







# Lower Missouri River Basin Water Plan 2014

Prepared by MT DNRC in Cooperation with the Lower Missouri Basin Advisory Council





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# I. Executive Summary

The Lower Missouri River Basin (LMRB) in Montana is blessed by a high quality natural environment that provides abundant fresh water for variety of uses. The Montana Water Use Act makes clear that the state's water, as a public resource, be inventoried and managed so that existing beneficial uses are maintained and, where possible, enhanced and expanded. Water, arguably our most precious natural resource, is closely tied to the basin's economy. Despite the fact that the LMRB generates more water within its borders than it uses, when an extended drought occurs, everyone suffers.

At the time of this writing, 2014 has been a banner water year for the LMRB in Montana. The basin has been blessed with above average precipitation. This year the basin's rivers, streams and reservoirs are able to provide the water necessary to satisfy both consumptive and non-consumptive uses across the basin.

About 2 million acre-feet of surface water and groundwater combined is diverted annually in the Lower Missouri Basin for irrigation, livestock watering, industrial, municipal, and domestic use. The largest consumptive use is irrigation, which accounts for almost 99 percent of all water diverted in the Basin. Only a fraction of the diverted volume is actually consumed: about 474,000 acre-feet, which is about 23 percent of the originally diverted volume. Irrigation accounts for 96 percent of the total consumption of diverted water in the Basin. Stock watering is the second largest consumptive use in the basin, amounting to 3 percent (15,000 acre-feet) of water consumed annually. The LMRB is home to only about 70,000 residents, with over half living in three counties: Hill, Fergus, and Roosevelt. The projected population at 2035 shows an increase to 82,000 residents. Water consumed by municipal and domestic supply constitutes a very small amount in the basin, less than one percent of total diverted water.

More than 75 percent of the Missouri River flow is not diverted, remaining in the river as it leaves the state. Not including reservoir evaporation, water consumed by beneficial uses within the Lower Missouri Basin is only about 5 percent of the total basin water budget. Only 23 percent of the amount diverted is actually consumed, leaving 77 percent of the diverted water to return to surface or groundwater sources. Fort Peck Reservoir evaporation is much greater than the amount of water consumed by all other beneficial uses in the Lower Missouri Basin, totaling over 611,000 acre-feet, or about 7 percent of the overall water budget.

For basins where irrigation is heavily developed and there are sizable water storage projects, such as the Musselshell River and the Milk River sub-basins, almost all of the water that is produced by the basin is captured or diverted more than once. This would especially be the case during dry years. Other streams, such as the Missouri River, have relatively less irrigation and the reservoirs are operated mainly for non-consumptive purposes, such as flood control or hydropower generation. Most flow in these basins is not diverted.

Some streams supplying significant irrigation development may have little or no storage capacity to capture high, early spring flows for release later in the irrigation season. Most of the water in these basins is therefore neither stored nor diverted since the bulk of the runoff does not correspond with intensive irrigation demands.

The majority of cropland in the Lower Missouri Basin is not irrigated, and the vast majority of irrigated parcels receive water from surface sources, which supply 97 percent of irrigation water. Groundwater sources supply only about three percent of all irrigation water in the Lower Missouri Basin. But groundwater can be important locally, especially with the lack of major perennial streams or major storage projects in this basin, and surface water quality concerns.



## A. Basin Advisory Councils and the Montana Water Supply Initiative (MWSI)

In 2013, under direction from the Montana Legislature, the DNRC launched the Montana Water Supply Initiative (MWSI) to work with citizens and community leaders to transform the current Montana State Water Plan into a dynamic guide to help residents and water managers in the state's major river basins: the Clark Fork and Kootenai, Yellowstone, Upper Missouri, and Lower Missouri. The Legislature directed DNRC to update the State Water Plan (SWP) and submit the results to the 2015 Legislative Session.

The 2009 Montana Legislature passed MCA 85-1-203 state water plan mandating that, "sections of the state water plan must be completed for the Missouri, Yellowstone, and Clark Fork River basins, submitted to the 2015 legislature, and updated at least every 20 years. The state water plan must set out a progressive program for the conservation, development, utilization, and sustainability of the state's water resources and propose the most effective means by which these water resources may be applied for the benefit of the people, with due consideration of alternative uses and combinations of uses." The legislation specifically directed DNRC to appoint a 20-member Basin Advisory Council (BAC) in each of the four major river basins in the state for the purpose of conducting public scoping sessions and developing recommendations for the state water plan.

#### PURPOSES OF THE BASIN ADVISORY COUNCILS The BACs are to:

- Provide input and recommendations to DNRC as required by 85-1-203(3);
- Serve as advisors to DNRC and provide an avenue of communication and discourse between the various interests within the basin;
- Evaluate strategies, studies, and proposed actions for improving the understanding management and conservation of water resources in the basin and,
- Act in an advisory capacity to the DNRC for purposes of the basin planning process.

#### ROLE OF DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION Ground rules were established that specified the roles of the LMBAC and DNRC.

See: http://www.dnrc.mt.gov/wrd/water\_mgmt/state\_water\_plan/bac\_guidelines.pdf. DNRC provided technical information and advice and acted as the project fiscal agent. DNRC contracted with Milton Mediation and Write-On-Point, located in Roundup, Montana for coordination and meeting facilitation during the scoping and recommendation development phases of the project. The contractors produced reports that detail the MWSI water planning process for the LMRB that can be found online at the link above or as appendices to this report.

#### THE LOWER MISSOURI BASIN ADVISORY COUNCIL 2013-2015

The Lower Missouri Basin Advisory Council (LMBAC) consists of 20 representatives assembled from key water interests with the basin: agriculture, conservation, industry, municipal, recreation and tribal. The work of the LMBAC culminating in the recommendations for the SWP was carried out in three phases:

Phase 1 – Public Scoping: LMBAC selection, public scoping, and determination of priority issues;

**Phase 2** – <u>Information Transfer</u>: presentations by practitioners and subject matter experts on topics related to the priority issues;

**Phase 3** – <u>Recommendation Development</u>: draft recommendations, conduct public review process, prepare and publish final recommendation report.



In addition to the specific recommendations contained in Chapter IX of this document, detailed descriptions of the methods and results of the scoping and recommendation development processes are contained in reports available at: http://www.dnrc.mt.gov/mwsi.

# **B.** Major Findings of the Lower Missouri Basin Advisory Council Scoping Process

After a kick-off meeting in Malta on October 2, 2013, 6 public meetings were held across the Lower Missouri River Basin to gather public input on the water resource issues of most concern to the citizens of the basin. 81 members of the public that engaged in the scoping effort identified a wide variety of water related issues. The LMBAC then prioritized these concerns into eleven primary issue areas. In order to develop a realistic scope of work for recommendation development, the LMBAC deliberated and discussed the issue categories and questions from the scoping efforts, built off the public's input, and prioritized issues to address with recommendations in the next phases of the MWSI. The LMBAC selected the following 6 priority issue areas listed below in no particular order. These issues are presented in far greater detail in Lower Missouri River Basin Water Resources Issues Scoping Report (Link -LMRB Issues Scoping Report).

- Surface Water Availability and Quality which includes information required to determine the amount of
  water that is legally and physically available for existing and future uses; options to capture additional spring
  runoff; voluntary conservation programs, or in the case of industrial water use, development of recycling
  technology; addressing aging infrastructure, effects of poor water quality on domestic and agricultural uses;
  and better coordination among the state agencies charged with managing water quantity and quality.
- 2. Groundwater Availability and Quality which includes mapping and characterizing aquifers that might provide opportunities for future uses; increased understanding of recharge rates, quality, and usage of groundwater; better understanding of the interactions between groundwater and surface water; and long-term monitoring of wells to gather information on changes in water quality and groundwater levels in response to climate variability and nearby water use.
- 3. Water Management which includes fair enforcement of water rights decrees; protection of senior water rights; the need for streamflow gages to support the work of water commissioners; and management of water levels in reservoirs in the Lower Missouri basin is critical to recreational uses and to the businesses that depend upon those uses.
- 4. Future Needs which includes recognition that Montana will need more water rather than less in the future; factors, including climate change, that may affect water supply; changes in the timing of spring run-off may impact access to available water necessitating revisions of water management practices; and recognition that water quantity and quality are directly related, and that poor water quality impacts some types of beneficial use.
- 5. **Implementation Strategies** which include reservations about how a state-wide water use plan can be implemented; the need for local watershed organizations to serve as examples of the positive results of communication and collaboration on local water management issues; and the need for the state-wide water use plan to be adaptable and responsive to changing water resource supply and demand.
- 6. Issues Specific to LMRB Sub-Basins In recognition of the great diversity between the 4 primary sub-basins of the Lower Missouri River Basin (Middle Missouri, Milk River, Fort Peck, and Musselshell), the LMBAC convened meetings to identify and address water management issues and challenges specific to these sub-basins. It is important to note that the recommendations specific to each sub-basin were not addressed by the LMBAC as a whole, but were rather developed by subcommittees specific to each sub-basin.



### C. Recommendations of the Lower Missouri Basin Advisory Council

The issues identified above were discussed, refined and re-categorized through a series of face to face meetings and conference calls throughout the fall, winter, and spring of 2013-2014. Phase 2 of the MWSI process entailed presentations from a variety of water resource experts that provided important technical information and background on issues like water policy, water rights, water quality, among others. The LMBAC and DNRC staff worked to develop Issue Statements to describe the main issue areas for which they developed concrete recommendations. The issue statements, specific goals and objectives followed by concrete recommendations are detailed in Section IX of this report. For brevity's sake each issue area, goals, and the final recommendations are set forth below. The full text of this report is available online (Link - LMRB Final Recommendations Report) as well as Appendix A to this document.

During the 18-month long planning process, DNRC worked with each of the four BACs on developing basin specific responses to the subject areas listed above. The results of this effort in the Lower Missouri River Basin along with supporting data are contained in this report. Each of the four basin plans serves as a standalone document for guiding the development and management of the basin's water resources. These basin plans will continue to evolve to meet the planning needs of their respective basins. Although the State Water Plan represents the outgrowth of these regional plans, only the State Water Plan has been formally adopted by DNRC. In the event that guidance in one of the basin plans is at odds with the State Water Plan, the direction offered in the State Water Plan takes precedence. Similarly, the policy recommendations offered in the basin plans represent the collective work of the individual BACs and should not be interpreted as carrying the authority of official state policy.

In areas of Montana, the ability to put water to a beneficial use is limited as much by water quality as physical availability. Water quantity and water quality are closely intertwined and the Montana Water Use Act recognizes this relationship (§85-2-311 MCA). However, this document offers limited guidance regarding water quality issues because DNRC has no authority to regulate water quality and the state water planning statute does not explicitly address water quality. The Department of Environmental Quality has primary authority over the regulation of water quality in Montana. For more information on water quality regulation in Montana, please reference DEQ's Montana Nonpoint Source Management Plan (Link) at

http://www.deq.mt.gov/wqinfo/nonpoint/nonpointsourceprogram.mcpx. Another good source of information is the Clean Water Act Information Center (Link) at http://deq.mt.gov/wqinfo/CWAIC/default.mcpx. These sites provide information, strategies and goals and reports that address water quality issues generally as well as water quality as it is affected by water quantity.

#### WATER USE ADMINISTRATION

#### A. Alignment of Adjudication with Actual Historic Use – Goal:

The support of efforts and processes to address claims of water use, and proposed changes to claimed water rights is essential for the protection of existing, valid water rights. It is also critical for determining how much water is available for future development and beneficial use.

- 1. **Short-Term Recommendation:** The Water Court and DNRC need to do a better job of communicating the adjudication process generally and the process of filing appropriate objections specifically to ensure the most accurate adjudication process possible.
- 2. Long-term Recommendation: Evaluate and develop processes to ensure water rights are accurately and consistently defined across Montana. DNRC and the Water Court should work together to develop a post-adjudication strategy to address issues such as place of use on claims that were verified by a less



demanding process than current examination methods. This effort will ensure a more consistent evaluation of all water right claims across Montana.

