most climate change scenarios. This increase in runoff is expected to only make up for between 33 and 37 percent of the expected increase in crop irrigation depletions. See the technical report, chapter 2, “Summary of Present and Future Water Supplies and Demands.”

Changes in Snowpack

The surface water runoff model would indirectly account for changes in streamflow as a result of changes in snowpack. The model determined if precipitation was likely to be rain or snow. For precipitation that was determined to be snow, a snowmelt component of that model was used to simulate the snowmelt and subsequent runoff produced. See the technical report, chapter 2, “Future Water Supplies.”

Changes in Timing and Volume of Runoff

The mean annual runoff centroid is expected to occur earlier in most Milk River subbasins under most scenarios. The streams in the St. Mary River watershed are all predicted to have annual volume centroid shifts of 7 to 9 days earlier (figure 2 in chapter 2) under climate change scenario *S5: Central Tendency*. The median streamflow of the St. Mary River is expected to increase 3,700 AF, and the median streamflow of the Milk River at the mouth is expected to increase 15,000 AF, for a total increase of 18,700 AF for year 2050 under climate change scenario *S5: Central Tendency*. This is a modest change, considering that the basins combined produce 780,000 AF per year on average. The upper areas of the Milk River basin are generally expected to have less runoff locally. See the technical report, chapter 2, “Future Water Supplies.”

Changes in Groundwater Recharge and Discharge

Groundwater use is limited in the St. Mary River and Milk River basins, primarily for domestic and stock watering purposes. Changes in groundwater due to climate change have not specifically been studied in the Milk River basin. However, surface water is connected to alluvial aquifers; therefore, effects of climate change on precipitation and/or surface water runoff might affect recharge to and/or discharge from groundwater. See the technical report, chapter 2, “Future Water Supplies.”

Increase in Demands from Rising Temperatures or Reservoir Evaporation

Average annual net reservoir evaporation for Fresno Reservoir is projected to increase by 2 inches for the future climate change scenario *S5: Central Tendency*. A similar increase would occur at Nelson Reservoir and from the river surface of the Milk River. The net irrigation requirement for the climate expected to exist in 2050 is about 4-1/2 inches greater than the net irrigation requirement for the present condition or a 24- to 29-percent increase in the net irrigation requirement, depending on basin location. See the technical report, chapter 2, “Future Water Demands.”

How Water and Power Infrastructure and Operations Would do in Face of Future Population Growth and Climate Change (Including how Changes in Water Supply Will Affect Reclamation Operations and Facilities)

Water shortages occur for Milk River irrigators every year with the present climate. Irrigation depletion shortages would increase on both a volume basis and on a percentage of demand basis for all the climate change scenarios when compared to *S0: Historic Climate Conditions*. The average shortage would increase by about 35,000 AF. See the technical report, Chapter 4: Baseline Condition and the Ability to Meet Future Water Demands.

Reclamation’s Ability to Deliver Water

St. Mary Canal diversion under the existing and future climate would be similar on average. However, during higher streamflow years under climate change scenario *S5: Central Tendency*, canal diversions are projected to increase by about 18,000 AF greater than under *S0: Historic Climate Conditions*. During lower streamflow years under climate change scenario *S5: Central Tendency*, modeled canal diversions were about 14,000 AF less than *S0: Historic Climate*

Conditions. Irrigation water shortages would increase. Water levels at Fresno Reservoir are expected to be lower due to higher releases to meet increased demands. See the technical report, chapter 4, “Meeting Future Demands.”

Construction of the Rocky Boy’s/North Central Montana Rural Water System may potentially reduce the contracted volume of water used from the Milk River for municipal purpose. See the technical report, chapter 2, “Future Water Demands.”

Hydropower Generation

Currently, there are no hydropower generating facilities in the St. Mary River basin or the Milk River basin. Four potential sites that may be viable have been identified through other studies. Future hydropower development in the two river basins should be based on the hydrology expected in the future, which could include the future streamflow developed information as part of this study. See the technical report, chapter 4, “Baseline Condition.”

Recreation at Reclamation Facilities

Fresno Reservoir elevations generally would be lower under future climate change scenarios (*S1 – S5*) than under *S0: Historic Climate Conditions*. This suggests recreation opportunities will be more limited in the future. See the technical report, chapter 4, “Meeting Future Demands.”

