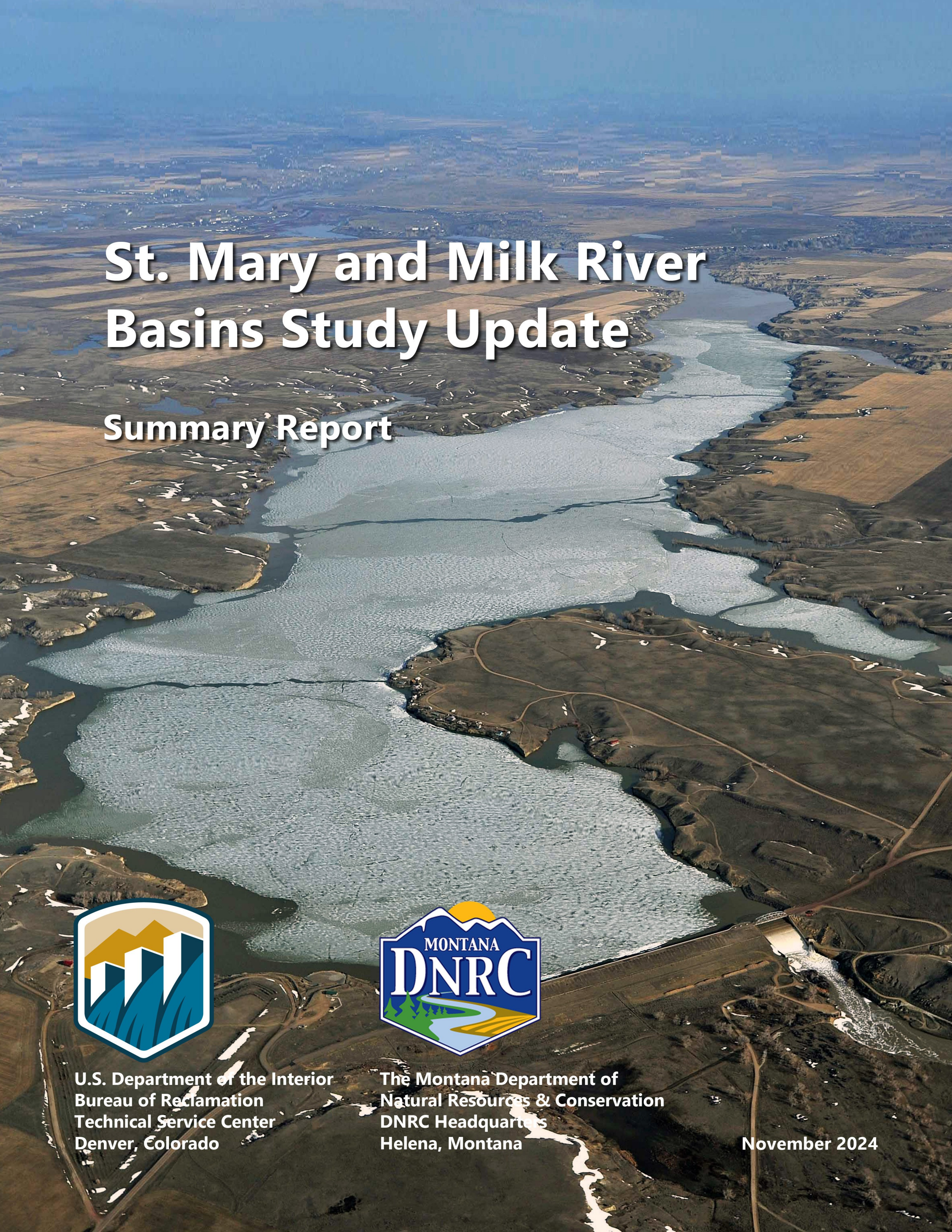


St. Mary and Milk River Basins Study Update

Summary Report

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

The Montana Department of
Natural Resources & Conservation
DNRC Headquarters
Helena, Montana

November 2024

Mission Statements

The U.S. Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, Native Hawaiians, and affiliated Island Communities.

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.

Montana Department of Natural Resources and Conservation's mission is to help ensure that Montana's land and water resources provide benefits for present and future generations.

Cover Photo – Fresno Reservoir, Milk River basin, Montana (Larry Mayer; April 22, 2018).

St. Mary and Milk River Basins Study Update

Summary Report

Prepared by:

Bureau of Reclamation
Technical Service Center
Denver, Colorado

U.S. Department of the Interior **June 2024**

Acronyms and Abbreviations

2012 Basins Study	2012 St. Mary and Milk River Basins Study
AF	acre-feet
Basins Study Update	St. Mary and Milk River Basins Study Update
cfs	cubic feet per second
EOWY	end of water year
ESA	Endangered Species Act
ft^3/s	cubic feet per second
IJC	International Joint Committee
KAF	thousand acre-feet
LAD	largest annual deficit
Milk River Project	Bureau of Reclamation Milk River Project
M&I	municipal and industrial
Montana DNRC	Montana's Department of Natural Resources and Conservation
MRJBOC	Milk River Project Joint Board of Control
North Fork	North Fork of the Milk River
PPR	Prairie Potholes Region
Reclamation	Bureau of Reclamation
SMRWG	St. Mary Rehabilitation Working Group
St.	Saint
State Water Plan	Montana State Water Plan
U.S.	United States
USGS	U.S. Geological Survey
yr	year

Symbols

>	greater than
%	percent
§	section

Contents

Page

Tables

Figures

Appendices

Appendix

Introduction

Water resources within the Saint (St.) Mary and Milk River watersheds are managed together by the United States (U.S.) and Canada through an International Joint Committee (IJC). The Bureau of Reclamation (Reclamation) Milk River Project (Milk River Project), which serves about 120,000 acres of irrigable lands, is one of the original five federal irrigation projects authorized by the Reclamation Act of 1902. Aging infrastructure, highly variable hydrology, reservoir sedimentation, and environmental challenges have contributed to persistent water management challenges in these watersheds.

Reclamation partnered with the State of Montana's Department of Natural Resources and Conservation (Montana DNRC) to complete the first St. Mary and Milk River Basins Study in 2012. This was one of the first studies of its kind under Reclamation's Water Sustain and Manage America's Resources for Tomorrow Basin Studies Program (Basin Studies Program) to evaluate how existing operations and infrastructure may perform under future water supply scenarios, and to evaluate the effectiveness of adaptation and mitigation strategies for meeting future water supply challenges.

St Mary and Milk River Setting

State: Montana, USA - Alberta, Canada

Major Cities: Havre, Malta,

Mean Annual Flow: 6.7 million AF

Basins Study Area: 490 square miles (St. Mary River in USA); 23,800 square miles (Milk River)

Major Water Uses: Municipal, agriculture, recreation, flood control, navigation, fish, and wildlife

Notable Reclamation Facilities: Milk River Project (1902)

The 2012 St. Mary and Milk River Basins Study (2012 Basins Study) showed that the Milk River irrigators have historically experienced an average crop irrigation demand shortage of 36 percent, due mostly to water shortages attributed to insufficient supply. The 2012 Basins Study recommended enhancing the river system model (new at the time) to further analyze single alternatives, as well as combinations, to address supply and demand issues in the basins, including Tribal development and international apportionment between the U.S. and Canada.

Since completion of the 2012 Basins Study, the State of Montana submitted the Montana State Water Plan (State Water Plan) in 2015. The State Water Plan lays out a path for managing Montana's Water resources, including recommendations for Montana DNRC to work with local water users and other government agencies to conduct basin-wide studies to evaluate water supply and demand challenges and related implications. Since completion of the 2012 Basins Study, data and modeling tools have further developed to broaden understanding of existing and potential future water shortages in these river basins. Further developed tools, along with the State's focus on resolving water supply and demand challenges, led Reclamation and Montana DNRC to work in partnership again to complete this 2024 St. Mary and Milk River Basins Study Update (Basins Study Update).

Study Area

The study area encompasses two watersheds. One watershed is the U.S. portion of the St. Mary River basin (approximately 490 square miles), from its headwaters in Glacier National Park to the border with Alberta, Canada. The other watershed is the Milk River basin (approximately 23,800 square miles), including its portions located in the U.S., as well as Alberta and Saskatchewan (figure 1).

The St. Mary River flows northeast from Glacier National Park, through the Blackfeet Reservation into Canada and to its confluence with Oldman River near Lethbridge, Alberta, where it eventually flows to the Hudson Bay. The Milk River originates in the Blackfeet Reservation and flows northeasterly into Canada at the Western Crossing of the International Boundary. The North Fork of the Milk River (North Fork) also originates within the Blackfeet Reservation. The North Fork flows into the mainstem Milk River north of the border with Alberta. The Milk River then re-enters the U.S. at the Eastern Crossing of the International Boundary just upstream of Reclamation's Fresno Reservoir. Major tributaries to the Milk River main stem include Big Sandy; Peoples and Beaver Creeks flowing from the south; Lodge and Battle Creeks; and Frenchman River, all of which flow into Montana from the north out of Saskatchewan.

The St. Mary River and Milk River are linked by the St. Mary Canal, which diverts water from the St. Mary River, downstream from Lake Sherburne and Lower St. Mary Lake, and is conveyed to the North Fork through a 29-mile canal, siphon, and drop system owned and operated by Reclamation (figure 2). In dry years, the St. Mary Canal supplies up to 95 percent of the flow in the Milk River.


St. Mary Diversion Dam Headworks

Water flowing through the St. Mary Canal is stored in Fresno Reservoir (around 90,000 acre-feet [AF] current storage capacity) on the Milk River near Havre, Montana, and supplies around 120,000 acres of irrigable land along the Hi-Line in eight irrigation districts. Major irrigation diversions from the Milk River begin just below Havre and continue for about 400 miles downstream to the Milk River's confluence with the Missouri River near Nashua, Montana. These diversions supply water to irrigation districts and to the off-stream Nelson Reservoir. The Milk River also supplies the municipal water needs of several communities including the City of Havre: the largest community in north-central Montana with a population of 9,354 (U.S. Census Bureau 2020). The river system also creates habitat for wildlife and recreational benefits.