3. Short term Recommendation: DNRC needs to educate water users and other appropriate agencies and entities of the importance of the change process. DNRC also needs to provide a better explanation of measures that have streamlined and simplified the current change process.

#### B. Completion of State-Wide Adjudication -- Goal:

Completion of the adjudication process is critical to the ability of water users and water managers to understand, manage, enforce, and defend Montana's water resources.

- 1. **Short-term Recommendation:** Provide the tools (funding and personnel) necessary for the Water Court and DNRC to complete the adjudication process at least to the point of Temporary Preliminary or Preliminary decrees not later than 2020.
- 2. **Medium -term Recommendation:** Support funding and if necessary extension of the Adjudication Program to move Temporary Preliminary to Preliminary decrees to complete an accurate adjudication process by 2024 and Final Decrees by 2027.
- 3. **Short-term Recommendation:** The state and the state's Congressional delegation must continue working to complete all the tribal water compacts still in process.

# STORAGE, DISTRIBUTION, INFRASTRUCTURE MAINTENANCE, AND APPLICATION EFFICIENCIES FOR IRRIGATION WATER

A. Strategy for Updating Infrastructure – Goal:

*Montana's aging water storage and delivery infrastructure* inventory must be updated, and a prioritization process for repair, alteration, or replacement implemented. In addition, more research on the positive and negative consequences of changing methods of water application will help avoid unintended consequences in the future.

- 1. Short Term Recommendation: Support operational funding to develop public/private partnerships to assess local capacity, incentives and financial commitments necessary to support state and federal authorizations that are adequate to complete infrastructure rehabilitation efforts
- 2. Short-term Recommendation: Set up an infrastructure improvement funding program to address problems with water storage and delivery systems, and increase funding caps for currently authorized grants and loans.
- **3.** Short-term Recommendation: Quantify the surface water-ground water impacts from changes in irrigation water distribution, application methods and timing across watersheds to account for wide-ranging precipitation patterns, geology and topography.

#### WATER RESOURCE INVENTORY AND MEASUREMENT

#### A. Streamflow Gages & Water Measurement -- Goal:

Funding for Montana's existing streamflow gage network must be ensured, as well as funding for new gages installed to monitor flows on streams that lack historical data. Selected water quality parameters should also be monitored by many of the gages. As demand for water within and outside the state increase in the future, measurement of water availability and water deliveries to end users will be essential for sound water management.

**Short-term Recommendation:** Maintain the existing stream gage network operated by the USGS for key mainstem and tributary gages via the USGS/DNRC Cooperative Agreement Program.



**Short-term Recommendation:** Institute a telemetered (real-time) stream gage program operated by DNRC/MBMG. Sub-basin watershed organizations should submit recommendations for new streamflow gage installation sites.

**Medium-term Recommendation:** DNRC should develop a program to encourage and incentivize the installation of measuring devices at the point of diversion.

#### B. Surface and Groundwater Research -- Goal:

A good understanding of surface and groundwater resources is necessary to ascertain the status of water resources in Montana. Surface and groundwater research, whether accomplished by federal, state, or contracted private entities, must be funded, starting with the most critical areas first, and eventually the entire state.

1. **Short-term Recommendation:** Adequate funding should be appropriated for research on surface and groundwater quantities in the state.

**Short-term Recommendation:** The Ground Water Steering Committee should re-evaluate project funding criteria for the Ground Water investigation Program to better reflect statewide priorities and directly implement priorities reflected in the State Water Plan.

#### C. Groundwater Aquifers: Quantity, Quality and Groundwater Monitoring -- Goal:

A more comprehensive system of groundwater monitoring for quantity and quality should be adopted by the state.

1. Short-term Recommendation: Support additional funding for groundwater assessments and investigations so that additional aquifers and groundwater/surface connections can be defined and characterized.

**Short-term Recommendation:** Identify and develop public/private partnerships to accomplish the stated objectives.

**Short-term Recommendation:** Change the Ground-Water Assessment Steering Committee prioritization process for groundwater research to divide the funding among all four state river basins. This will balance priorities across rural-urban conflict situations, emerging ground water needs/limitations and quantifying new ground water resources.

**Short-term Recommendation:** Request that DEQ and DNRC work together to educate and encourage local subbasin groups to address water quality and other issues associated with water use or activities that affect water quantity or quality.

**Short-term Recommendation:** Support local, state, and federal efforts and increase funding through existing DNRC grant programs to control flowing wells to better conserve groundwater resources.

**Medium-term Recommendation:** Increase funding levels for the Ground Water Assessment Program (GWAP) and the Ground Water Investigation Program (GWIP) administered through the MT Bureau of Mines and Geology to advance more projects across all four major river basins. Funding needs to address the increased need for information and keep pace with rising research costs.

#### FUTURE DEMANDS ON WATER RESOURCES

#### A. Future Demands -- Goal:

There may be strategies that if adopted would increase the quantity and quality of water available to help meet future resource demands for both consumptive and non-consumptive uses.



1. Short-term Recommendation: Explore the potential for small off-stream storage projects in the Lower Missouri River basin

**Short-term Recommendation:** Various water banking strategies should be explored as a tool to facilitate transfers of water to differing uses.

#### WATERSHED ORGANIZATIONS

#### A. Watershed Organizations -- Goal:

The state should recognize and support autonomous grassroots organizations in watershed basins. These organizations will help local, state and federal agencies, organizations, and citizens work from the same water resource playbook in order to optimize collaborative problem-solving efforts.

**1. Short-term Recommendation:** Support continuation and expansion of the Watershed Capacity Building Program initiated by the 2013 Legislature.

**Short-term Recommendation:** Build on Montana's Watershed Coordination Council's work, to increase the capacity of sub-basin community forums to function collaboratively with agencies to identify, respond, and resolve important water quantity and quality issues within their region.

**Short-term Recommendation:** Utilize the MT Watershed Coordination Council to distribute financial and technical assistance to existing and new watershed groups.

**Short-term Recommendation:** Enhance education opportunities through the state's conservation districts to more broadly address water resource issues by providing additional grant funding opportunities.

**Short-term Recommendation:** Review the roles of resource agencies in data collection, data analysis, data publication, collaboration with other state and federal agencies, and enforcement of laws and regulations. Make necessary changes to clarify roles, responsibilities and effectiveness. Create a user-friendly template to communicate all of the above to those who work with and depend on water.

**Short term recommendation:** Convene water resource agencies, BAC members, and local sub-basin stakeholders for conferences and workshops to assess the merits, purpose and structure for ongoing BACs in all the four regions.

# STATE WATER-USER PROFILE



#### Everyone eventually finds a niche in life. Beverly Terry was born into hers on the banks of the Missouri River.

You can find her by driving miles of gravel road across the tablelands north of Great Falls. The road zigs along section lines, the prairie spreads flat to the sky, except for the dark, distant mountain ranges collecting clouds.

Grain bins glint in the sun. Horned larks flurry out of the way. Space and more space. Miles of quiet. The road finally tips down through gravel layers, down to the floodplain of the Missouri River, the green bottoms, the groves of cottonwood, the high scarps of riverbank.

Her house is perched on the edge of the sliding, whispering current, surrounded by a few trees, with quaint yard decorations, some flowers. It is where she has spent her entire life, and where generations of her family have lived, operating the Virgelle Ferry, since 1960.

Pull your car up to the call box, toggle the switch to sound a horn and ring a pager, and in a few minutes Terry will emerge on a four-wheeler, jounce her way down to the metal ferry deck, and usher you aboard. It's the county road job she's held for more than 20 years, since 1992.



Terry grew up on this spot, some 20 miles downstream of the confluence with the Marias River, where Lewis and Clark spent some time fretting about which fork to take in June of 1805. Her family lived in the homestead shack her parents added a third bedroom onto to accommodate their brood of 10. Her mother operated the ferry while her dad worked odd jobs and

trapped along the river valley. Later, her folks moved another house onto the location, and in 2004, when the new ferry was delivered, Terry got her present home in the bargain.

"I love the quiet," Terry says. "I wake up every morning at 5:30 and lie there, listening to the birds outside, the breeze in the cottonwoods. It is so peaceful."

During the school year, Terry teaches sixth grade on the Rocky Boy reservation, a 37-mile commute each way, but from Easter through hunting season, in November, you'll find Terry running the ferry, answering that timeless need to get across the river.

Drive up the steep metal ramp onto the steel deck, park in front of the fabric netting at the far end, and Terry introduces you to her specialty, the five-minute conversation. She revs the engine and the boat begins its crawl across the wide flow, running off of a pulley hitched to thick cable. The subtle force of the Missouri

# STATE WATER-USER PROFILE

powers past, and for the trip, the river dimension takes over – motion, inertia, that sense of coming from somewhere, going somewhere, an endless gathering. It grabs you, leans against you, makes you imagine.

"I meet people from all over the world," Terry says. She is wearing blue river sandals, matching blue beaded earrings. Red hair falls loosely around her face. Her smile is easy and warm. "My daughters used to say that I could get more information about people in five minutes than most people get in a year. You never know who will drive up."

Terry says she averages about 20 vehicles a day, but has logged as many as 89. "Sometimes I'm out here for hours at a stretch in the hot sun. But then, the other day, no one came all day long. That was a first."

She guesses that roughly a third of the traffic is tourists, another third locals, and the final third service vehicles. "People visiting friends, going to church, fixing pipelines, heading for town, delivering packages, out to see the scenery. I've taken livestock, especially on the old, wooden boat. They get spooked by the metal deck, so I don't get many animals anymore."

The former, wood-decked ferry is parked a half mile up the road, in the town site of Virgelle, population 2. Her current boat was delivered in 2004, fabricated in Plains, Montana, labeled Hull no. 2. The spotlights and ramp motors run off of a solar panel mounted on her house. The engine is a 3-cylinder job that Terry says she "has some suggestions about when it comes time for a rebuild."

"Used to be six ferries running along the Missouri," Terry says, "including one a little ways up the Marias. Now there are three."

Terry remembers the antique Ford car group that rode the ferry, motorcycle tours, all manner of farm vehicles. "Once I had a wedding party from Virgelle and the engine overheated halfway across. Didn't know if those guys were going to make the ceremony," she laughs.

"Spring and high water is the most dangerous time," she says. "When there is a lot of debris or ice in the river, I won't run. I wake up at night hearing trees bump along the bottom, and sometimes they go right under the boat. Once we had a tree snag on the ferry and tip it up. We had to chainsaw it off. It was like an iceberg – way more of that tree below the water than you could see. Sometimes the high water gets up past the pulley tower and I have to shut down."

The ferry slides gently into the gravel on the south side of the channel. The car eases down the ramp. A hand waves out the window. Terry notices a red pickup coming down the road. She waits there, anticipating another conversation. Swallows cut through the air overhead. Sandhill cranes call from a nearby field. ■

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# **II. Introduction**

At the time of this writing, 2014 has been a banner water year for Montana. The Lower Missouri River Basin has been blessed with above average precipitation. This year it's streams and reservoirs are able to provide the water necessary to satisfy both consumptive and non-consumptive uses across the basin. However, Lower Missouri water users are keenly aware of their vulnerability to drought. This is particularly true for irrigated agriculture where many users depend on return flows from upstream flood irrigators to satisfy their rights. Similarly, instream flow advocates remain vigilant knowing that during low-flow periods, non-consumptive uses such as habitat, tourism and hydropower can be adversely affected by consumptive uses operating outside priority dates.

With the potential for increasing demands and supply variability, the time is ripe to put Montana on a course toward a more sustainable water future, a course that provides the water necessary for existing and potential future uses necessary for economic growth. The guiding legal principles are in place: the Montana Constitution with its provisions for a clean and healthful environment, and the Montana Water Use Act with its provisions for allocation according to the prior appropriation doctrine ("first in time is first in right"). However, like so many complex resource stewardship challenges, a wide range of opinion exists about how to achieve the end goal of increasing water availability.

### A. Statutory Authority for Water Planning

Article IX, Section 3 of Montana's Constitution states "All surface, underground, flood, and atmospheric waters within the boundaries of the state are the property of the state for the use of its people and are subject to appropriation for beneficial uses as provided by law". The Constitution also states that "The use of all water that is now or may hereafter be appropriated ....shall be held to be a public use."