Fish and Wildlife Habitat

Model results show that Bowdoin National Wildlife Refuge water levels are lower under most climate change scenarios, with a possible corresponding reduction in habitat. See the technical report, chapter 2, “Future Water Demands.”

Threatened, Endangered, and Candidate Species under ESA

Bull trout and pallid sturgeon flow requirements might be quantified in the future. Current water operations to benefit the piping plover are expected to continue into the future. See the technical report, chapter 2, “Future Water Demands.”

Water Quality Issues (Including Salinity)

Increased evapotranspiration under the climate change scenarios could decrease flows and increase salinity. Minimum releases during the non-irrigation season are provided under contract. See the technical report, chapter 2, “Future Water Demands.”

Water Flow and Water-Dependent Ecological Resiliency

Climate change in northern Montana is generally projected to increase annual mean temperatures, modify streamflow volumes both positively and negatively, and shift the peak of the hydrograph both forward and backward. These effects are localized in different regions of the two basins and have potential to affect ecological resiliency for aquatic species in these basins, primarily the ability of invertebrate and fish species to adapt to changing habitat conditions. See the technical report, chapter 2, “Future Water Demands.”

Flood Control Management

Lake Sherburne and Fresno Reservoir provide flood control benefits by storing water during the peak runoff period. More information is needed about designated flood control space in Fresno Reservoir, considering the future loss of storage due to sedimentation. Variability of streamflow is expected to increase and it is anticipated that peak streamflows will also increase. Flood control benefits are expected to continue at about the same level since Reclamation has an adaptive management approach to flood control at Fresno Reservoir. See the technical report, chapter 4, “Meeting Future Demands.”

Development of Options to Improve Infrastructure and Operations to Supply Water in the Future

Three alternatives related to improving Reclamation-related facilities were evaluated to test the river system model and to assess each alternative’s potential for providing water supply to meet demands in year 2050. One alternative was evaluated for a Montana-owned tributary reservoir in the lower basin. One alternative was evaluated for a proposed dam in Alberta, Canada, that would allow Alberta to more fully use Canada’s share of Milk River flow. See the technical report, Chapter 5: Alternatives to Meet Water Demands.

Comparison of the Options, Findings, and Recommendations (Including Costs, Environmental Effects, Risks, Stakeholders’ Opinions, and Other Aspects)

The primary purpose of this Basin Study was to develop a river system model with the capability to analyze a wide range of potential alternatives that could address present and future water needs in the St. Mary River and Milk River basins; therefore, no feasibility studies are currently recommended. Water compacts for two Indian reservations have been agreed upon with Montana, but are not yet approved through Congress. Thus, the water needs for these significant

Chapter 6: WaterSMART Basin Study Requirements

uses are not yet fully known. The river system model can be a useful tool for helping the Tribes, Montana, and the U.S. plan and implement these two water rights settlements.

This Basin Study recommends updates and refinements to the river system model and periodic status updates to managers involved in water-related issues in the basins. See the technical report, Chapter 6: Findings and Recommendations.