Fresno Reservoir

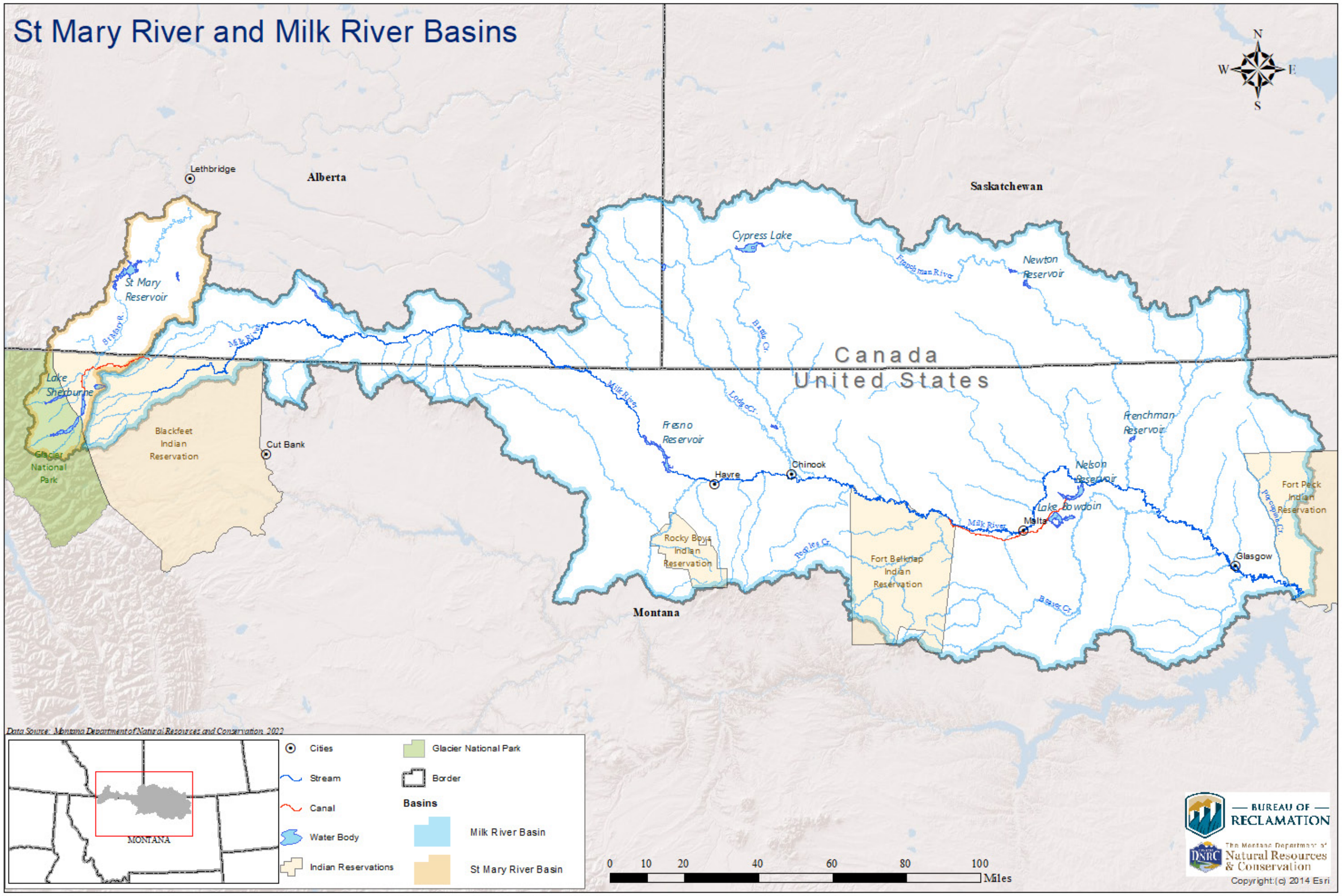


Figure 1.—St. Mary and Milk River Basins Study Update overview map.

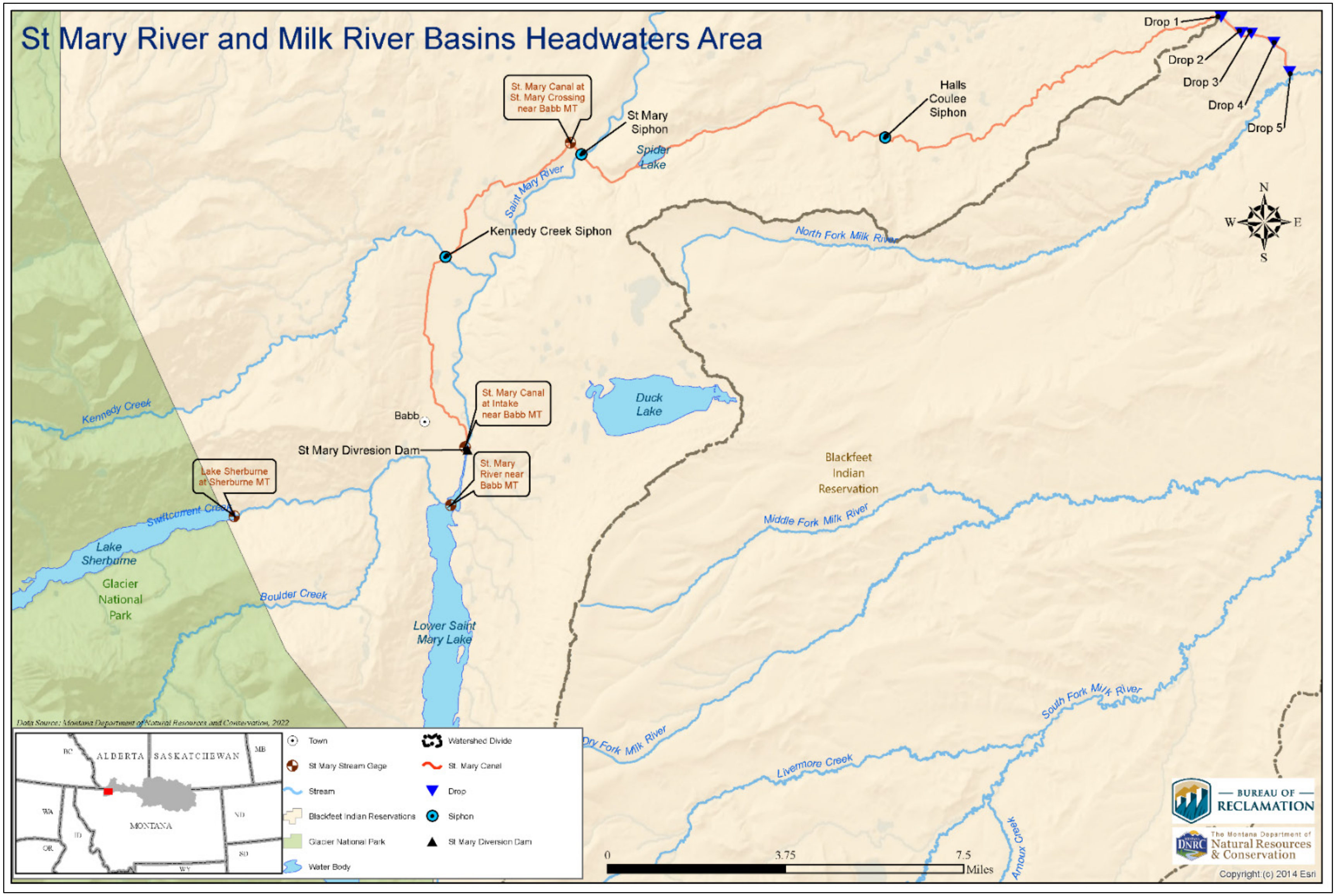


Figure 2.—St. Mary River facilities map.

There are few large-scale irrigation facilities in the Milk River basin besides those on the main stem of the river. One important facility is the Frenchman Dam, owned by the State of Montana, located on Frenchman River. It was constructed in 1953 with an original storage capacity of about 7,600 AF.

There are ten 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 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.

There are several species listed under the Endangered Species Act (ESA) which can be found in the St. Mary River and Milk River regions. 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's Department of Fish, Wildlife, and Parks has identified 27 "Species of Special Concern" in the St. Mary River and Milk River regions. Pallid Sturgeon are one such species known to use the Milk River downstream from Vandalia Diversion Dam. Additional "Species of Special Concern" in the Milk River include paddlefish, sturgeon chub, blue sucker, and sauger.

Humans have occupied northern Montana for at least 11,900 years, evidenced by finds of distinctive stone and other 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.

The five most populous counties in the study area, including counties of Glacier, Hill, Blaine, Phillips, and Valley, had a total population of 48,936 people in the 2020 census. Native Americans make up about 36 percent of the regional population.

Existing Challenges

Water users and managers in the St. Mary and Milk River basins face similar challenges to those in other watersheds in the western U.S. where finite water supplies serve increasing demands. Specifically, challenges in St. Mary and Milk River basins are centered around aging infrastructure, reservoir sedimentation, water shortages, water rights adjudication, and environmental challenges. The greatest demand in the study area is for irrigation, comprising about 87 percent of the total consumptive water demand. Reservoir evaporation accounts for about 12 percent and all other uses about one percent (DNRC 2014). In the study area, most of the water has already been appropriated for irrigation, hydropower generation, municipal water supply, and instream flows to support fisheries and recreation.

Aging, under-designed canals are not able to supply enough water to irrigators even when an adequate water supply is available. For example, the St. Mary Canal capacity is about 600 cubic feet per second (ft^3/s) down from its original design capacity of 850 ft^3/s due to active landslides along the canal. Most of the structures of the St. Mary Canal, which is more than 100 years old, have exceeded their design life and need major repairs or replacement. The St. Mary Diversion Dam and Canal were completed in 1915 as part of the Milk River Project in north-central Montana. On May 17, 2020, a concrete drop structure (Drop 5) failed on the St. Mary Canal, northwest of the town of Cut Bank, within the Blackfeet Indian Reservation. When the structure failed, the St. Mary Canal, which conveys water 29 miles to the Milk River could not deliver water until October 15, 2020, when the drop structure was rebuilt.

Existing St. Mary Diversion Dam

The Infrastructure Investment and Jobs Act has set aside 100 million dollars directed to facilities that have failed in the last two years and prevented water delivery for irrigation. This money will be used to fund the replacement of the St. Mary Diversion Dam and Headworks, and the construction of a fish protection structure that will comply with the ESA.

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. According to the North-Central Montana Regional Feasibility Study (Reclamation 2004), Fresno Reservoir has lost about 29 percent of its original 127,200 AF storage capacity to sedimentation. Moreover, future demands are projected to increase, particularly under various future climate change scenarios, leading to even more competition for a limited water resource. In addition, the Swiftcurrent Dike, which directs Swiftcurrent Creek into Lower St. Mary Lake has contributed to erosion problems and sedimentation in Lower St. Mary Lake.

Water shortages have been a major concern in the Milk River basin. This Basins Study Update indicates average historical water shortages of 77 thousand AF (KAF) per year, about 37 percent of the amount of water needed for optimal crop growth (compared with 36 percent reported in the 2012 Basins Study). Shortages may be caused by various factors including periodic severe droughts and development of more irrigated lands than the available water supply can support in most years. Aging, deteriorating, and outmoded design of facilities may also contribute to water shortages even when an adequate water supply is available.