The Montana Legislature recognizes that in order to achieve the public policy objectives specified in § 85-1-101 MCA "and to protect the waters of Montana from diversion to other areas of the nation, it is essential that a comprehensive, coordinated multiple-use water resource plan be progressively formulated to be known as the 'state water plan'" (§ 85-1-101(10) MCA).

Responsibility and statutory authority for developing the state water plan is given to DNRC in § 85-1-203 MCA with instructions to "gather from any source reliable information relating to Montana's water resources and prepare from the information a continuing comprehensive inventory of the water resources of the state." As directed by the Legislature in § 85-1-203(2), MCA, "the state water plan must set out a progressive program for the conservation, development, utilization, and sustainability of the state's water resources, and propose the most effective means by which these water resources may be applied for the benefit of the people, with due consideration of alternative uses and combination of uses".

Sections of the state water plan must be completed for the Missouri, Yellowstone, and Clark Fork River Basins, submitted to the 2015 Legislature, and updated at least every 20 years. Montana citizens are given a formal role in the planning process through water user councils established in accordance with the instructions given by the legislature in § 85-1-203(4), MCA. The role of the water user councils is to make recommendations to DNRC on the basin-wide plans.

In developing and revising the state water plan, DNRC is instructed to consult with, and solicit advice from, the Environmental Quality Council. The legislature, by joint resolution, may revise the state water plan.



# B. History of Water Planning in MT

#### STATE-WIDE PLANNING HISTORY

Water is arguably Montana's most valuable natural resource. The rivers, streams, lakes, and groundwater have shaped the stories of our rich history of settlement, agriculture, mining, industry, and recreation, and our quality of life. As the physical and economic needs of the state evolve, planning for the conservation and development of our water resources also evolves.

Initial efforts at water resources planning in Montana centered on the development of irrigated agriculture to promote settlement of the west. Water development projects were seen not just as desirable but as essential to the economic viability of the state. In 1895, the Montana Legislature created the Arid Land Grant Commission to manage the reclamation of lands granted to the State under the federal Carey Land Act of 1894. In 1903, the Commission was abolished and replaced by the Carey Land Act Board. 1903 also saw the U.S. Congress authorize construction of the Milk River Project as one of the first five reclamation projects built by the newly created Reclamation Service (now Bureau of Reclamation) under the Reclamation Act of 1902.

In the 1920s, the Montana Irrigation Commission produced county-by-county plans for irrigation development. In addition, the Commission assisted in organizing and management of irrigation districts around the state. It also had jurisdiction over the sale of water, water rights, and the contracting of water for irrigation. The Commission was abolished in 1929.

The precarious position of agriculture and the livestock industry in Montana during the early 1930s promoted extensive individual and group effort towards seeking ways to put Montana's water resources to beneficial use. Late in 1933, a special session of the state legislature passed House Bill No. 39, creating the State Water Conservation Board. The act creating the Board declared that the public interest, welfare, convenience and necessity required the construction of a system of works for the conservation, development, storage, distribution, and utilization of water. Broad powers were given to the Board, allowing it to cooperate and enter into agreements with all federal and state agencies, and to investigate, survey, construct, operate, maintain, and finance the construction of projects.

Between 1934 and 1960, the Board built 181 water conservation projects. These included 141 dams and reservoirs, 815 miles of canals, 23 miles of domestic water supply pipelines, and 24 miles of transmission lines to bring power to pumping stations. All told, the Board's actions created 438,017 acre-feet of storage and developed 405,582 acres of irrigated land (R. Kingery, personal communication 12 July 2013.). This period also saw congressional approval of all the major federal water projects in Montana. These include Fort Peck, Canyon Ferry, Hungry Horse, Tiber, Yellowtail, and Libby dams.

When Montana began to negotiate the Yellowstone Compact with Wyoming and North Dakota in 1939, the need for cataloging the state's water resources and their use became apparent. As a result, the 1939 Legislature authorized the collection of data pertaining to water use. Between 1942 and 1971, Montana undertook a comprehensive county-by-county assessment of water use. The resulting reports, known collectively as the Montana Water Resources Survey, contain an examination of water rights, water uses, and irrigation development in almost every county in Montana. This information was collected and published from 1943 thru 1965 by the State Engineer's Office and from 1966 through 1971 by the Water Conservation Board. The historical information contained in the surveys is an invaluable tool in today's efforts to adjudicate Montana's water rights.

In 1967, the Montana Legislature recognized the need for a comprehensive state water plan with passage of the Montana Water Resources Act of 1967 (89-101.2 R.C.M. 1947). The act abolished the Water Conservation Board



and transferred its powers and duties to the Water Resources Board. The act stated that the "public policy of the state is to promote the conservation, development, and beneficial use of the state's water resources to secure maximum economic and social prosperity for its citizens." The act also designated the Water Resources Board as the state agency with responsibility to "coordinate the development and use of the water resources of the state as to effect full utilization, conservation, and protection of its water resources." The Board was empowered to prepare a "continuing comprehensive inventory of the water resources of the state", and prepare a "comprehensive, coordinated multiple-use water resources plan known as the 'state water plan'."

The responsibilities given to the Board reflect a change in direction and purpose of water resource planning from "conservation" of water through irrigation to a total concern for full use of our water resources through comprehensive multiple-use planning. In 1971, the Water Resources Board became the Water Resource Division of the Montana Department of Natural Resources and Conservation (DNRC).

Between 1972 and 1981, DNRC conducted a number of reconnaissance-level planning studies in each of Montana's major river basins in conformance with federal principals and guidelines and with federal grant assistance. While these plans produced volumes of valuable technical information, inadequate consideration was given to the institutional and political feasibility of implementing the plan recommendations. Consequently, the plans had little effect on water management decision-making. These plans were also ineffective vehicles for addressing the state's most critical water management problems such as interstate water allocation, quantification of federally reserved water rights, water use efficiency, instream flow protection, and groundwater management. Federal funding to support state water planning ended in 1981.

In 1987, DNRC embarked on a new approach to developing the state water plan. After reviewing the water planning processes of other western states, DNRC adopted an approach similar to that used in Kansas. Under this approach, the state water plan provided a forum for all affected parties, including those without jurisdictional responsibility, to collaboratively work together on resolving water management issues. This new approach included the formation of a State Water Plan Advisory Council and issued-focused Steering Committees. The resulting state water plan focused on the following nine water resource issues:

- 1. Agricultural Water Use Efficiency (1989)
- 2. Instream Flow Protection (1989)
- 3. Federal Hydropower and State Water Rights (1989)
- 4. Water Information System (1989)
- 5. Water Storage (1990)
- 6. Drought Management (1990)
- 7. Integrated Water Quality and Quantity Management (1992)
- 8. Upper Clark Fork Basin Water Management (1994)
- 9. Groundwater (1999)

Between 1999 and 2009, DNRC water planning resources were focused on assisting irrigation districts, conservation districts, and local watershed groups with water supply studies and drought management plans.

In 2009, the Montana Legislature amended the state water planning statute to direct DNRC to update the state water and report to the 2015 Legislature. The 2009 amendments also specify a number of items that the state water plan must address, including:

• Inventory of consumptive and non-consumptive uses associated with exiting water rights.



- An estimate of the amount of groundwater and surface water needed to satisfy new future demands;
- An analysis of the effects of frequent drought and new or increased depletions on the availability of future water supplies.
- Proposals for the best means to satisfy existing water rights and new demands.
- Possible sources of water to meet the needs of the state; and
- Legislation necessary to address water resource concerns in the Yellowstone, Missouri, and Clark Fork Basins.

#### BRIEF HISTORY OF WATER PLANNING IN THE LOWER MISSOURI BASIN

The Reclamation Act of 1902 provided funding for the development of irrigation projects in the 17 arid states that make up the American West. This law marked the earliest effort to plan and implement an approach for managing water and developing the infrastructure critical to the success of the homesteaders that followed in the wake of the Homestead and Desert Land Acts. The Milk River Irrigation Project, authorized in 1903, was one of the first irrigation projects initiated in the United States under authority of the Reclamation Act. The project's objective was to provide a stable source of water for irrigation in the lower Milk River Valley. A bold plan to divert water from the St. Mary's river to augment flows in the Milk River emerged to become the largest and most ambitious trans-basin diversion project of the time.

At 2,320.7, miles the Missouri is America's longest river. It is not surprising, therefore, that the planning effort that continues to shape the river and the basin today started as a result of events far below the headwaters in southwestern Montana. A series of extreme droughts during the 1930s and severe flooding in 1943 that inundated many areas along the Missouri River prompted a surge of interest in water planning for the Missouri River Basin. Planners felt that increased management of the river and its tributaries would not only reduce future flooding, but also benefit the region through increased irrigation, hydropower production, and enhanced navigation.

The Bureau of Reclamation (BOR) and the U.S. Army Corps of Engineers were both called upon by Congress to develop plans to harness the unruly river. BOR's plan, developed by William Sloan, focused upon increasing irrigation for agricultural stability and increasing hydropower for regional economic growth. The Corps of Engineer's plan, spearheaded by Colonel Lewis Pick, concentrated on reducing flooding and increasing navigation in the lower basin.

The two plans were eventually merged into the Missouri River Basin Development Project commonly known as the Pick-Sloan Plan. The combined plan was submitted to Congress and enacted as part of the Flood Control Act of 1944. In appreciation of Colonel Pick and William Sloan's efforts in the development of the plan, the project was officially dedicated as the Pick-Sloan Missouri Basin Program in 1970. The highlight of the plan was to be the construction of 5 large multi-purpose dams along the upper main stem of the Missouri.

Completed in 1940 as part of the New Deal and the Public Works Administrations effort to help restore and develop regional economies left in tatters following the Great Depression, Fort Peck Dam was folded into the larger effort of the Pick-Sloan Plan. Fort Peck Dam is operated by the U. S. Army Corps of Engineers as a multipurpose project, but flood control and navigation in downstream states play primary roles in dam operation.

Montana's role as a headwaters state and its direct relationship to other states and their people that depend on these waters has driven much of the planning effort in Montana. In 1965, Congress passed the Water Resources Planning Act, which provided funding to individual states for water planning activities. The act created river basin commissions to oversee planning for the development and protection of the country's major river basins. Basin planning emphasized close coordination among interested local, state, and federal agencies. These



comprehensive plans were expensive. Preparation of Yellowstone River Basin Plan in the late 1970s cost \$2.4 million. Funding for this basin planning program ended in 1981 prior to completion of a plan for the Missouri River in Montana.

#### WATER RESOURCE SURVEYS

As mentioned above, early water planning activities in Montana and the nation were focused on developing irrigation projects to distribute water across the landscape to support and promote agricultural production. During the 1930-1940s, the state and federal governments spent much of their time and money on designing and implementing water conservation projects. Then, between 1953 and 1972, the Montana Water Conservation Board and the State Engineers office produced and published comprehensive water resource surveys of the irrigation projects in most of the counties in the state. These surveys were developed from courthouse records, individual contacts, state and federal agency data, field surveys and aerial photographs. They summarize settlement and water use, including survey maps, at the time of publication. These important documents are still used for historical reference and provide the basis for understanding water use, which are political subdivisions rather than watersheds, so it is difficult to tease out the specific information related only to the areas that drain to the Lower Missouri Basin. These water resource surveys remain a valuable tool for characterizing and understanding the communities and water distribution systems in the basin.

### C. Methodology for Developing the Lower Missouri Basin Water Plan

#### CONVENING THE LOWER MISSOURI BASIN ADVISORY COUNCIL

To begin the legislatively mandated update of the state water plan, DNRC launched the Montana Water Supply Initiative (MWSI). DNRC determined that public involvement was crucial to acceptance of any plan that might be drafted for submittal by the Montana Legislature. DNRC appointed a 20-member Basin Advisory Council (BAC) in each of the four major river basins in the state for the purpose of conducting public scoping sessions and developing recommendations for the state water plan. Due to its large size and geographic and climactic variability, the Missouri River watershed was split for planning purposes into upper and lower basins. The Upper Missouri Basin planning area was split from the Lower at the confluence of the Marias River. This point was chosen due to the fact that the Missouri River Basin above the Marias River is closed to new appropriations. In the Lower Missouri River Basin, a facilitation contractor was engaged in early July to begin the process of soliciting and selecting BAC members.