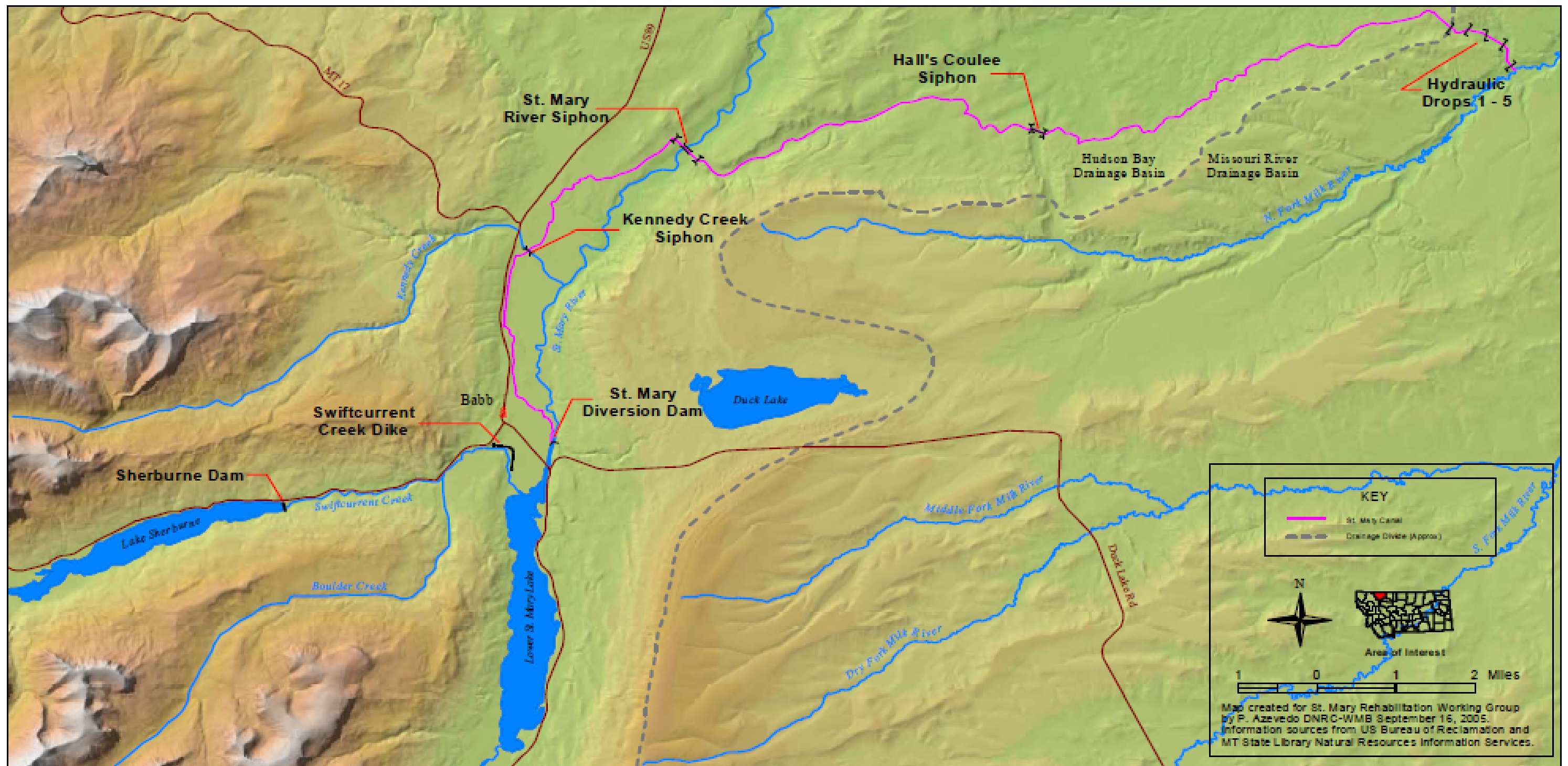


Figure 6: Upper St. Mary River basin diversion and conveyance system.

References Cited

- DNRC and Reclamation, 2012. *St. Mary River and Milk River Basins Study Technical Report*. Technical Service Center, Denver, Colorado.
- Hydros Consulting, Inc., 2011. *Memorandum on Historical Model Calibration for the St. Mary River and Milk River Basins Study Model*. Hydros Consulting. Boulder, Colorado, to Larry Dolan, DNRC, Helena, Montana.
- Montana State University, 2011. *Poverty Report Card*. Bozeman, Montana. Accessed February 2012.
<<http://www.montana.edu/extensionecon/poverty.html>>
- Reclamation, 2004a. *North Central Montana: Alternatives Scoping Document*. U.S. Department of the Interior, Billings, Montana.
- _____, 2004b. *North Central Montana Regional Feasibility Report*. U.S. Department of the Interior, Billings, Montana.
- _____, 2010. *Climate Change Analysis for the St. Mary and Milk River Systems in Montana*, Technical Memorandum No. 86-68210-2010-04. Technical Service Center, Denver, Colorado.
- _____, 2011a. *SECURE Water Act Section 9503 (c) – Reclamation Climate Change and Water 2011*. Technical Service Center, Denver, Colorado.
- U.S. Census Bureau, 2010. State and County QuickFacts. Accessed February 2012.
<<http://quickfacts.census.gov/qfd/index.html>>
- _____, 2012. America FactFinder. Accessed February 2012.
<<http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml>>