Irrigation in the Milk River basin

Water Rights Adjudication plays a large role in the allocation of water among users, and additional challenges exist due to ongoing water rights settlements among the U.S. and tribal nations, as well as negotiations between the U.S. and Canada over apportionment. Waters of the St. Mary and Milk River are divided between the U.S. and Canada through the Boundary Waters Treaty of 1909 and further defined by the 1921 IJC Order. Further, the Montana Legislature established the Reserved Water Rights Compact Commission in 1979 as part of the statewide stream adjudication process. The Reserved Water Rights Compact Commission was authorized to negotiate settlements with federal agencies and tribal nations within the State of Montana. Water compacts in the St. Mary and Milk River basins have been completed for the Blackfeet, Rocky Boy's, Fort Belknap Indian Community, and Fort Peck Reservations; U.S. Fish and Wildlife Service (Bowdoin National Wildlife Refuge Complex); and the National Park Service (Glacier National Park).

Existing environmental challenges in the basins which are associated with water management include conveyance structure impediments for ESA-listed species, as well as concerns around sufficient water supply to support ESA-listed and State-listed species in the Nelson Reservoir and Bowdoin National Wildlife Refuge areas. The St. Mary Diversion Dam has been identified as detrimental to bull trout, an ESA-listed threatened species, and other State "Species of Special Concern," by impeding fish passage at the dam and entrainment into the St. Mary Canal.

Pallid Sturgeon (source: U.S. Fish and Wildlife Service Mountain Prairie Region)

Pallid Sturgeon, also an ESA-listed endangered species, are found in the Missouri River and lower Milk River. The river flows and water quality are critical for support of species throughout the study area.

Extreme events, including floods and droughts have also impacted water users in the study area, as well as swings between extreme wet and extreme dry conditions. For example, major flooding across the basin occurred in 2011 and was followed by severe drought in 2012, representing new and unprecedented variability that is likely to become more common in the future.

Basins Study Purpose and Development

The purposes of the Basins Study Update are to summarize new science, to understand current and future water supply challenges, and to identify and evaluate strategies for improving resiliency and water supply reliability. Strategies include actions like changing current management practices, changing operations, and modifying or developing new infrastructure.

The Basins Study Update achieves the following objectives pursuant to Reclamation's Basin Studies Program:

- Assess current and projected future water supply; this study focuses on use of information characterizing the distant past (paleohydrology), the recent past (historical hydrology), and projected future hydrology.
- Assess current and projected future water demand.
- Evaluate water supply risks by analyzing simulated performance of water and power infrastructure, and operations under hydrology scenarios listed above.
- Identify and evaluate potential strategies that may reduce any water supply and demand imbalances; development and evaluation of strategies includes outreach and involvement by stakeholders.

Figure 3 depicts the components of the Basins Study Update. A tradeoff analysis is performed as a way of evaluating the effectiveness of strategies using agreed upon criteria.

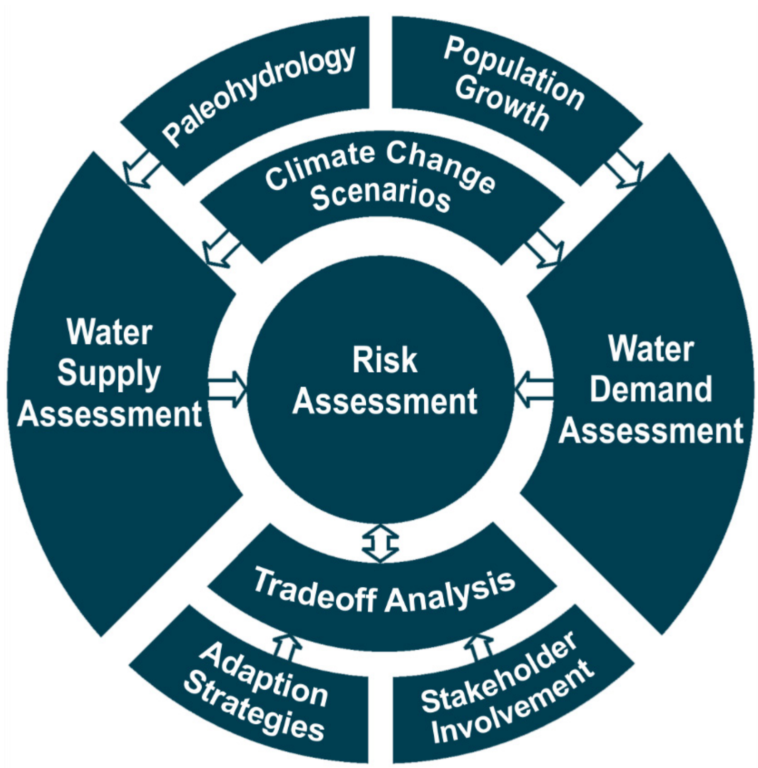


Figure 3.—Overview of the components of the St. Mary and Milk River Basins Study Update.

The Basins Study Update builds upon the 2012 Basins Study and supports the identified goals in the updated State Water Plan. One important objective of this Basins Study Update was to make improvements to the river system model (planning model) that was developed in the 2012 Basins Study using the Riverware™ software. Improvements to the St. Mary and Milk Rivers planning model laid the foundation for evaluating historical (including distant past) and future projected water supply and demand. With these improvements, the river system model serves as a robust and credible decision support tool to evaluate and analyze the following:

- Potential changes in the region's water supplies and demands.
- Adaptive water management strategies.
- Infrastructure deficiencies and needs.
- Operational modifications.
- Other watershed planning initiatives.

Some of the same strategies that were evaluated in the 2012 Basins Study were also evaluated in the Basins Study Update using the St. Mary and Milk Rivers planning model. Comparisons of results are summarized in this report and the accompanying full Basins Study Update report (Reclamation 2024). Additional strategies were also evaluated and summarized.

Collaboration and Outreach

Basin Studies' costs are equally shared between Reclamation and non-Federal partners. Reclamation and Montana DNRC were partners in this Basins Study Update. In addition, Reclamation contracted with the U.S. Geological Survey (USGS) Northern Rocky Mountain Science Center for technical support to develop paleohydrology scenarios (Martin and Pederson 2019) for this Basins Study Update and to provide guidance for their application. Collaboration and outreach with stakeholders and tribes are also key components of these studies.

Study Partners

BUREAU OF RECLAMATION

MONTANA DNRC — The Montana Department of Natural Resources & Conservation

Guidance and Technical Support

USGS — science for a changing world

Reclamation and Montana DNRC engaged with stakeholders in the study area to keep them abreast of the status of the Basins Study Update throughout the process. Status briefings were provided to the Milk River Project Joint Board of Control (MRJBOC) and the St. Mary Rehabilitation Working Group (SMRWG) throughout the study.

The MRJBOC represents the eight Milk River Project irrigation districts and encompasses the largest group of water users in the Milk River basin. The SMRWG is a stakeholder group with representation from every major stakeholder in the St. Mary and Milk River basins. The SMRWG has representation from Fort Belknap Indian Community, the Blackfeet Nation, individual irrigators, Milk River Watershed Alliance watershed group, county government, municipalities, recreation communities, Montana State University Extension agents, conservation districts, and the agricultural community. The MRJBOC also has representation on the SMRWG. The SMRWG meetings are also frequently attended by community leaders, elected officials and their staff, and the public. By keeping these two key organizations updated on the study, all stakeholders in the basins were provided opportunity for input throughout the study. Both organizations' meetings are open to the public. Study updates were also provided to the International Joint Commission's Accredited Officers Technical Working Group.

Another important component of each basin study is collaboration with other ongoing efforts in the study area. This Basins Study Update was conducted in coordination with the Fort Belknap Indian Community Compact settlement, the Blackfeet Tribe Compact settlement, and the ongoing International Joint Commission Study. Additional information on each of these efforts is provided in the accompanying full Basins Study Update report.

Methodology and Approach

The Basins Study Update incorporates newly developed data and tools to quantify water supply and demand, and to evaluate strategies to address imbalances. Reclamation and Montana DNRC used a scenario approach to develop water supply and demand data for a range of plausible conditions. These scenarios may be considered storylines because the likelihood of any individual scenario coming to fruition is small, but collectively they are useful to test how the river basins may be impacted by different scenarios.

Water supply scenarios may be described as scenarios of streamflow, reservoir inflows, and local inflows which are simulated by hydrologic and statistical models. Groundwater and surface water interactions were modeled by simulating return flows and incorporating aquifer characteristics into the St. Mary and Milk Rivers planning model.

Water demand scenarios may be described as scenarios of evaporative demands from reservoirs, agricultural demands via crop evapotranspiration, and phreatophyte demands via riparian vegetation evapotranspiration; they also incorporate population estimates for municipal and industrial (M&I) water use.

Scenarios of water supply and demand encompass three types: paleohydrology (spanning a common set of water years from 1581–1998), historical reference (encompassing water years 1981–2015), and projected future scenarios under three planning horizons: the 2020s (which encompasses water years 2010–2039[1]), the 2050s (which encompasses water years 2040–2069), and the 2080s (which encompasses water years 2070–2099).

Figure 4 illustrates the scenarios developed for the Basins Study Update showing the variability in streamflow under different scenarios.

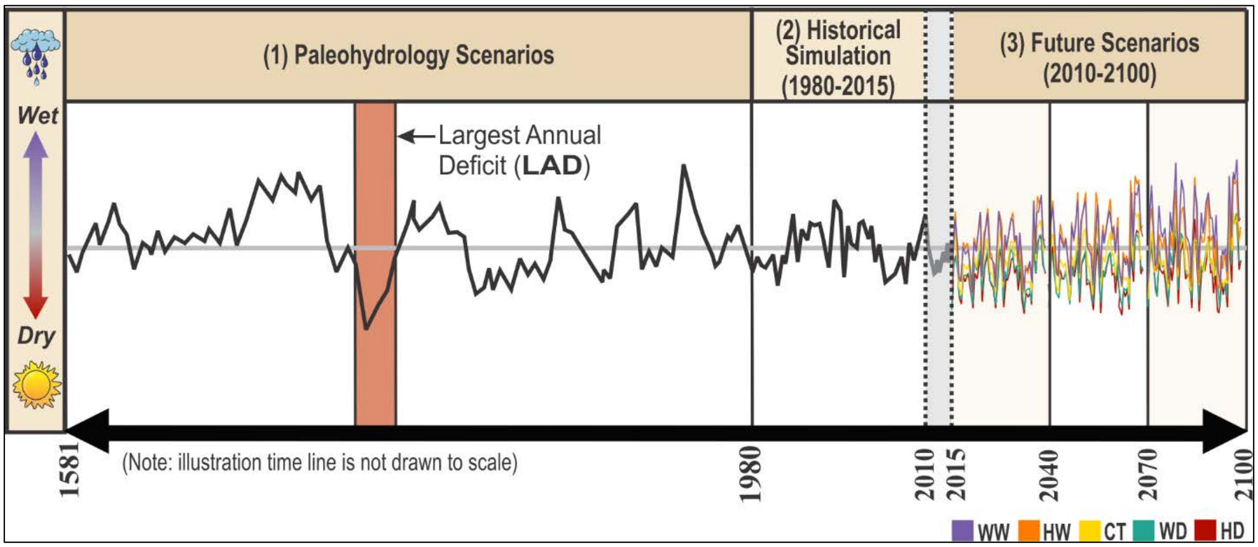


Figure 4.—Illustration of scenario approach for St. Mary and Milk River Basins Study Update.[2]

Details of the different scenario types are provided below.