Through several weeks of phone calls, emails, and personal contacts, a list of over 100 potential candidates or organizations that might wish to put forth candidate's names, was developed, and letters and emails were sent out requesting applications. At the same time, several press releases were disseminated from both DNRC headquarters for statewide distribution, and by the facilitation team for local distribution. Cooperation from news media was good, and enough applications were received to constitute broad representation on the BAC. Representatives from agriculture, conservation, energy, municipal supply, and tribal interests were chosen for the Lower Missouri BAC. A kick-off meeting of the BAC was held in Malta on October 2, 2013. *Table II-1* shows a list of LMBAC members and the organizations they represent.



Table II-1: Lower Missouri River Basin Advisory Council.

	Name	Organization	County
1	Harlan Baker	Chippewa Cree Tribe	Hill
2	Bill Bergen	Delphia – Melstone Canal	Musselshell
3	Arnold Bighorn	Fort Peck Tribe	Roosevelt
4	David Galt	MT Petroleum Association	State
5	Bob Goffena	Musselshell County	Musselshell
6	Doug Hitch	Judith Basin CD	Judith Basin
7	Jane Holzer	MT Salinity Control Association	State
8	Dick Iverson	Public / Irrigator	Roosevelt
9	Kristi Kline	MT Rural Water	State
10	Rhonda Knudsen	Public / Irrigator	Roosevelt
11	Mike Lawler	Public / Conservation	Fergus
12	Peter Marchi	Musselshell Distribution Project	Meagher
13	Walt McNutt	Richland County Commission	Richland
14	Mike Nieskens	Dry Prairie Rural Water	Valley
15	Jennifer Patrick	Milk River Joint Board	Hill
16	Jim Peterson	Public / Irrigator	Fergus
17	Randy Perez	Fort Belknap Tribes	Blaine
18	Dolores Plumage	Blaine County	Blaine
19	Eric Vanderbeek	Big Spring Creek Watershed	Fergus
20	Dwight Vanetta	Farm Bureau NE Land & Minerals Association	Roosevelt

Attention was also given to the need for technical advice throughout the planning process. At the request of DNRC, ten individuals were named as ex officio members of the Lower Missouri BAC (*Table II-2*). These individuals attend the meetings and provide input, however, in accordance with BAC guidelines referenced above, they are not voting members

(see http://www.dnrc.mt.gov/wrd/water\_mgmt/state\_water\_plan/bac\_guidelines.pdf.)

 Table II-2: Lower Missouri Basin Advisory Council Ex Officio Members.

	Last Name	First	Agency	
1	Brummond	Andy	Montana Department of Fish Wildlife and Parks (Lewistown)	
2	Kruzich	Greg	US Bureau of Reclamation	
3	Frankfurter	Jill	US Geological Survey	
4	Ruggles	Mike	Montana Department of Fish Wildlife and Parks (Billings)	
5	Reiten	John	Montana Bureau of Mines and Geology	
6	Ockey	Mark	Montana Department of Environmental Quality	
7	Irvin	Scott	Montana Department of Natural Resources & Conservation	
8	Probert	Tom	US Bureau of Land Management	
9	Daggett	John	US Army Corp of Engineers	
10	Potts	Richard	US Fish, and Wildlife Service	



#### PHASE 1 MWSI – ISSUES SCOPING

After assembling the advisory council in the fall of 2013, DNRC engaged the BAC in a public outreach exercise to ascertain the issues of most importance to citizens throughout the basin. Six BAC scoping meetings were scheduled, and an advertising campaign successfully generated press coverage of the meeting schedule and purpose by newspapers, regional agriculture publications, watershed newsletters, television stations, and radio stations. Paid display advertisements were also placed in newspapers serving the six areas where meetings were scheduled.

A total of 167 people attended the six scoping meetings, including 81 members of the public (Table II-3). Public participation at Glasgow was sparse, with only one public participant attending. But the BAC, staff, technical advisers, and other agency representatives nevertheless carried on a valuable discussion of issues. The best public participation occurred in Harlowton, largely the result of involvement of a local community leader who assisted in setting up the meeting and encouraging attendance. The success of this method will guide preparations for public meetings during the recommendation hearings phase of the MWSI process.

Location	BAC Members	Staff Members	Technical Advisers	Public	Total Attendance
Lewistown, 10-8-13	7	5	4	14	30
Glasgow, 10-23-13	5	7	4	1	17
Culbertson, 10-24-13	7	4	1	13	25
Roundup, 10-30-13	4	7	1	15	27
Harlowton, 10-31-13	5	6	4	22	37
Havre, 11-7-13	6	7	2	16	31

Table II-3: Lower Missouri River Basin Scoping Meeting Attendance.

Each of the scoping meetings began with introductions around the tables, which were arranged so that participants faced each other. DNRC staff members made brief presentations on the MWSI process and presented current data on water resources in the basin. Given the small size of the gatherings and the wishes of the public participants, the whole group participated in an active discussion format to develop a listing of important water resource issues at each meeting. The facilitator made sure that every person attending had an opportunity to express their personal concerns, and participants rated the meetings successful. Some written testimony was presented by participants, or was submitted later, and that testimony is a part of the record for the scoping meetings. A complete list of issues developed at the six scoping meetings appears in the Final Lower Missouri River Basin Water Resources Issues Scoping Report (link).

#### Lower Missouri River Basin Advisory Council Selected Core Issues

A two-day meeting was scheduled in Lewistown on December 2-3 to allow the BAC time to consider all the issues raised at the scoping sessions, and choose which ones would be considered in the next phases of the MWSI process. A draft of this report was made available to them prior to the meeting; although no prioritization or selection of issues of highest concern was made.

Discussion and debate of all issues of concern to the public participants continued during the remainder of the two-day meeting. Two additional meetings conducted via conference calls allowed BAC members to make final



decisions on issues to be considered in Phases 2 and 3 of the MWSI. The issues ultimately selected by the Lower Missouri River Basin BAC are listed below.

#### Surface Water Availability and Quality

There is widespread concern among participants in the scoping process that, given the current status of the state's water rights adjudication process, water compacts, and water resource research; it is not possible to determine how much water is legally and physically available for existing and future uses. A complete inventory of current consumptive and non-consumptive uses has not yet been compiled by the state. Participants also generally agree that it might be possible to store more water from spring runoff by increasing the capacity of existing reservoirs or by building new small-scale reservoirs.

Negotiation for additional lease water from federal storage projects for use within the state may be an option. Water supply might be increased by adoption of voluntary conservation programs, or in the case of industrial water use, development of recycling technology. Permits allowing the mixing of fresh water with water recycled from other uses might be a way to reduce quantity otherwise lost to consumptive uses. Water is lost for use by its original appropriator as it is delivered to a field by aging infrastructure that could more efficiently serve its purpose if repaired or replaced. Residents who rely on surface water for domestic and agricultural uses are concerned about the poor quality of water flowing in many streams in the Lower Missouri River Basin and the need for better coordination among the state agencies charged with managing water quantity and quality.

#### Groundwater Availability and Quality

Working with limited funding, researchers have mapped and characterized some aquifers in the state that might provide opportunities for future uses. Participants in the MWSI process agree that more study is needed on recharge rates, quality, and usage of groundwater, and that interactions between groundwater and surface water should be more thoroughly explored. The Madison Group Aquifer, the largest known high quality aquifer underlying the central part of the state, is a possible source of additional water, but limited data exist on its age and the effects large drawdowns might have on its discharge to springs (particularly Big Springs and Warm Springs.) People voiced a wish to add new monitoring wells to MBMG's database to gather long-term information on groundwater level response to climate and nearby water use, and on changes in water quality.

#### Water Management

Fair enforcement of water rights decrees is important to Montana's water users. They also want assurances that their senior rights will be protected whenever new water right permits are granted by the state. Streamflow gages are an important tool used by water commissioners to ensure accurate deliveries, as well as to provide data about how much water might be available for storage or distribution, predict floods, and in some cases provide a method for monitoring surface water quality. Long-term funding for operation and maintenance of existing gages is at risk, and if additional gages were installed in critical areas, water management could improve. Management of water levels in reservoirs in the Lower Missouri River Basin is critical to recreational uses and to the businesses that depend upon those uses. Residents are nervous about energy development and the possibility of accidental contamination of aquifers or streams.

#### **Future Needs**

It is difficult if not impossible to forecast the demand for water 20 years into the future. Global and national economics drive the energy industry through its boom and bust periods, towns grow and shrink in response, and the technology used for exploration and production changes rapidly. Water recycling processes are being developed so that industrial water can be re-used. Everyone agrees, however, that the state will need more water rather than less in the future, and various factors, including climate change, may affect water supply. Changes such as the timing of spring runoff may interfere with available water supply for beneficial uses,



necessitating revisions of water management practices. Water management concerns are no longer limited to irrigation, floods, or hydroelectric power, but now encompass sufficient water supplies for municipalities, recreation, industry, wildlife, and instream flows. People recognize that water quantity and quality are directly related, and that poor water quality impacts some types of beneficial use. Healthy river ecology is also an important consideration.

#### **Implementation Strategies**

BAC members and public participants alike expressed reservations about how a statewide water use plan could be implemented. Such a plan based on recommendations made through the MWSI process will of necessity be complex, and there is concern that our state legislators will be pressed to find time to study and understand it. Implementation will require broad-based support from stakeholders to help legislators understand the critical importance of water to our citizens and our economy. There are watershed organizations in the basin that can serve as examples of the positive results of communication and collaboration on local water management issues. When adopted, the statewide water use plan will need to be adaptable and responsive to changing water resource supply and demand.

#### **Issues Specific to LMR Sub-basins**

In the **Musselshell River** basin, the accuracy of the adjudication process has been questioned by some is in question because of the method used by the water court to determine claimed historical place and amount of use. This basin also suffers more from a burgeoning noxious weed crop than some other basins, the result of weed seed dispersal by the catastrophic 2011 flood.

The **Milk River** basin is dependent on the St. Mary's diversion canal for much of its water supply for agricultural and municipal use. There are questions of infrastructure condition, project funding, and tribal water rights that need to be addressed before a rehabilitation project can begin. Water quality and shrinking capacity of water storage reservoirs are also critical concerns.

**Judith River** basin residents are protective of the high-quality water flowing from Big Spring, and are concerned that possible high-volume production wells proposed for tapping the Madison aquifer might jeopardize the quantity or quality of the spring water. More research needs to be conducted on recharge rates and interactions between surface water and the aquifer. The number and location of oil and gas leases in the Judith River basin is a concern because of potential contamination of the Madison Group Aquifer and its recharge areas due to energy development. Irrigators are concerned that Ackley Lake will not provide enough water to meet their needs in the future.

Residents in the **Lower Missouri River** basin downstream of Fort Peck dam are heavily impacted by water releases made by the U.S. Army Corps of Engineers. Water flows can cause river channels to migrate, erosion eats away at productive fields, and the cold water affects the downstream fishery. Because of the almost annual necessity to perform bank stabilization, there may be a need for an expedited permit process for approval of these projects. Energy development in Montana and North Dakota is raising concerns about water quantity and quality in the future.

#### PHASE II - INFORMATION TRANSFER

Members of the Lower Missouri River BAC conducted several conference calls to begin the process of developing goals, objectives, and recommendations. The group met again in Lewistown on February 18, 2014, and at Fort Peck Dam on March 5, to develop recommendations and alternatives that will be forwarded to DNRC for consideration in development of a statewide water resource plan. Due to weather, long distances, and difficult travel routes, the BAC also held a series of conference calls to develop policy alternatives to address prioritized issues. The group also relied on technical advisors and other experts to provide background



information and data on a host of issues. Table II-4 identifies the experts who presented information to the BAC and the topics they covered.

Date	Speaker	Торіс
12/2/2013	Jim Peterson – State Senator	Water In The American West
2/18/2014	Jill Frankforter – U.S. Geological Survey	Water Quality & Energy Development- Historic and Current Issues in Eastern MT
2/18/2014	John Reiten – MT Bureau of Mines & Geology	Status of Groundwater Investigations in Eastern MT
2/18/2014	Tom Richmond- MT Board of Oil & Gas	Historic and Current Energy Production Trends in Montana
3/5/2014	Clayton Jordon – USBR	Reservoir Operations at USBR Projects in MT
3/5/2014	John Daggett – US Army Corps of Engineers	Reservoir Operations at Fort Peck Dam as a Component of Missouri River Management

Table II-4: Speakers and information presented during Phase 2 of the MWSI.

#### 1. Phase III - Recommendation Development

To help the BAC to begin thinking about recommendations, Bill Milton, the facilitator, requested that each BAC member choose one of the issues that emerged from the scoping process and craft a policy recommendation that would address the issue in a statewide context. This exercise generated a series of weekly conference calls among BAC members, DNRC staff, facilitation staff, and technical advisors.

Issue statements underwent several re-organizations along the way, and recommendation language was considered and debated during face-to-face meetings and conference calls. By the third week of April, the BAC was ready to present its work to the public for comment. A *Draft Recommendation Development Report* was developed and distributed online and via email to an extensive list of interested of parties. The public had the opportunity to comment on the report via an online comment form, through written comments, or by attending four public meetings that were held throughout the basin. Attendance at the public meeting was limited (Table II-5), but the conversation was spirited at all of these discussions. The BAC received valuable public input on all of the recommendations presented.

Location	BAC Members	DNRC Staff	Technical Advisers	Guests/ Public	Total Attendance
Harlowton, 4-29-2014	4	5	1	8	18
Lewistown, 4-30-2014	6	5	1	28	40
Havre, 5-6-2014	4	5	0	9	18
Wolf Point, 5-7-2014	4	3	1	3	11

Table II-5: Public Attendance at meetings to hear comment on draft recommendations.



On May 28, 2014, the LMBAC met at the Fort Peck Dam to consider comments gathered through the four public meetings as wells as comments submitted online by 45 individuals. After much discussion the LMBAC adopted 28 individual recommendations in 6 subject areas by unanimous consent. A complete presentation of issue statements, goals, objectives, and final recommendations are detailed in Chapter IX of this report. A complete presentation of the topics considered and changes made through the course of public meetings and final deliberations is available online *(Link - Final Recommendation Development Report)* and as Appendix A to this report.

During the 18-month long planning process, DNRC worked with each of the four BACs on developing basin specific responses to the issues identified in the Phase 1 scoping process. The results of this effort in the Lower Missouri River Basin along with supporting data are contained in this report. Each of the four basin plans serves as a standalone document for guiding the development and management of the basin's water resources. These basin plans will continue to evolve to meet the planning needs of their respective basins.

Although the State Water Plan represents the outgrowth of these regional plans, only the State Water Plan has been formally adopted by DNRC. In the event that guidance in one of the basin plans is at odds with the State Water Plan, the direction offered in the State Water Plan takes precedence. Similarly, the policy recommendations offered in the basin plans represent the collective work of the individual BACs and should not be interpreted as carrying the authority of official state policy.



# III. Basin Profile of Lower Missouri Basin

# A. Demographic, Economic, and Social Setting

#### LAND USE AND OWNERSHIP

The map below provides the breakdown between ownership types in the LMRB. The concentration of federal and state lands is much lower in most of the Lower Missouri than in the Upper Missouri, Clark Fork and Kootenai river basins and is dominated by private and tribal ownership. Distribution of landownership in the LMRB is similar to the Yellowstone basin.

Figure III-1: Land Ownership in the Lower Missouri River Basin.



Lower Missouri Basin Land Ownership

The following demographic data are excerpted from a longer report. The full text of the complete report is included in *Appendix B* – *Socioeconomic Portrait of the Lower Missouri River Basin.* 



### POPULATION

#### **Recent Estimates**

Between the 2010 census and July 1, 2013, the population of the Lower Missouri Basin increased 2.4 percent to 76,209. During the same period, Montana's population increased 2.6 percent to 1,015,165. The Lower Missouri Basin is the only of Montana's four major basins with neither a "Metropolitan" nor a "Micropolitan" Statistical Area. According to the White House Office of Management and Budget (OMB 2013), a "Metropolitan Statistical Area" is considered to have "at least one urbanized area of 50,000 or more population, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting ties." "Micropolitan Statistical Areas" are defined similarly with the exception that the area's core consists of "at least one urban cluster" with a population between 10,000 and 50,000.

Table III-1 lists populations of counties in the Lower Missouri Basin for 2013. Nearly one-fifth of the basin's residents lived in Hill County. More than half of the basin's population resides in the three largest counties: Hill, Fergus, and Roosevelt. The populations of 6 of the basin's 15 counties declined between 2010 and 2013. Between 2010 and 2013, Roosevelt County ranked 90<sup>th</sup> among the fastest growing U.S. counties with populations of at least 10,000 after growing by 6.7 percent to 11,125 during the period. The fastest growing county in the nation was Roosevelt County's neighbor across the North Dakota border, Williams County, which grew by 32.1 percent between 2010 and 2013.

The populations of Montana's seven Indian reservations totaled 66,598 in 2010, with 12,859 reservation residents in the Lower Missouri Basin.

#### Projections

Population trends are challenging to project because they are complex, arising from national, regional, and local dynamics that shape the geography of socioeconomic development and patterns of population change over time. The longer the time horizon and the smaller the region, the more difficult it is to accurately predict population change.

Population projections are provided here to inform deliberations of

water management issues in which population levels are but one factor among many in determining demand for water. The intent is neither to predict nor forecast precise population levels at particular points in time and locations in Montana; rather, the aim is to offer reasonable estimates of magnitudes of population growth that would presumably relate to the supply and demand for water over the course of the planning period.

Two sets of population projections are offered here. One set extrapolates trends seen in the period between the 1990 and the 2010 censuses. These projections are provided at the state, county, basin, and sub-basin levels. The other set relies on projections at the state and county levels developed by the Montana Department of Commerce (MT Commerce) using REMI, a population projection product of Regional Economic Models, Inc. (REMI). Population levels were projected through the 20-year planning period to 2035.

# **Table III-1**: Lower MissouriBasin Counties population for2013.

Blaine	6,604
Daniels	1,791
Fergus	11,501
Garfield	1,290
Golden Valley	859
Hill	16,568
Judith Basin	2,016
McCone	1,709
Musselshell	4,629
Petroleum	506
Phillips	4,179
Roosevelt	11,125
Sheridan	3,668
Valley	7,630
Wheatland	2,134



As shown in Table III-2, extrapolating from the average annual rate of population change between 1990 and 2010 results in a decrease of 8,159 residents in the basin by 2035. In contrast, the MT Commerce model forecasts a population increase of 7,508 through 2035, reflecting assumptions about changes in the basin's age structure, birthrate and survival rates, and migration patterns over the period.

Table III-2: Population Projections – Lower Missouri Basin.

		Average Annual Rate	2035	Change 2010-35
1990-2010	Extrapolation	-0.43%	70,871	-8,159
MT Comme	rce	0.38%	82,070	7,508

The MT Commerce model forecasts a net gain in population in the basin, in contrast to the overall decline that would occur if recent trends continue. (The sum of the county projections does not equal the basin population projected due to compounding effects related to the basin and county projection calculations.)

#### HOUSING

The number of households in the Lower Missouri Basin in 2010 was 29,129, with an average size of 2.4 people (U.S. Census Bureau; 2007-2011 American Community Survey Profile Report). The total number of housing units was 37,629, with 29,129 occupied and 2,555 for seasonal, recreational, or occasional use.

#### INCOME AND EMPLOYMENT

Total personal income (TPI) comprises: net earnings in the forms of wages and salaries, supplemental earnings,

and proprietors' income; transfer payments; and income from dividends, interest, and rent. In 2012, TPI in the Lower Missouri Basin was \$3.1 billion, 8 percent of TPI for Montana of \$39.3 billion.<sup>1</sup> Between 1990 and 2012, TPI in the Lower Missouri Basin increased by 49 percent, compared to an increase for Montana of 80 percent.

Per capita personal income (PCPI) in the Lower Missouri Basin in 2012 was reported to be \$40,528, compared to \$39,126 for Montana. Personal income in 2012 (adjusted to 2013 \$s) for the major basins in Montana **Table III-3:** Total Personal Income for 2012 in the MajorBasins – Adjusted to 2013 Dollars.

	<u>Total</u>	Per Capita
Clark Fork	13.0 billion	35,896
Lower Missouri	3.1 billion	40,528
Upper Missouri	12.8 billion	40,676
Yellowstone	10.4 billion	41,448
Montana	39.3 billion	39,126

is displayed in (Table III-3). With \$13.0 billion, the Clark Fork Basin was the basin with the highest amount of total personal income, but the lowest per capita personal income by a substantial margin. The sparsely populated Lower Missouri had the lowest TPI by a considerable amount, but the basin nearly matched the Upper Missouri's \$40,676 for the highest PCPI among the state's four major basins.

PCPI in the Lower Missouri and the Yellowstone Basins increased at rates greater than the statewide increase with increases of 61 percent and 58 percent, respectively. Between 2007 and 2012, PCPI in the Lower Missouri

<sup>&</sup>lt;sup>1</sup> Figures are from the U.S. Department of Commerce, Bureau of Economic Analysis, Table CA30, adjusted for inflation to 2013 dollars. Estimates are based on administrative records and survey and census data collected by various agencies.



increased by 19 percent while PCPI in the Clark Fork declined by 1 percent. The impacts of the recent recession are evident as are the contributions of strong prices for agricultural commodities and activity in the energy sector.

# Key Economic and Water Use Sectors

#### AGRICULTURE

Irrigation is the dominant commercial consumptive use of the state's water resources, accounting for 96 percent of all surface and ground water withdrawn for any purpose, about 11 million acre-feet. Irrigation water withdrawals include all water consumed by irrigated crops and pasture in addition to water lost in irrigation conveyance and application systems. Montana's irrigated crops include alfalfa, barley, cherries, corn, grass, oats, potatoes, sugar beets, and wheat. Irrigated agriculture is also an important component of the state's economy producing direct economic benefits through increased production and crop value and generating jobs and income for many Montanans.

Agricultural water usage varies across the state and is affected by climate, geology and soils, water storage and conveyance infrastructure, and proximity to water. In the Lower Missouri (downstream of Fort Peck Reservoir) and Yellowstone River (downstream of the Powder River confluence) valleys, irrigated agriculture is generally more robust economically than in other parts of the state. In these areas, agriculture is expanding, with more expansions being planned, in part because water supplies are available for appropriation and suitable land is relatively cheap and available. In the upper parts of these basins and the mountain valleys that lie west of the Continental Divide, however, subdivision and other development has increased land values significantly in the last 20 years and water availability is affected by basin closures and in-stream flow reservations.

Irrigation also has important indirect economic effects. These impacts materialize as irrigation increases the ecosystem's ability to produce some non-crop goods and services and decreases its ability to produce others. These effects, called externalities, have an impact on jobs and income throughout Montana. For example, some irrigation systems increase the supply of recreational opportunities on reservoirs and generate jobs in related economic sectors. At the same time, they may eliminate recreational opportunities and affiliated jobs by dewatering streams and reducing instream water quality.

The externalities of irrigation are economically important throughout the state, although their importance varies from place to place. In many locations, they are more important than the direct increase in crop values resulting from irrigation. Evidence for this conclusion comes from several sources. In many places, the value of irrigated land is determined more by the land's ability to provide attractive scenery and other amenities than by its ability to increase net farm earnings. Several analyses have determined that society's willingness to pay to leave water in some streams and rivers exceeds farmers' willingness to pay to use the water for irrigation. All else equal, counties in the upper Great Plains with greater water-related recreational opportunities, often at irrigation-related reservoirs, typically have higher household incomes than those with lesser opportunities. Throughout Montana and other western states, counties with stronger natural resource amenities, such as water-related recreational opportunities, have higher rates of growth in jobs, higher levels of household income, and higher concentrations of entrepreneurs.