> Paleohydrology — Paleohydrology was developed from tree rings to provide a record of hydrologic conditions over the past 1,000 years, as far back as 1018 for Milk River at Western Crossing of the International Boundary (Reclamation 2021; 2021 SECURE Water Act Report). The study team developed daily streamflow timeseries over 35-year periods (consistent with the historical reference period) which encompass extreme droughts that were identified from tree rings over a common period of 1581 to 1998. The managed river systems are most impacted by single annual drought events due to the limited carryover storage of water from one year to the next. Therefore, periods with the largest average annual deficit (LAD) in the paleohydrology record were identified in the

[1] This near-term future planning horizon overlaps with the historical baseline period (1980-2015) because the future climate projections used develop scenarios of future climate represent future as beginning in 2006. Climate projection data was used to develop each scenario of future climate.

[2] Table legend: warm-wet (WW), hot-wet (HW), a middle range central tendency (CT), warm-dry (WD), and hot-dry (HD).

paleohydrology record (table 1). Using similar methodology, LAD droughts were also identified and evaluated in the instrumental record alongside notable droughts experienced in the historical reference period.

Historical simulations — To represent natural streamflow (i.e. unmanaged) over the historical reference period (water years 1981-2015), daily streamflow was simulated for a network of key inflow locations.

Future scenarios — Future hydrologic scenarios based on general circulation model projections were developed and provide the best estimate of what could occur over the coming century with respect to climate dynamics and warming. For this Basins Study Update, each scenario for a particular time horizon is considered an equally likely future planning scenario. These scenarios include five climate timeseries, developed for the region that represent a range of projected changes in temperature (less warming to more warming). These are called warm-wet, hot-wet, a middle range central tendency, warm-dry, and hot-dry. These scenarios also include precipitation (from decreases to increases) for three future time horizons: the 2020s, the 2050s, and the 2080s.

Table 1.—Summary of paleohydrology drought events

Location of streamflow reconstruction	Event	Rank	Year start	Year end	Length
Milk River at the Western Crossing	LAD	1	1747	1748	2
Milk River at the Western Crossing	LAD	2	1602	1607	6
Milk River at the Western Crossing	LAD	3	1622	1623	2
Milk River at the Western Crossing	LAD - Instrumental (LAD Inst)	NA	1931	1946	16
Study area	Notable historical drought 1 (Hist 1)	NA	1996	2009	14
Study area	Notable historical drought 2 (Hist 2)	NA	1928	1936	9

Water Supply Scenarios

Water supply across the St. Mary and Milk River basins is variable, with most of the Milk River basin water supply coming from the St. Mary River basin. Understanding of historical and projected future water supply is important for determining apportionment to the U.S. and Canada, as well as availability of water to the Milk River Project and other users. Even small changes in annual precipitation can have large effects downstream; when coupled with the variability from extreme events, these changes make managing these resources a challenge.

Groundwater is a limited resource in the St. Mary River and Milk River basins, used primarily for domestic and stock water purposes. Wells used for these two purposes generally pump less than about 1.5 AF per year per well. Springs and wells with sources from alluvial deposits in coulees are used widely throughout the Milk River basin. While they may be developed locally, they are not considered productive aquifers. In addition to local domestic and stock water use, groundwater is also used to supplement the surface water supply for the city of Havre and is the main supply for the city of Malta.

The Water Supply Assessment component of the Basins Study Update summarizes potential changes in hydroclimate across the study area, incorporating scenarios of projected future climate as well as scenarios of drought developed from tree-ring based reconstructions of streamflow. To evaluate potential hydrologic changes, a modeling framework was developed to address the complexities in the regional hydrologic landscape.

Depression storage in the Frenchman River basin, within the PPR

Physical hydrologic processes that are uniquely important in the St. Mary and Milk River basins compared with other watersheds in the western U.S. include glacier processes, frozen soils, snow redistribution, and depression storage. The Prairie Potholes Region (PPR) in the north-central U.S. extends north into central Canada and spans much of the Milk River basin. The PPR watersheds have low-slope surface drainage networks including lakes and wetlands, resulting in storage conditions that vary in time. Consequently, significant portions of a watershed within the PPR could be considered non-contributing for some portion of time, as depression storage fills, not leaving enough water for runoff. Due to these complexities, a new hydrologic modeling framework was developed for the Basins Study Update, specifically designed for intended use in planning, design, and operational decisions.

The hydrologic modeling framework was implemented and calibrated over the historical reference period, water years 1981–2015, for each subbasin in the study area. The calibration process compared simulated streamflow with a daily naturalized streamflow dataset developed by Montana DNRC using twice-monthly natural flow records from the IJC in addition to observed gage records and consumptive use estimates.

The study area was discretized into three hydrologically similar regions, named the St. Mary Basin, the Upper Milk Basin, and the Plains, as illustrated on figure 5. The gray regions do not contribute streamflow to the study area and are not included in the hydrologic modeling. Subbasins within these regions were determined to have similar hydrologic characteristics and thereby have consistent hydrologic model parameters within these regions.

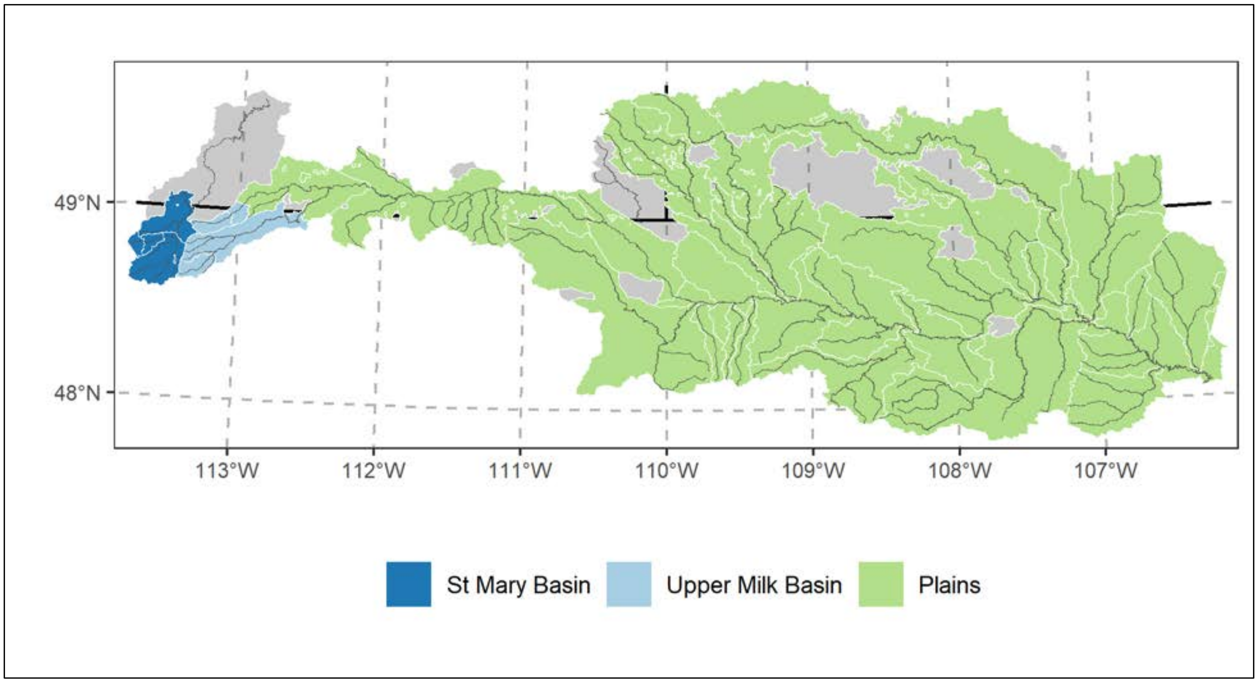
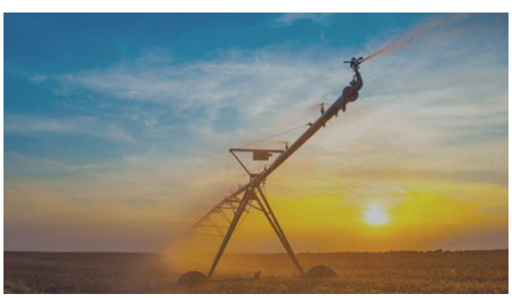


Figure 5.—Hydrologically similar regions within the St. Mary and Milk River basins.

Water Demand Scenarios

Water demands in the St. Mary and Milk River basins are dominated by agricultural irrigation. Previous studies have indicated that significant irrigation shortages already occur in the basin. Additional water demands within the St. Mary and Milk River basins include M&I demands for the communities of Havre, Chinook, Harlem, Hill Country, and North Havre Water districts. Other demands include phreatophyte demands, specifically deep-rooted cotton woods, evaporation from the mainstream Milk River and reservoirs, as well as instream demands for fish, wildlife, and recreation.



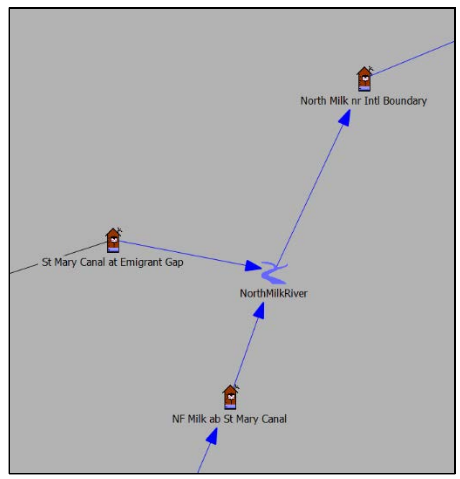
Milk River basin irrigation

The historical reference period was used to develop a reference demand scenario for comparisons with paleohydrology and future scenarios. The historical reference period combines modeled historical agricultural demand (assuming irrigated crop acreages from a representative year 2013), modeled historical reservoir evaporation (assuming an average reservoir depth), M&I for the largest municipalities (Havre, Chinook, Harlem, Hill County, and North Havre Water District), and current (2022) operational policies for river and reservoir management.