#### INDUSTRIAL, MINERAL AND ENERGY RESOURCES

Mining and petroleum production are important uses of water through-out Montana. These uses of water are more episodic than others; with use closely tied to economic markets and the life of an ore body or petroleum play. Most of the water used for hydro-fracking is used in the lower Missouri and Yellowstone basins. Hydropower is also an important non-consumptive use of water throughout the state.



There are several active and inactive mines in the Upper and Lower Missouri Basins. The malting plant near Great Falls is a relatively new industrial use in the basin. In order to develop, they leased water and used a portion of the City of Great Falls' water reservation. Hydropower is a major industry in the Missouri Basin. There is 1 major hydropower project in the Lower Missouri River Basin at Fort Peck Reservoir.

Industrial water uses in the Lower Missouri River Basin include petroleum production and refining, hydropower generation, coal-fired power generation and non-agricultural food production. Coal, oil, metals, and natural gas are natural resources mined in the Missouri River watershed. Oil and natural gas production occurs throughout the basin and some consumptive use occurs for the hydro fracturing process. All of these uses are relatively small in comparison to water used for irrigated agriculture.

#### MUNICIPAL AND DOMESTIC

This water use category includes domestic water use, whether supplied by an individual on-site well, a major municipality's water supply system, a community system in a subdivision, or non-community systems at schools, restaurants, and other facilities. Municipal suppliers have diverse demands they must fulfill, which makes planning challenging. Water quality plays a role as well. Some municipalities rely on higher-elevation storage, which brings unique challenges (ice damage, forest fire effects, etc.). Municipal water demand figures vary widely, and may include residential, commercial, industrial, universities and government agencies. In-home water use is not generally highly consumptive, but lawn and garden uses are. Several municipalities in the Yellowstone and Missouri Basins have water reservations for future use. Municipalities are being creative in other ways in planning for future water needs, including buying shares from state-owned reservoirs, leasing Bureau of Reclamation contract water, requiring existing water rights be transferred to the city when a city annexes land (both surface water and groundwater rights), and purchasing nearby rights to change to municipal use. DNRC continues to develop policies for rainwater harvesting and wastewater reuse. DNRC is asking that anyone proposing rainwater harvest of more than 0.1 acre feet contact DNRC before moving forward. Regarding wastewater reuse, if the reuse is a new beneficial use of water a water right permit or change may be needed.

#### **RECREATION AND TOURISM**

Recreation and tourism are also major uses of water in the state. Montana residents make frequent use of rivers, streams, natural lakes and reservoirs. Ten million visitors come to Montana each year to hike, fish, ski, bike, hunt, kayak, boat, and explore. When travelling in Montana, visitors indicated that clean waterways and clean air are among the most important attributes to their experience, as well as wildlife viewing opportunities, scenic vistas, open space, viewing the night sky, and access to public lands and waterways. Recreational opportunities are protected by instream flow rights on several Montana rivers, including the lower Missouri River mainstem, the Judith River and Big Spring Creek.

#### **Environmental Concerns**

The Missouri River is 2,341 miles long and drains one-sixth of the United States. It is home to about 10 million people in 10 states and 28 Native American tribes. In Montana, the Missouri River system drains about 56 percent of the state, about 83,000 square miles, running 1,020 miles from its ultimate source to the North Dakota state line. Nationwide, over the course of the past 60 years, one-third of the river has been channelized and another third impounded. These changes have provided important benefits for Missouri River Basin citizens, but have also significantly altered the ecosystem. Today, numerous fish and wildlife species are federally-listed as endangered, threatened or species of special concern (MREAP).



In the typical pre-development Missouri River flow regime, a flood pulse resulted from rain and melting snow runoff, first in March from the Great Plains and then during late June from the Rocky Mountains. Flows declined through the summer and fall, reaching their low point in late December.

Historically, the Missouri River changed course on a regular basis. The channel relocated over 2,000 feet or more a year in some places and deposited huge amounts of silt in other places. It is estimated that 11 billion cubic feet of sediment was carried past St. Charles, Missouri in 1879. That is enough soil to cover a square mile of ground over 200 feet deep. It was largely due to this movement of large amounts of sediment that created the braided channels that threatened bottomland farms and towns affected by the migrating channel. A primary purpose of flood mitigation was to reduce the Missouri's historical meandering.

Native fish and wildlife evolved with this historical flow regime and depend on it to meet their different seasonal habitat and reproductive needs. Today, the spring flood pulse is suppressed by the many dams and reservoirs on the system. Dam releases alter the natural flow regime by providing higher flows from July through November, and eliminating summer and fall low-water periods (MREAP).

As compared to pre-development conditions, few high elevation sandbars form because the high flows necessary to create them have been eliminated. Sandbars that do remain become covered with unwanted vegetation because the scouring flows needed to clear them are unavailable. Similarly, the absence of regular high flows has suppressed the recruitment of several native species, the cottonwood, the Missouri River's signature tree species, is one of the most notable. Native fish spawning cues, formerly triggered by increasing water temperatures combined with rising river stages, have also been lost within many river reaches (MREAP).

Many of the same issues identified above apply to some of the Lower Missouri River's many tributaries. Rivers like the Milk and the Musselshell have suffered similar effects as a result of changes in their flow regimes.

Of the twelve fish species listed in Table III-4, only the Pallid Sturgeon is a federally listed endangered species. The other eleven are identified as species of concern. Among the factors suspected of contributing to its decline: loss of longitudinal connectivity (i.e., high head run of the river impoundments, low head diversion dams) and altered hydrology primarily due to water development.



**Table III-4:** List of fish species of concern in the Missouri River as indicated by the MT Natural Heritage Program.

Common Name	Scientific Name	Status
Pallid Sturgeon	Scaphirhynchus albus	G1, S1, E
Blue Sucker	Cycleptus elongatus	G4, S2, S3
Paddle Fish	Polyodon spathula	G4, S1, S2
Sturgeon Chub	Macrohybopsis gelida	G2, S2
Yellowstone Cutthroat	Oncorhynchus clarki bouvieri	G4, T2, S2
Sauger	Sander canadensis	G5, S2
Pear Dace	Margariscus margarita	G5, S3
Sicklefin Chub	Macrhybopsis meeki	G3, S1
Sturgeon Chub	Macrhybopsis gelida	G3, S2, S3
Shortnose Gar	Lepisosteus platostomus	G5, S1
Northern Red Belly Dace	Chrosomus eos	G5, S3
Iowa Darter	Etheostoma exile	G5, S3

**G1 S1** - At high risk because of **extremely limited** and/or **rapidly declining** population numbers, range and/or habitat, making it highly vulnerable to global extinction or extirpation in the state.

**G2 S2** - At risk because of **very limited** and/or **potentially declining** population numbers, range and/or habitat, making it vulnerable to global extinction or extirpation in the state.

**G2 S3** - Either very rare and local throughout its range, or found locally in a restricted range, or vulnerable to extinction throughout its range.

G4 S4 - Apparently secure, though it may be quite rare in parts of its range, and/or suspected to be declining.

**G5 S5** - Common, widespread, and abundant (although it may be rare in parts of its range). Not vulnerable in most of its range

E - Listed federally endangered.

In addition to species of concern and endangered fish, two bird species stand out - the Least Tern (Endangered) and Piping Plover (Threatened). These shorebirds use the Yellowstone and Missouri Rivers for breeding and nesting habitat. Their preferred habitat is sparsely vegetated sandbars along rivers or lakes and reservoir shorelines. The significant decline of these bird species is directly related to the current operation of water storage systems and the elimination of their habitat. The large reservoirs formed by the six dams on the Missouri River and Yellowtail Dam on the Bighorn River in the Yellowstone have greatly changed the character of these rivers by reducing the higher spring flows necessary for creating sandbar nesting habitat and raising summer flows that would under natural circumstances be low enough to keep tern and plover nests dry during the rearing season. (USFWS, 50 FR, 21784)

# STATE WATER-USER PROFILE



Snapshot of a Paddler's Life WRITTEN BY AL KESSELHEIM, PHOTOS BY THOMAS LEE

The modest home of Jim Greene and Martha Vogt is a shrine to their passion. Wooden Grey Owl paddles propped in room corners. Framed quotes from The Wind In The Willows. A Carl Wimar print of "Indians Crossing the Upper Missouri". Upstairs, jars with dried beaver scat, raptor pellets, turtle shells, a bag of Goldeneye feathers. The banister on the stairway is a beaver-gnawed branch. Clyde Aspevig's "The Passage" hangs on one wall, a landscape perspective along the wild portion of the Missouri River, near Hole in the Rock.

Out in the garage hang four canoes, each meticulously maintained. Wood gunwales, cane seats, paddles resting across the thwarts, boats for flatwater and rapids, solo and tandem, ready for the next trip, redolent with memories of past ones.

Jim and Martha's second date was in a canoe, when Jim took her out to see a heron rookery on the Clark Fork outside of Missoula. "We got in the boat that day and I saw that she knew how to hold a paddle and take a stroke," Greene remembers. "That made an impression."

Martha grew up paddling rivers and lakes in Michigan, but Jim introduced her to whitewater, and their relationship revolved around time in canoes on the Blackfoot, Clark Fork, and Bitterroot Rivers.

"Canoeing is a metaphor for relationships," Greene says. "The teamwork, the communication, knowledge of your partner."

"That teamwork is a beautiful thing," adds Vogt. "When you make a sweet eddy turn together, or come in to shore just right, or work together setting up camp.

"It can go the other way, too. If we're not in a good space together emotionally, it doesn't tend to go well!"

"Whenever life is hard," adds Greene, "we tell each other to 'keep the paddles in the water'."

In 1995, the couple took a long trip through the Wild and Scenic section of the Missouri River together, and fell in love with the landscape. They took along James Willard Schultz's Floating on the Missouri, a classic account of a late fall trip Schultz took with his Indian wife in 1901. Vogt and Greene read sections of the book to each other as they paddled down the same stretches.

"Every time back we see new things," says Greene. "The weather is always different, and we notice things we haven't seen before."

Greene and Vogt work as seasonal BLM campground and river launch hosts along the Missouri, based at

"Whenever life is hard we tell each other to 'keep the paddles in the water.'" Coal Banks Landing or Judith Crossing. They also survey and study the campsites along the river to record camper impacts on the landscape.

"We keep finding reasons to go back," Vogt laughs. "We cover historic sites, too."

—Jim Greene

### STATE WATER-USER PROFILE



"We like to give back to the river because it has given us so much," adds Greene. "When I check someone in at the river launch, I always tell them to take their time. I even discourage them from taking books to read because it distracts from the experience of being there."

For Jim and Martha, part of giving back to the Missouri involves serving on the board of the Friends of the Missouri Breaks National Monument, working with BLM state archaeologist, Zane Fulbright, and taking part in Lewis and Clark activities.

Vogt and Greene cherish the Missouri for its unchanged scenery, and for the sense of all the history that has taken place there.

"Last year we were on Cow Island on September 23rd, the same day the Nez Perce crossed on their flight toward Canada in 1877. I remember we ran aground in some shallows and I thought, that's why they crossed here," says Greene.

"We like to think about Lewis and Clark pulling up the river, fifteen miles a day. They were tougher in those days," says Greene. "What they did was truly incredible."

"I'm actually even more drawn to the Indian sites," says Vogt. "When you find teepee rings it's always a perfect spot, with a breeze to keep the bugs down, the best views to see things coming."

"It makes me think of that Charlie Russell painting about the Indians discovering Lewis and Clark," says Greene. "Russell was really good at providing perspective on the social context as well as the landscape."

When Vogt and Greene climb into the canoe together, Vogt takes the stern and Greene mans the bow. "Most times we've gotten in trouble in the canoe, we've been switched. Now, if things look dicey, we always change back to our preferred positions."

They have paddled together so long, over so many miles, that very little needs to be said. Mile after mile, strokes in synch, the wide sky overhead and the cliffs and coulees beckoning. Along the way they stop and explore, walking up draws, checking out old buildings, noticing birds and wildlife, finding nature's tidbits.