Water supply and demand scenarios were developed in parallel so that each water demand scenario coincides with a corresponding water supply scenario. These collectively were input in the St. Mary and Milk Rivers planning model. Agricultural and evaporative demands were adjusted for projected changes in temperature and precipitation to develop future scenarios. Several assumptions were made when creating the future scenarios, specifically that agricultural practices, irrigation acreage, and crop distribution were assumed to remain static throughout time. Additionally, M&I demands, which account for less than one percent consumptive use in the study area, were assumed to remain unchanged in future scenarios. Water demand scenarios for the paleohydrology period were developed by selecting from historical reference period water demands based on similar water years.

St. Mary and Milk Rivers Planning Model

Impacts of water supply and demand under the historical, projected future, and paleohydrology scenarios on water management in the study area were evaluated using the St. Mary and Milk Rivers planning model. Model results can be used to evaluate how various categories of water use (agricultural water deliveries, flood control operations, ecological resources, and recreation) may be impacted by these scenarios relative to recent historical conditions. The St. Mary and Milk Rivers planning model was originally developed as part of the 2012 Basins Study and was updated to improve model mass balances, canal efficiencies, and additional model parameters (Reclamation 2022).



St. Mary and Milk Rivers planning model excerpt

Water Supply Assessment

All climate projections suggest a warmer future compared to the historical reference period. Future climate projections present a range of drier to wetter conditions on an annual basis; however, changes in mean monthly precipitation show a consistent pattern with historically wet months (April and May) likely to get wetter, while summer months are likely to get drier, relative to the historical period (figure 6).

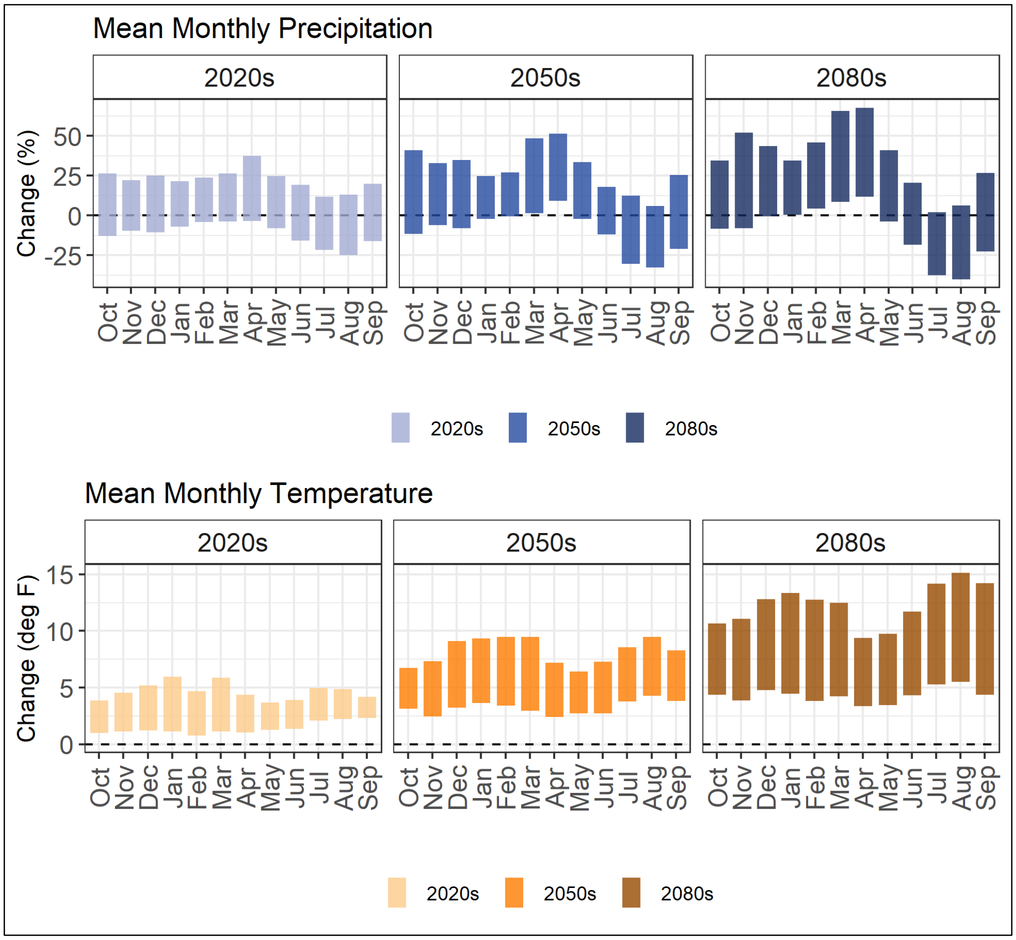


Figure 6.—Range of projected change in average monthly precipitation (%) and air temperature in degrees F across the study area.[3]

As influenced by changes in climate across the study area, annual water supply is projected to increase in all three hydrologic regions (the St. Mary Basin, Upper Milk Basin, and in the Plains) under all future scenarios compared to recent history. Temperature increases are projected to lead to decreases in peak snowpack for all future scenarios, with progressively greater decreases toward the end of the twenty-first century (figure 7). Future projections also predict a shift to earlier snowmelt driven runoff. These changes in snowpack and snowmelt timing, coupled with projected changes in the seasonality of precipitation and higher temperatures, lead to increased spring flows and decreased summer flows. These results indicate an increased reliance on stored water supplies to meet consumptive demands during summer months.

[3] The bounds of the range are defined as the 10th and 90th percentiles of change for each month.

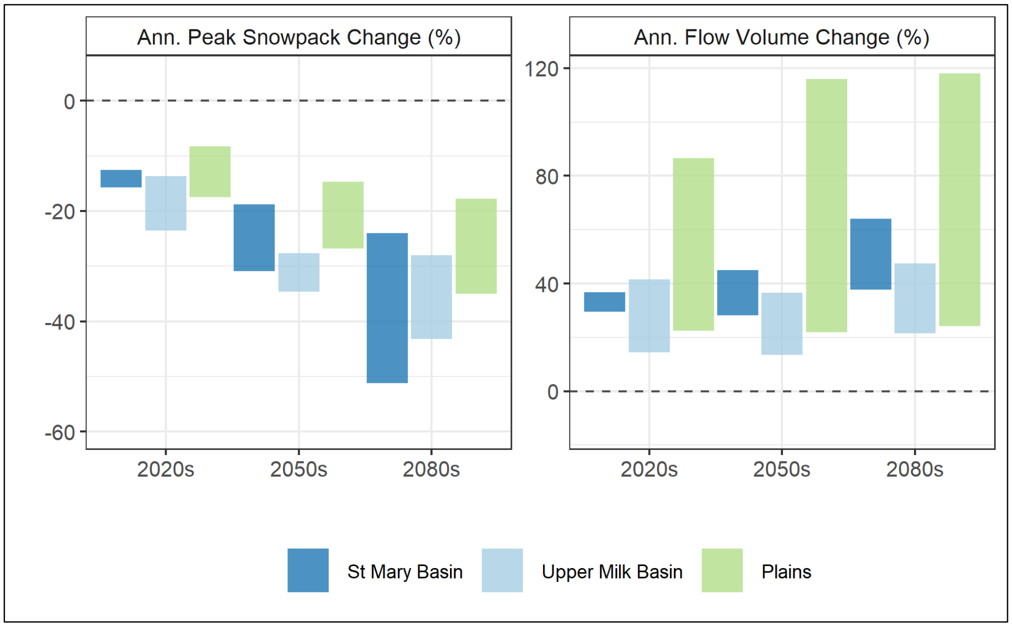


Figure 7.—Projected changes in annual peak snowpack and annual flow volume in percent for the 2020s, 2050s, and 2080s compared with a 1980-2015 reference historical period.

Milk River Project changes also indicate an increase in the number of heavy precipitation events (events with greater than one inch-per-day of rainfall) and an increase in the number of days with temperatures above 95 degrees Fahrenheit. Increases in extreme precipitation events coupled with projected temperature increases and changes in the seasonality of water supply may leave areas more vulnerable to flooding during winter and spring seasons and water supply shortages late in the irrigation season.

Projected changes in average monthly streamflow for the 2080s at Swiftcurrent Creek, above Lake Sherburne in the St. Mary River basin, are presented on figure 8. Annual precipitation in the Swiftcurrent Creek basin is projected to increase for all future scenarios. Increased precipitation in conjunction with increased temperatures in the Swiftcurrent Creek basin results in increased peak flows with a shift in peak flows toward earlier in the year. The grey shaded region on figure 8 represents the range of the 25th to 75th percentiles of the statistically resampled projected streamflow, which illustrates the associated uncertainty.

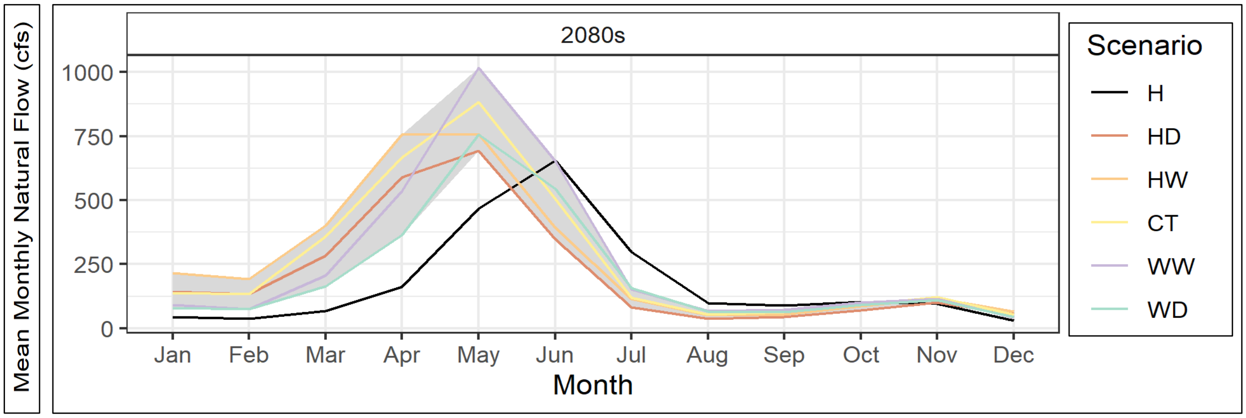


Figure 8.—Historical and projected average monthly streamflow for the 2080s at Swiftcurrent Creek at Sherburne (USGS ID 05016000).

Evaluation of the reconstructed paleohydrology record (results summarized in the full study report) showed that the range of annual streamflow over approximately the last 500 years is greater than the range over the historical scenario period (1980–2015). This is to be expected in part because of the larger number of years contributing to the range. Droughts spanning 2 to 8 years are common in the study area; however, significantly longer drought events lasting 10 to 30 years do occur, including the Dust Bowl (>15 years) centered around the 1930s. Figure 9 illustrates the LAD droughts identified in table 1 in the context of annual variability in streamflow at Milk River at the Western Crossing, with the Dust Bowl drought shaded in blue.

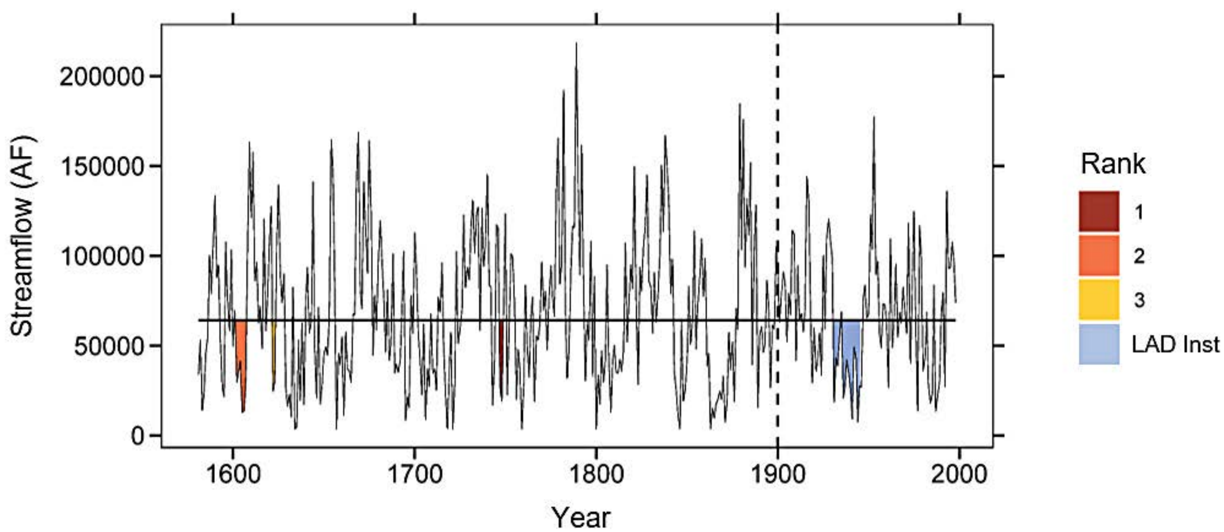


Figure 9.—Paleohydrology drought events at Milk River at the Western Crossing (shaded regions) within the context of the water-year annual reconstructed streamflow record.

Water Demand Assessment

Analysis of the projected future demands show that future warming in the study area will cause overall increases in agricultural water demand and reservoir evaporation relative to the historical reference period.

Warming temperatures impact the timing of agricultural demands in future scenarios. Increases in temperatures allow for earlier planting and green-up of crops, as well as longer growing seasons overall for perennial crops, and additional cutting events for alfalfa. The largest percent changes in average annual agricultural water demands occur in the Upper Milk Basin region at higher elevations relative to the Plains (no irrigation occurs in the modeled portion of the St. Mary Basin; figure 10).

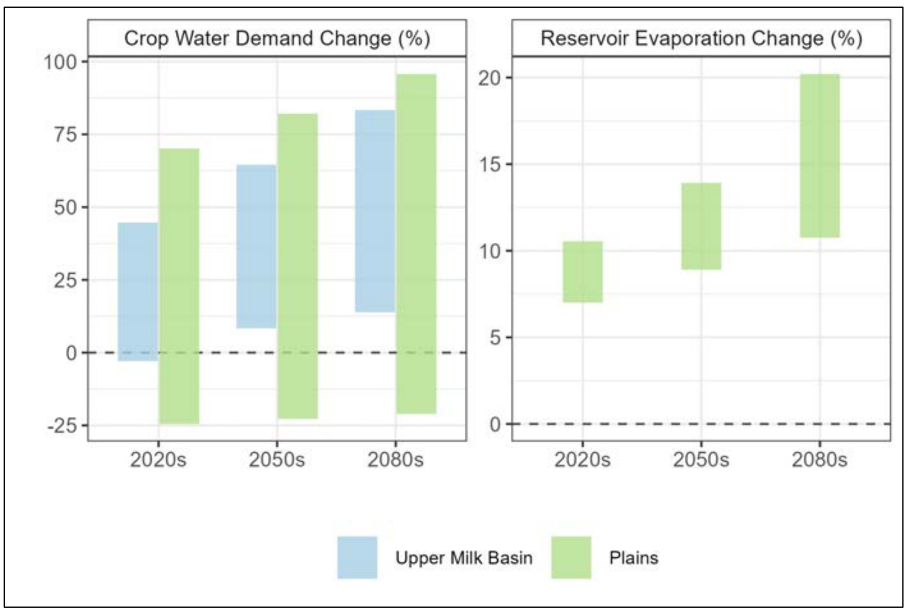


Figure 10.—Projected changes in annual crop water demand and reservoir evaporation in percent for the 2020s, 2050s, and 2080s compared with the 1980 to 2015 historical period.

Despite variable changes in precipitation**,** reservoir evaporation is projected to increase compared with the historical reference period for all reservoirs within the study area due to increased temperatures, with the greatest increases toward the end of the twenty-first century (see figure 10). Increases in reservoir evaporation vary seasonally with the largest increases during the summer when evaporation rates have historically been at their peak. Increases in water supply, coupled with demand increases, result in variable outcomes for reservoir storage, with some scenarios indicating increases in end of water year (EOWY) storage (September 30) and others projecting decreases. Phreatophyte demands and Milk River and evaporation losses in the St. Mary Canal are also projected to increase for all future scenarios, up almost 60 and 30 percent, respectively.

Risk Assessment

The risk assessment for this Basins Study Update evaluates the implications of historical and future water supply and demand on water management in the study area. The St. Mary and Milk Rivers planning model was used to compute risk assessment measures related to agricultural water deliveries, managed river flows, and reservoir levels, among other things, throughout the study area. A suite of measures was developed to evaluate these model results and their impacts on current and future water management risks. The use of quantitative risk assessment measures facilitates a deeper understanding of potential future impacts on specific resources and objectives relevant to water management in the study area. These measures, summarized in table 2, are based on input from stakeholders and resource managers and were identified in accordance with the Basin Study Directives and Standard (WTR 13-01 2016).

Table 2.—Risk assessment measures

Measure category	Measure description
Hydrologic response	Change in annual flow volume
	Change in April–September flow volume
	Change in October–March flow volume
	Change in day of centroid of streamflow timing
	Change in end of month reservoir storage
	Change in monthly reservoir inflows
Water deliveries	Change in EOWY reservoir storage
	Change in April 1 reservoir storage
	Change in monthly depletions, depletion requests, and depletion shortages
	Change in annual depletions, depletion requests, and depletion shortages
Flood control operations	Change in number of days above flood pool elevation
	Change in average daily reservoir pool elevation
	Change in number of days streamflow exceeding active flood levels
Ecological resources*	Change in daily streamflow
	Change in 7-day low and high streamflows
Recreation	Change in unusable days at boat ramps

* The ecological resources category includes; fish and wildlife habitat; species listed as an endangered, threatened, or candidate species under the ESA; flow and water dependent ecological resiliency; and water quality.

An illustration of how various measures, including inflows to the St. Mary Canal, EOWY storage in Lake Sherburne, and annual streamflow at Milk River at Nashua gage, may change under projected future and paleohydrology scenarios is provided on figure 11. In wet years, demand for water from the St. Mary River basin to supply irrigators in the Milk River basin may be less than in dry years. For the 2080s future time horizon, with projected increases in precipitation particularly in winter months, all projected future scenarios indicate reduced flows through the St. Mary Canal; little change in EOWY storage in Lake Sherburne; and changes in annual streamflow at Milk River at Nashua Ranging from a 22 percent increase to a 21 percent decrease.

If extreme drought events in the paleohydrology period were to occur under current management conditions (colored bars), St. Mary Canal inflows would be greater; EOWY storage in Lake Sherburne would be greater or have little change; and streamflow at the Milk River at Nashua gage would decrease. However, under notable historical drought events that were identified, the 2000s drought (LAD Inst on figure 10) would reduce inflow to the St. Mary Canal, increase EOWY storage in Lake Sherburne, and reduce streamflow at the Milk River at Nashua gage. Interestingly, the 1930s drought (Hist 2 on figure 11) would increase inflow to the St. Mary Canal, reduce Lake Sherburne EOWY storage, and reduce Milk River streamflow at Nashua. This illustrates the fact that extreme drought events may not be equally experienced across the study area, and deeper investigation is needed to fully understand implications.

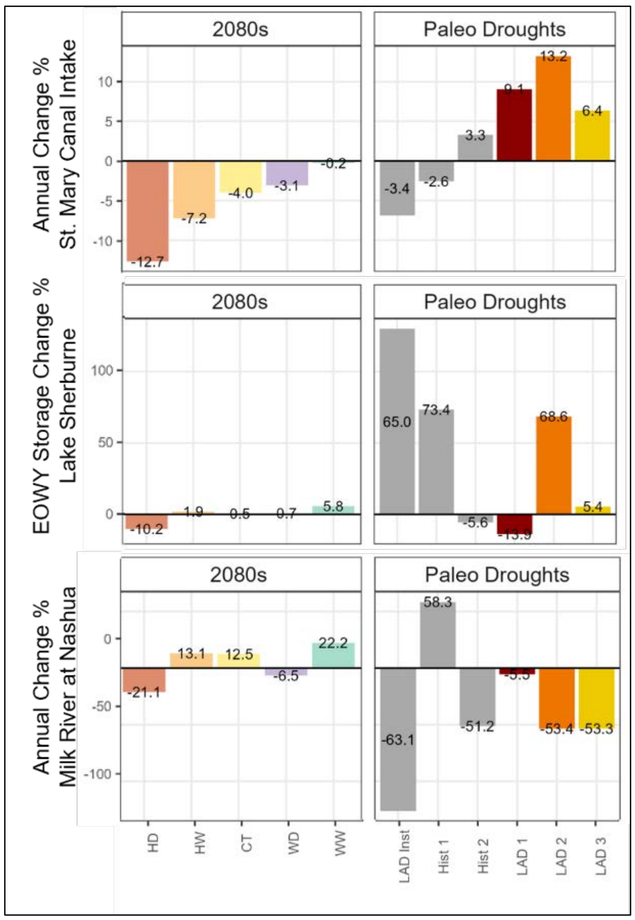


Figure 11.—Results of three risk assessment measures displayed as percent changes between the 2080s and historical reference period, and between extreme drought events and historical reference period.

Strategies

Strategies were identified as part of this Basins Study Update to address water management challenges in the study area. These strategies were developed in cooperation with study partners and through stakeholder outreach. They address impacts of future water uses and infrastructure and allow for evaluation of mitigation options to prepare for future water uses.