In Schultz's book, his Indian wife talks about the water spirits in the big, swirling eddies. "I always make a point of saying hello to those spirits," says Vogt.

In a framed quote from Kenneth Grahame's The Wind in the Willows next to the front door of their home, Vogt and Greene sum things up.

"The river . . . . What it hasn't got is not worth having, and what it doesn't know is not worth knowing."

All this partnership needs is a canoe to set in the water. ■





# IV. Water Resources in the Lower Missouri River Basin



### A. Physiography and Hydrography

The Lower Missouri River Basin in Montana starts at the confluence of the Missouri and Marias Rivers at Loma at an elevation of 2,575 feet (Figure IV-1). Downstream 20 miles at Virgelle, the river trends southeast and cuts a path through historic territory of the Lewis and Clark Expedition. The river is bounded by prairie bench lands and badlands and flanked by distant small mountain ranges with elevations exceeding 8,000 feet. The river passes the coal bank areas near Virgelle, then meanders through sandstone canyons and hoodoos on its way through the Upper Missouri Breaks National Monument. Arrow Creek and the Judith River add their flow from the Little Belt and Big Snowy Mountains to the south.

Streamside relief increases as the river cuts downstream, and the valley opens up to extensive cottonwood galleries, multiple river channels, and large islands. After passing Fred Robinson Bridge, the river joins the impounded waters of Fort Peck Reservoir. The Musselshell River drains several central Montana mountain ranges, running through 200 miles of prairie and cottonwood bottoms before contributing flow to Fort Peck Reservoir at UL Bend.



Figure IV-1: Physiographic Map of the Lower Missouri River Basin.

## Lower Missouri Basin Physiography



The Milk River originates on the east slopes of Glacier National Park, passing through 200 miles of Canada grassland before reentering Montana north of Havre. The Missouri is joined by the Milk downstream of Fort Peck Dam and continues eastward. Below Wolf Point, the Redwater River, Poplar River and Big Muddy Creek contribute small flows and the Missouri River eventually meets the Yellowstone River just downstream of the North Dakota border.

In Montana, the Lower Missouri River Basin drainage encompasses 49,800 square miles; about one-third of the total land area of the state. There are only a few major tributaries to the main stem, and although they originate in mountainous settings, they generally drain semiarid, relatively low-elevation prairie landscapes. The Missouri River exits Montana at an elevation of 1,870 feet, having dropped 705 feet and travelling 457 miles from Loma to Fort Union.

#### GEOLOGY

Eastern Montana has gently rolling plains made up of large quantities of sediment accumulated in broad valleys and reworked by glacial episodes. At least three times during the Pleistocene Epoch, the northern part of the Missouri plateau has been the terminal area of continental ice sheets (Clayton et al., 1980; Zelt et al., 1999).



The Tertiary and Quaternary valley fill deposits consist of unconsolidated gravel, sand, silt, till and clay and occur adjacent to the larger streams and rivers in the Lower Missouri River Basin (Whitehead, 1996). The origin of the valley fill material includes eolian, fluvial, glacial, alluvial fan, and landslide depositional environments that are deposited above older bedrock. Their high permeability makes them great sources for aquifers, but in some areas their water quality may make them not fit for human or livestock consumption. Some geologic formations have high concentrations of saline minerals, and the interaction of water with the soil from these geologic formations makes many of the shallow aquifers north of the Missouri River not potable.

Gravel-covered benches obscure bedrock in some areas, but elsewhere, deep incision by rivers such as the Milk, Judith, Musselshell, and Missouri Rivers has provided excellent exposures of the bedrock in the stratigraphic section. The bedrock includes sandstone, siltstone, shale, and carbonate rock types of the Cenozoic, Mesozoic, and Paleozoic Eras. The youngest bedrock exposed in the Lower Missouri Basin is the Tongue River Member of the Tertiary Fort Union Formation. The oldest rocks exposed are in the Big Snowy and Little Belt Mountains and are the Mississippian/Paleozoic Madison Group. Bedrock aquifers in the Kootenai Formation, Swift Formation, and Madison Group outcrop in the surrounding mountains, dipping gently beneath the relatively low permeability Colorado Group across the basin.

The Lower Missouri Basin contains numerous faults, crustal folds, arches, and troughs that buckled the rocks underneath the plains. These hydrostructures may exist sub-regionally and locally and consist of geologic folds and fault/fracture zones that play a role in defining the limits of groundwater boundaries in the basin. These features can be either barriers to, or pathways for, groundwater flow. Faults that are barriers have the type of displacement that grinds up rock and creates very low permeability fault gouge along the fault plane, isolating the aquifers on each side. Additionally, faults with significant vertical displacements may offset the interflow zones that host the aquifers on each side of the fault. Significant water level differences have been identified in wells near such hydrostructures in the Lower Missouri Basin. Folds and their associated faults can create linear zones of low permeability that affect the lateral continuity of groundwater flow in aquifers.

Dense metamorphic, igneous, or Paleozoic sedimentary rocks form the cores of the island mountain ranges such as the Sweet Grass Hills, Little Rocky, Bears Paw, Big Snowy, Little Belt, and Judith Mountains. While folded and faulted Mesozoic and Paleozoic sandstone, shale, and limestone outcrop along the margins of these mountain ranges.

#### SUB-BASINS

The Lower Missouri River Basin is divided into four large, distinct sub-basins, each having unique water resource features and issues; Milk River, Musselshell River, Middle Missouri River, and Lower Missouri River (Figure IV-2). The sub-basin divisions are hydrologically and geographically distinctive, and correspond to Hydrologic Unit Code (HUC) boundaries. Table IV-1 lists sub-basin land areas and approximate median outflows. Total outflow from the Middle Missouri River sub-basin includes inputs from the entire Upper Missouri Basin and the Musselshell River, which contributes at the sub-basin mid-point. Outflow from the Lower Missouri River sub-basin represents outflow volume for the entire Missouri River basin in Montana, since it is the furthest downstream gage in the state. At this point, the Missouri River drains approximately 92,000 square miles, including the Upper Missouri Basin and portions of southern Canada.



Figure IV-2: 2015 Montana Water Supply Initiative, Lower Missouri River Basin sub-basins.



Each sub-basin hosts several small or intermittent tributaries to their respective mainstem river. The tributaries are important mainly on a local basis, providing some water to irrigated prairie uplands, but failing to add much additional flow to the river mainstems. Some of these tributaries, such as the Judith River or Frenchman River, are relatively significant and will be detailed within the context of their host sub-basin. However they are not regionally significant and will not be delineated individually (Figure IV-3).

Table IV-1: Sub-basins of the Lower Missouri River Basin.

Sub-basin	Drainage Area (sq. miles)	Approximate Median Annual Sub-basin Outflow (AF)
Milk River	22,322	474,300
Middle Missouri River	14,080	6,732,000
Musselshell River	7,846	198,500
Lower Missouri River	10,800	7,326,000


Figure IV-3: Flow accumulation in the Lower Missouri River Basin.

### Lower Missouri Basin Average Annual Flow Accumulation



### **B. Surface Water Resources of the Lower Missouri River Basin**

### CLIMATE

There are no "mild" climatic zones within the Lower Missouri River Basin. The climate ranges from very cold and moist at the higher elevations of the western basin to arid, cold desert status in parts of the lower elevations to the east (Kottek, M., J. Grieser, C. Beck, B. Rudolf, and F. Rubel, 2006). The climate of the lower basin, which is mainly a steppe landform, is generally classified as Continental as it is located entirely east of the Continental Divide. However, zones in and around the higher elevations represent a Highlands climate regime, which is partially characterized by heavy seasonal snowpack. Temperature and precipitation vary greatly by season and elevation throughout the Lower Missouri River Basin.

Climate in the study area is influenced by the interplay of air masses originating in the northern Pacific Ocean, the Gulf of Mexico, and Arctic regions (Missouri Basin Inter-Agency Committee, 1969). Winter climate is largely dominated by frigid Arctic air masses, although the winter is also known for periodic westerly, relatively warm "Chinook" winds originating from the northern Pacific coast. The greatest 24-hour temperature change attributed to Chinook winds occurred at Loma at the upper extent of the basin. The warm winds raised the temperature from -54°F to 48°F (Horvitz, et al., 2002).

Spring and summer seasons are influenced by the interaction of air masses from these three regions, which bring the most moisture during these seasons (WRCC, Climate of Montana).



### PRECIPITATION

The majority of the Lower Missouri Basin is arid or semiarid, receiving only 11 to 13 inches of precipitation annually (Figure IV-4). At an elevation of 2,570 feet above mean sea level, Loma receives 12.6 inches of precipitation, and downstream 350 miles, Wolf Point receives the same amount. Further downstream near the Montana–North Dakota state line, Culbertson receives slightly more, 13.4 inches, at an elevation of 1,920 feet.

With few exceptions, average annual precipitation at valley bottom sites in the lower basin is remarkably similar. In the Milk River sub-basin, the cities of Havre and Glasgow are separated by 150 miles and about 400 feet elevation difference. Havre receives 12.7 inches and Glasgow receives 12.2 inches of precipitation annually. Malta, located midway between these two cities, receives 12.6 inches. In the Musselshell sub-basin, Mosby receives 12.2 inches and Roundup 12.4 inches. Harlowton, which is 140 miles upstream from Mosby and is 1,800 feet higher, receives 13.1 inches.

Portions of the Milk River and Middle Missouri River sub-basins are especially arid. Areas around Jordan, Glasgow, Malta, and to the northwest of Havre receive less than 11 inches annually (WRCC, 2013).

Figure IV-4: Lower Missouri River Basin Average Annual Precipitation.



Lower Missouri Basin Mean Annual Precipitation

Mountains comprise a relatively small portion of the basin total land area, but are important because of the water their winter snowpack contributes during the springtime snowmelt. High-elevation snow water accumulates over a seven-month period in Montana, and the National Resource Conservation Service (NRCS) Snowpack Telemetry (SNOTEL) sites measure precipitation and snow water accumulation in mountain ranges throughout the state (Figure IV-5). There are very few SNOTEL sites in the lower basin.



Figure IV-5: NRCS SNOTEL network in the Lower Missouri River Basin.

# Lower Missouri Basin SNOTEL Network



The Bears Paw, Big and Little Snowy, Little Belt, and northern Crazy Mountains and the Sweet Grass Hills all contribute valuable snowmelt water to their respective sub-basins and to the overall water budget of the Lower Missouri Basin. Runoff from the mountains is especially important to local water sources and stream management, since many of the smaller tributaries drop to extremely low flow levels or temporarily dry completely during the summer season.

Areas in and around the mountain ranges receive greater precipitation than the surrounding lower elevation prairie benches and valley bottoms. At 2,490 feet, Havre receives 12.7 inches of precipitation. In the same vicinity, Rocky Boy Agency at 3,700 feet on the edge of the Bears Paw Mountains receives 17.7 inches. The Rocky Boy SNOTEL site, located another 1,000 feet higher, receives almost 27 inches (Figure IV-6). Not only does elevation increase the total amount of precipitation and snow, but it alters the timing of greatest water supply, which occurs when the snowpack melts in the spring months.



Figure IV-6: Precipitation Comparison in the Upper Milk River sub-basin.



At 4,130 feet, Lewistown averages 17.7 inches of precipitation annually; a relatively large amount in the Lower Missouri Basin. Lewistown is located at the end of a large valley bounded on the east and south by mountains causing orographic lift and increased precipitation. Just south of Lewistown at an elevation of 6,050 feet in the Big Snowy Mountains, the Crystal Lake SNOTEL site receives 38.2 inches; more than double that of Lewistown. Figure IV-7 compares monthly precipitation amounts at these two sites.



Figure IV-7: Comparison of Precipitation at Lewistown and Crystal Lake.



Lewistown receives the bulk of its precipitation during the spring and summer months. Almost half of the annual total falls during the three months of May, June, and July. The period April through September receives 72 percent—almost three-quarters—of the annual total. Located in the valley bottom, Lewistown receives much less precipitation during the winter months. December, January, and February account for only 12 percent of the annual total. The Crystal Lake SNOTEL site also receives the bulk of its precipitation during the summer months. Sixty percent of the annual total falls during the six-month window from April through September. However, winter accumulations are also significant at this higher elevation site. All winter months receive more than two inches of precipitation at this higher elevation.