An overview of the strategies by location are presented on figure 12. Strategies are separated into four categories. The first set evaluates system-wide water management strategies to address current and future water needs. The second set of strategies evaluates the impacts of future water uses in the St. Mary and Milk River basins. To help mitigate the impact of these future water uses, a third set of strategies were evaluated to assess the effectiveness of potential mitigation strategies to meet these future demands. A last mitigation strategy was included to evaluate the impacts of a complete failure of the St. Mary Canal on the system under current conditions. A final set of strategies evaluates different combinations of these system wide water management strategies, future uses, and mitigation strategies. Key findings from these strategies are summarized on figure 12.

Strategies Evaluated

System Wide Water Management Strategies

- Conveyance and On-farm Efficiency Improvements
- St. Mary Canal Capacity Increase
- Fresno Reservoir Capacity Increase
- Annual Balancing of US/Canada Shares

Providing Water for Future Uses

- 5 KAF for Blackfeet Tribe (Compact)
- Proposed 60 KAF Off stream Storage Project in Ft. Belknap Compact

Mitigating Future Water uses

- Duck Creek Canal
- Nelson Pumps
- Dodson South Canal Capacity Increase
- Mitigate 35 KAF for Fort Belknap Water Rights Settlement Implementation
- St. Mary Canal Failure

Combined Strategies

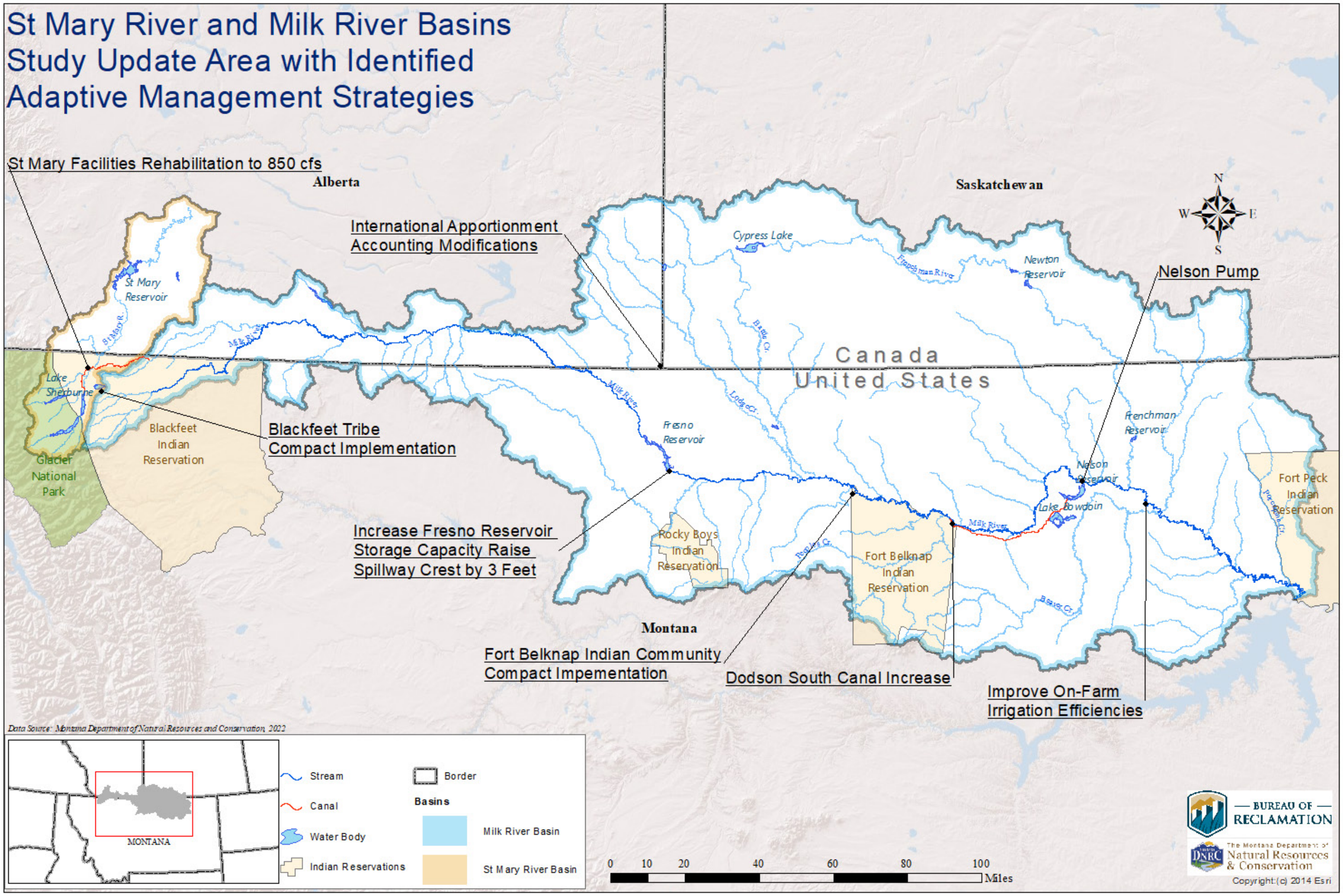


Figure 12.—Overview of strategy locations.

System-Wide Water Management Strategies

Several strategies were identified with the intent to alleviate current and future challenges related to water supply availability and growing agricultural demands. Two strategies focus on the St. Mary Canal; the first strategy targets infrastructure improvements to increase the capacity of the canal and the second evaluates management changes to U.S. and Canadian apportionment of the St. Mary River, from the current two-week balancing period to an annual balancing period. Improvements in water supply availability were also explored through increases in the Fresno Reservoir capacity. Lastly, a final system-wide water management strategy targets mitigation to water demands by increasing on-farm efficiencies for all Milk River Project users.

St. Mary Diversion Dam Headworks

Providing Water for Future Uses

Increased demand for water in the future is a likely factor for long-term planning. The Basins Study Update considered two future water uses in the region. The first strategy evaluated reserved water rights for the Blackfeet Tribe included in the 2009 Blackfeet Tribe Water Rights Settlement (§85-20-1501:1511 Montana Code Annotated). Specifically, this settlement includes conveying 5,000 AF of the Tribe's St. Mary water right through the St. Mary Canal. The second strategy evaluated future water supplies identified in the 2001 Fort Belknap Indian Community Water Rights Settlement (§85-20-1001 Montana Code Annotated), specifically focused on implementation of a 60 KAF off stream storage project.

Mitigating Future Water Uses

Several mitigation strategies have been identified to address the impacts of the future water uses. These include additional infrastructure projects, including: implementation of the Duck Creek Canal, with a capacity of 200 ft^3/s, which would convey water from the Ft. Peck Reservoir via a new canal to the Milk River upstream of Vandalia Dam; increasing the capacity of the Dodson South Canal (from 500 to 700 ft^3/s) which is fed by flows from the Milk River upstream of Dodson to the Upper Malta Irrigation District; and, implementation of the Nelson Pumps which would divert from the Milk River to Nelson Reservoir, effectively returning seepage losses back to the Nelson Reservoir.

An additional strategy was evaluated which was initially presented as part of the Fort Belknap Compact to mitigate effects of the implementation of the 60 KAF off stream storage project in combination with several mitigation strategies including raising the Fresno Dam, implementation of the Nelson Pumps and Duck Creek Canal and increasing the capacity of the Dodson South Canal.

A final strategy was identified to address growing concerns of a catastrophic failure of the St. Mary Canal. We evaluated the impacts of this critical failure on both historical and future conditions.

Combined Strategies

Additional strategies were evaluated to assess the combined impact of system-wide water management strategies, strategies providing water for future use, and mitigating future water use strategies, detailed in the previous section. These combined strategies include different variations of future water uses and mitigation of future water uses, in combination with system-wide water management strategies. Evaluated combinations include:

- Combination of capacity increases for the St. Mary Canal and Dodson South Canal with and without the implementation of the 60 KAF off stream storage project.

- Combination of capacity increases for the St. Mary Canal and Fresno Reservoir with and without the implementation of the 60 KAF off stream storage project.

- Combination of system-wide management strategies and mitigation strategies, including Conveyance and On-Farm Efficiency Improvements, the Fresno Reservoir Capacity Increase, the St. Mary Canal Capacity Increase, operation of the Nelson Pumps, Duck Creek Canal, and the proposed 60 KAF off stream storage project.

Tradeoff Analysis

A trade-off analysis was conducted to evaluate the relative benefits and impacts of the presented adaptation strategies using the identified risk assessment measures. Results of the tradeoff analysis are presented for five summary metrics: St. Mary Canal diversions, water deliveries to all irrigators in the basin, water delivery shortages to all irrigators in the basin, water delivery shortages to Milk River Project irrigators, and Milk River outflow at Nashua. All metrics were evaluated based on annual average values for each of the climate scenarios. Results are separated into three different scoring categories which are assigned unique colors and symbols as presented in table 3. Table 4 summarizes the qualitative impact of each adaptation strategy on the chosen metrics.

Table 3.—Scoring rubric for the adaptation strategies tradeoff analysis

Favorable: A favorable score meant that the strategy was interpreted as having a positive impact.	↑
Neutral: A neutral score meant that the strategy was interpreted as neither performing in a net positive nor negative manner.	—
Less Favorable: A negative score meant that the strategy was interpreted as have a negative impact.	↓

Table 4.—Key findings

Strategy	St. Mary Canal Diversion	Water deliveries	Water delivery shortages	Milk River Project users water delivery shortages	Milk River Outflow at Nashua
Conveyance and On-farm efficiency improvements	—	—	↑	↑	—
St. Mary Canal capacity increase	↑	↑	↑	↑	↑
Fresno Reservoir capacity increase[4]	—	—	↑	↑	—
Annual balancing of U.S./Canada Shares	↑	↑	↑	↑	↑
5 KAF for Blackfeet Tribe (Compact)	↓	—	—	↓	—
Proposed 60 KAF off stream storage project in Ft. Belknap Compact	—	↑	↑	↓	↓
Duck Creek Canal[5]	—	↑	↑	—	↑
Nelson Pumps[5]	—	↑	↑	↑	—
Dodson South Canal capacity increase[5]	—	↑	↑	↑	—
Mitigate 35 KAF for Fort Belknap Water Rights Settlement implementation[5]	—	↑	↑	↑	↑
St. Mary Canal failure	↓	↓	↓	↓	↓

[4] The methodology for implementing the Fresno Reservoir Capacity Increase as well as the rules for Fresno Reservoir releases have been identified as an area for model improvements. These future model improvements may provide further insights into the impacts of increasing the reservoir's capacity.

[5] Strategies are evaluated against the future water use Proposed 60 KAF Off stream Storage Project in Ft. Belknap Compact strategy instead of the Baseline scenario to evaluate its ability to mitigate this future water use.

St. Mary Canal Diversion

Flow through the St. Mary Canal provides critical water supplies to downstream users in the Milk River basin. Increasing the capacity of the St. Mary Canal and adjusting the balancing period for dividing U.S. and Canadian shares of the St. Mary River significantly increased average annual flow volumes through the canal. The annual balancing of U.S./Canada share of the St. Mary River strategy had the greatest impact on increasing flow through the St. Mary Canal, especially in the future scenarios, with the most significant increases in flows across the canal occurring later in the summer. Increasing the capacity of the St. Mary canal had the largest impact during the driest water years and significantly increased flows from May through July during snowmelt when flows through the canal are most limited by its capacity.

Increasing the capacity of the St. Mary Canal was also evaluated in the 2012 Basins Study. Although both basins studies indicated significant positive impacts of increasing the canal capacity, the 2012 Basins Study showed higher overall increase in flow volume across the entire historical period, compared to the current study which indicated a greater impact during the driest water years when water supply is the most critical (table 5).

Table 5.—Impacts of the St. Mary Canal Capacity strategy on diversions through the St. Mary Canal for the historical scenario in the 2012 and current basins studies

Strategy	Water year type	2012 Basins Study		Current Basins Study Update	
		Change (AF/yr)	% change	Change (AF/yr)	% change
St. Mary Canal capacity increase	All	20,000	10.1%	8,516	5.3%
	Driest 5 years	1,000	0.7%	11,789	8.6%

Water Deliveries

System-wide water management strategies that increased flow across the St. Mary Canal, including the canal capacity increase and annual balancing strategy, had the largest impact on increasing water deliveries to downstream users. Increasing the capacity of the Frenso Reservoir, though it did increase the average storage volume in the reservoir for all scenarios, saw a relatively low increase in water deliveries in comparison. However, the Fresno capacity increase was most effective during the extreme paleodrought events, indicating its potential importance in the driest water years.

Water deliveries were significantly impacted by the evaluated future water uses. Providing 5 KAF for the Blackfeet Tribe (Compact) reduced flows from the St. Mary Canal to the Milk River, reducing the total water delivery to downstream users. Implementation of the proposed

60 KAF off stream Storage Reservoir successfully increased the available storage volume in the system and increased the total volume of water deliveries to all water users in the study area, though not all users saw delivery increases.

Mitigation strategies also impacted water deliveries. Implementation of the Duck Creek Canal successfully increased streamflow volumes for all scenarios below its outlet in the Milk River near Vandalia; however, a significant volume of flows from Duck Creek were used by the irrigators closest to the outlet, with little impacts to other users. Implementation of the Nelson pumps and increased capacity of the Malta South Diversion had the greatest impact of the individual mitigation strategies on increasing total water deliveries in the study area, especially in the futures and the extreme paleo drought event scenarios.

Water Delivery Shortages

Water delivery shortages are an important metric for evaluating unmet demands, especially during the future scenarios where increases in agricultural water demands are expected to outpace potential increases in future water supplies. Increasing water supply and deliveries in the system was an effective pathway for reducing shortages in the system for several of the system wide management strategies and mitigation strategies. However, one system wide water management strategy decreased water delivery shortage by increasing the on-farm and conveyance efficiency improvements, which was successful for all scenarios. Improvements to conveyance and on-farm efficiencies had the largest impacts during the driest water years and during the early irrigation season from May through June, when irrigation demands are anticipated to increase due to a warmer climate.

The 2012 Basins Study also evaluated the impact of conveyance and on-farm efficiency improvements and increasing the capacity of the St. Mary Canal (table 6). Both the 2012 and current Basins Study Update saw decreases in water delivery shortages with efficiency improvements and increases in the St. Mary Canal capacity. However, the 2012 Basins Study results showed higher reductions in delivery shortages for the Conveyance and On-farm efficiencies improvements strategy, largely due to a greater 17 percent overall efficiency improvement compared to the 5 percent improvement in the current Basins Study Update. Though the 2012 Basins Study indicated a higher overall reduction in water delivery shortages for the historical period, both the St. Mary Canal capacity and efficiency improvements strategy in the current Basins Study Update indicate better performance in the driest water years, relative to the 2012 Basins Study.

Table 6.—Impacts of the conveyance and on-farm efficiency improvements strategies on total water delivery shortages across the study area for the historical scenario in the 2012 and current basins studies

Strategy	Water year type	2012 Basins Study (17%)		Current Basins Study Update (5%)	
		Change (AF/yr)	% change	Change (AF/yr)	% change
Conveyance improvements and on-farm efficiency improvements	All	-20,000	-18.9%	-1,515	-1.9%
	Driest 5 Years	-15,000	-8.7%	-3,251	-2.3%
St. Mary Canal capacity increase	All	5,000	-4.7%	-2,238	-2.8%
	Driest 5 Years	1,000	0.6%	-3,285	-2.3%

Milk River Project Users Water Delivery Shortages

Several of the presented strategies have variable impacts on individual water users. Though operation of the 60 KAF off stream storage reservoir results in increases in total water deliveries in the study area, shortages to Milk River Project users increase, with the largest impact during the drought events.

The system wide water management strategies and several of the mitigation strategies, including implementation of the Nelson pumps and increasing the capacity of the Dodson South Canal, provide potential pathways for reducing shortages to Milk River Project users and reducing the impact of future water uses. Results showed that there are multiple combinations of these system wide water management strategies and future water use mitigation strategies which can effectively reduce delivery shortages for existing and new water users, more than the individual strategies alone, both in the Mitigating 35,000 AF for the Fort Belknap Water Rights Settlement strategy and the combination strategies.

Milk River Outflow at Nashua

Milk River streamflow at Nashua before it flows into the Missouri River provides a metric to examine the potential impacts of water management on in-stream flow as well as potential environmental and water quality impacts of each strategy on the system. Milk River flows at Nashua were also evaluated as part of the 2012 Basins Study for the Conveyance and On-farm Efficiency improvements (table 7). The 2012 Basins Study indicated large decreases in flow at the Nashua gage compared to the current Basins Study Update, which indicated a small increase, likely due to the larger efficiency change evaluated in the 2012 Basins Study.

Implementation of future water uses reduced flows at Nashua for all scenarios; however, several of the mitigation strategies successfully reduced the impact of these future uses on Milk River outflow at Nashua.

Table 7.—Impacts of the conveyance and on-farm efficiency improvement strategies on average annual total Milk River outflow near Nashua for the central tendency futures scenario in the 2012 and current basins studies

Strategy	Water Year Type	2012 Basins Study (17%) Change (AF/yr)	2012 Basins Study (17%) % change	Current Basins Study Update (5%) Change (AF/yr)	Current Basins Study Update (5%) % change
Conveyance improvements and on-farm efficiency improvements	All	18,000	-3.8%	5,107	1.0%
	Driest 5 years	13,000	-9.9%	2,063	0.7%

Next Steps and Future Considerations

The datasets and modeling tools developed and refined in this Basins Study Update are valuable contributions to greater scientific understanding of the watersheds and to ongoing and future studies. For example, the St. Mary and Milk Rivers planning model is being used in the IJC study for exploring opportunities for apportionment of St. Mary and Milk River water between the U.S. and Canada. It is also being used in ongoing tribal water rights negotiations. Even as the planning model has been expanded for use in these studies (in addition to this current Basins Study Update), the modeling team has identified needed improvements to the planning model to make it more robust as a decision support tool; specifically, improving representation of water deliveries from Fresno Reservoir and improvements to the implementation of the “Letter of Intent” for St. Mary and Milk River credit accounting between the U.S. and Canada.

The hydrologic modeling framework developed for this Basins Study Update provided a meaningful dataset for use in evaluating water supply and demand imbalances. However, the hydrologic modeling framework developed for this study had not been fully tested outside these watersheds and will be submitted for publication in peer-reviewed literature. Further evaluation of this modeling approach and testing may identify improvements for future application. Future studies, where continuing improvements to the methods and datasets may be identified, will benefit from the use of other datasets developed for this study, including the hydroclimate dataset and the naturalized flow dataset, which was published by the Montana DNRC.

Uncertainty

The analyses provided in this report reflect the use of best available datasets and data development methodologies at the time of the study. This Basins Study Update was peer reviewed in accordance with Reclamation's and the Department of the Interior's policies. This report is intended to inform and support planning for the future by identifying potential future scenarios.

It is important to acknowledge the uncertainties inherent within projecting future planning conditions for water supply and demand. For example, projections of future climate, water demand, and land use, contain uncertainties and assumptions that vary geographically and temporally depending on the model and methodology used. Trying to identify an exact impact at a particular place and time remains difficult, despite advances in modeling efforts over the past half-century. Accounting for these uncertainties, Reclamation and its stakeholders used a scenario planning approach which encompasses the estimated range of future planning conditions. More detailed information about uncertainties related to each part of the study is available in the St. Mary and Milk River Basins Study Update full report.

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Appendix A

Program Requirements Cross Walk Table

WTR 13-01, Basin Studies, Required Elements	Location in Basins Study Update Full Report
9.A. Projections of future water supply and demand (1) Changes in snowpack; (2) changes in the timing and quantity of runoff; (3) changes in groundwater recharge and discharge; and (4) any increase in: a. the demand for water as a result of increasing temperatures; or b. the rate of reservoir evaporation.	Water Supply Assessment Chapter (supplemental information in Appendix B. Water Supply Development) Water Demand Assessment Chapter (supplemental information in Appendix C. Water Demands Development)
9.B. Analysis of how existing water and power infrastructure and operations will perform given any current imbalances between water supply and demand and in the face of changing water realities due to climate change and population growth, including an analysis of the extent to which changes in the water supply will impact Reclamation operations and facilities, including: (1) Ability to deliver water, including the impacts of drought; (2) hydroelectric power generation; (3) Recreation; (4) Fish and wildlife habit; (5) applicable species listed as endangered; (6) water quality; (7) flow and water dependent ecological resiliency; and (8) Flood control and/or management.	Risk Assessment, Water Management Implications Section Hydropower impacts do not apply in the St. Mary and Milk River basins due to minimal hydropower production. Streamflow measures were used to evaluate (5), (6), (7).

WTR 13-01, Basin Studies, Required Elements	Location in Basins Study Update Full Report
Development of appropriate adaptation and mitigation strategies to meet current and future water demands. Adaptation and mitigation strategies include: (1) modification of any reservoir or operating guideline in existence; (2) development of new water management, operating, or habitat restoration plans; (3) development of new water management, operating, or habitat restoration plans; (4) development of new water infrastructure; and (5) development or improvement of hydrologic models and other decision support.	Risk Assessment with Strategies, Approach to Strategy Analysis
9.D. A quantitative or qualitative trade-off analysis of the adaptation and mitigation strategies identified.	Risk Assessment with Strategies, • System Wide Water Management Strategies; • Providing Water for Future Uses; • Mitigating future Water Uses; and • Combined Strategies Chapters.
11.B. Technical Sufficiency Review, List of Reviewers	Appendix K. Peer Review Report
11.C. Technical Sufficiency Review, Level of Review	Appendix K. Peer Review Report
11.D Technical Sufficiency Review, Documentation of Results	Appendix K. Peer Review Report