### TEMPERATURE

Air temperatures in the Lower Missouri Basin are highly variable, but are generally frigid in the winter and hot in the summer. January is typically the coldest month and July is the warmest. The historic record high temperature in Montana is 117°F at Medicine Lake, in the extreme northeast corner of the state. Winter low temperatures within the basin have been recorded as low as -54°F at Poplar, -51°F at Glasgow and Opheim, and -46°F at Lewistown (WRCC).

Figure IV-8 illustrates Mean Annual Air Temperatures in the Lower Missouri Basin. The higher elevations within the western mountains have the lowest mean annual temperatures, less than 37°F. However, the lowest instantaneous temperatures may be found at the lower elevation plains or valley bottom town sites, where cold winter air sometimes stagnates. The average annual temperature of the basin is 43°F, which is slightly warmer than that of the Upper Missouri River Basin, resulting partially from the overall lower elevations of the Lower Missouri Basin.





Basin wide, the 1981-2010 normal annual minimum air temperature is about 29°F, and the annual maximum temperature is 57°F. In general, the most northern parts of the basin have colder temperatures than the southern parts of the basin, in areas of similar elevation.

Lewistown, Havre, Glasgow, and Culbertson all have similar mean annual temperatures, which range from 43°F to 44°F, although mean monthly temperatures vary from town to town. In the Musselshell sub-basin, Roundup is much warmer in the winter months and slightly warmer in the summer months. Consequently, Roundup has a mean annual temperature of 48.5°F, almost 5 degrees warmer than the High-Line towns (WRCC). Figure IV-9 shows a comparison of monthly mean temperatures for Glasgow, located in the Milk River sub-basin, and Roundup, located in the Musselshell sub-basin.



**Figure IV-9:** Comparison of Mean Monthly Temperature at Glasgow and Roundup, in degrees Fahrenheit.

### STREAMFLOW

Most of the Lower Missouri River Basin main-stem flow comes as melted snow water from the mountainous Upper Missouri River Basin. Near the upstream extent of the lower basin at Virgelle, average annual main-stem flow is 8,510 cubic feet per second (cfs). Downstream near the Montana-North Dakota state line at Culbertson, the average annual flow is 10,110 cfs. Therefore, the Lower Missouri River Basin contributes only 16 percent of the total Missouri River flow. The additional water comes from the few major tributaries, such as the Judith, Musselshell, and Milk Rivers, with some water imported from the Saint Mary River via trans-basin diversion. Table IV-2 lists important gages and flow volumes within the Lower Missouri Basin. Figure IV-10 shows locations of U.S. Geological Survey (USGS) Stream Gaging stations with the Lower Missouri River Basin.



Table IV-2: Selected USGS gaging stations in the Lower Missouri River Basin.

Stream and Gage Location	USGS Site Number	Average Annual Flow (cfs)	Average Annual Volume (AF)	Drainage Area (square miles)
Missouri River at Virgelle	06109500	8,510	6,160,000	34,379
Judith River near Winifred	06114700	292	211,600	2,731
Musselshell River at Mosby	06130500	274	198,500	7,846
Milk River at Nashua	06174500	655	474,300	22,322
Missouri River below Fort Peck Dam	06132000	9,293	6,732,000	57,556
Redwater River near Vida	06177500	11	8,030	547
Poplar River near Poplar	06181000	117	85,110	3,174
Big Muddy Creek near Culbertson	06185110	22	16,130	2,684
Missouri River near Culbertson	06185500	10,110	7,326,000	91,557

Figure IV-10: USGS Stream Gage locations within the Lower Missouri River Basin.

### Lower Missouri Basin USGS Gage Locations





### MILK RIVER SUB-BASIN

The Milk River originates in upland hills and plateaus of the Blackfeet Indian Reservation with a small headwaters piece in Glacier National Park at 9,000 feet. The river flows northeasterly across the Blackfoot Indian Reservation prairie and then 216 river miles through the southern portion of the Canadian province of Alberta before reentering Montana. The Milk River sub-basin occupies 15,500 square miles in Montana, most of which is prairie grassland. Fresno Dam stores Milk River water near Havre, and the river continues east to eventually join the Missouri River below Fort Peck Dam.

Figure IV-11: Milk River Sub-Basin



### Milk River Sub-Basin

The St. Mary River also begins high in Glacier National Park. The Saint Mary Siphon, a trans-basin project constructed between 1907 and 1925, sends additional water into the Milk River Basin for use in Montana. This project is administered by the Boundary Waters Treaty of 1909, which allocates water between Canada and the United States (International Joint Commission).

### **Surface Water**

North of Browning, Montana, the Milk River main stem is formed at the confluence of the South and Middle Forks of the Milk River. The USGS operates 15 stream gaging stations in the Milk River sub-basin, although several of these are operated only during the irrigation season (Table IV-3).

Site Name	USGS Site Number	Mean Annual Streamflow (AF)	Mean Annual Streamflow (cfs)	Period of Record	Drainage Area (sq. miles)
Milk River at Eastern Crossing	06135000	245,600	339	1917 - 2013	2,525
Big Sandy Creek near Havre	06139500	18,320	25.3	1946 - 2013	1,805
Milk River at Havre	06140500	279,300	386	1898 - 2013	5,785
Milk River near Saco	06164510	278,500	384	1977 - 2013	17,670
Milk River at Nashua	06174500	474,300	655	1940 - 2013	22,332



The Milk River sub-basin generally lacks high-elevation, mountainous, snow-accumulating areas. Due to this predominant prairie topography and a lack of high elevation snowpack to bolster spring and summer stream flows, the Milk River water supply is naturally very inconsistent from year to year. The Milk River and most of its tributaries are generally more dependent on rain than snow. Milk River water is stored in a succession of reservoirs, which helps to build a more dependable supply. Water imported from the St. Mary River (about 178,500 acre-feet annually) also enhances supply (USBR, DNRC, 2012).



### Tributaries

The few major tributaries to the Milk River are small, but they are very important to the sub-basin uplands and to the river main stem. Like the Milk River itself, these are prairie streams, exhibiting a high degree of variability in flow characteristics. They typically originate at low elevations, lacking the snowpack-dominated character of mountain streams, and provide an inconsistent annual water supply.

Big Sandy Creek originates in the Bears Paw Mountains and runs north to contribute an average of 25 cfs during the irrigation season (April through October). Battle Creek and the Frenchman River begin in the Cypress Hills region of the Canadian province of Saskatchewan. Battle Creek joins the Milk River near Chinook, Montana, contributing an average of 63 cfs. The Frenchman River is larger, averaging 100 cfs at the Canada border, ultimately reaching the Milk River near Saco, Montana. South of Saco, Beaver Creek originates in the Little Rocky Mountains, flows north, and adds an average of 158 cfs. Rock Creek adds 22 cfs near Hinsdale, Montana.

### **Streamflow Variability**

The Milk River sub-basin water supply is largely dependent on rain instead of snow. As a result, the supply is highly variable, both monthly and annually.

Figure IV-12 shows daily discharge of the Milk River at the 10-, 50-, and 90-percentile levels, at Nashua. These flow levels correspond to the highest year in 10, the median year, and the lowest year in 10, respectively. This gage is located near the mouth of Milk River and measures the flow remaining after all upstream uses of Milk River water have been satisfied.



Figure IV-12: Normal Range of Flow for the Milk River at Nashua, MT.

Figure IV-12 illustrates the vast range of Milk River flows. The highest year in 10 (90<sup>th</sup> percentile flow) approaches 9,000 cfs, while the lowest year in 10 (10<sup>th</sup> percentile flow) is barely visible at the bottom of the



graph, peaking in late March at 118 cfs. The high flows are related to extreme precipitation events, such as the spring rains during 2011.

The Milk River also exhibits large variability in annual yield. Figure IV-13 shows the annual yield of the river at Nashua. In 1984, the annual yield was only 37,000 acre-feet, but in 2011 the annual yield was 2.5 million acre-feet. Flow volume during 2011 was 68 times greater than it was in 1984. The median years experienced annual yields of 300,000 acre-feet to 400,000 acre-feet.

The period 2000 through 2009 appears to be the longest nearly continuous period of low water conditions for the Milk River. Through this period of gaged record, there are several years of below-median flow volume, as indicated by the orange and red columns. However, the drought periods shown here are not as continuous as in other locations, owing to the highly variable nature of a prairie water supply environment, and partially attributable to the greater importance of rain as opposed to snow.



Figure IV-13: Milk River at Nashua, Annual Total Runoff by Year.

### MUSSELSHELL RIVER SUB-BASIN

The Musselshell River originates at elevations approaching 10,000 feet in the Little Belt and Crazy Mountains. The main stem is formed by the confluence of the north and south forks near Martinsdale. The river first runs east through the small towns of Harlowton and Roundup, then swings north near Mosby, eventually emptying into Fort Peck Reservoir after 340 miles.



Figure IV-14: Musselshell River Sub-Basin





Much of this 9,600 square mile sub-basin is prairie grassland, although the upper sub-basin is defined by mountain ranges and upland hills. There are two somewhat distinct areas of the Musselshell sub-basin: the mountainous, snow-dominated upper sub-basin, and the prairie, rain-dominated, lower sub-basin. Stream gradient is vastly different in these two parts of the Musselshell sub-basin, with the upper reaches being much steeper, typical of their mountainous setting. The lower reaches exhibit extensive meandering typical of prairie streams with a lower gradient. The upper sub-basin also receives much more precipitation than the lower sub-basin, mainly due to the higher elevations, which accumulate a significant winter snowpack.

The entire river benefits greatly from the seasonal snowpack of the Castle, Crazy, Little Belt, and Snowy Mountains, and hydrographs at various stations throughout the length of the river reflect both a classic snowmelt-influenced supply peak, and a rapid decrease and low supply of a prairie stream. Streamflows are typically very high in May and June, peaking during the annual snowmelt, then taper off rapidly through the summer months. Musselshell River water is stored in a succession of reservoirs having a total storage capacity of about 165,000 acre-feet.



### **Surface Water**

The USGS currently operates seven stream gaging stations in the Musselshell River sub-basin, although three of these are operated only during the irrigation season. Table IV-4 summarizes the mean annual streamflow, period of record, and drainage area for the year-round gages. In this sub-basin, as in the entire Lower Missouri Basin, water yield per square mile greatly decreases as drainage area increases downstream away from the higher elevation mountain regions.

Site Name	USGS Site Number	Mean Annual Streamflow (AF)	Mean Annual Streamflow (cfs)	Period of Record	Drainage Area (sq. miles)
Musselshell River at Harlowton	06120500	112,989	156	1907 - 2013	1,125
Musselshell River near Roundup	06126500	145,582	201	1946 - 2013	4,023
Musselshell River at Musselshell	06127500	155,800	215	1928 - 2013	4,568
Musselshell River at Mosby	06130500	198,500	274	1929 - 2013	7,846

Table IV-4: Summary of Continuous USGS Stream Gages in the Musselshell sub-Basin.

### Tributaries

The Musselshell River sub-basin includes several small but important tributaries. Many of these streams run intermittently, and only a few add significant flow after partially satisfying upland water uses. The upper watershed receives some input from Haymaker, Hopley, and Lebo Creeks. Near Harlowton, American Fork adds an average of 44 cfs to the Musselshell River main stem during the May-through-October irrigation season.

The river transitions to more of a prairie stream character in the area between Ryegate and Roundup, losing gradient and increasing in sinuosity. There are very limited tributary inflows through this mid-section of the watershed. Streams such as Big Coulee and Willow Creek run intermittently and typically dry up completely during the summer.

Relatively far downstream in the sub-basin near Mosby, Box Elder Creek adds an average 30 cfs to Flatwillow Creek during the irrigation season. Flatwillow Creek, perhaps the most important tributary to the main stem and especially the lower part of the Musselshell sub-basin, contributes 130 cfs to the Musselshell River.

Musselshell River streamflows exhibit large seasonal fluctuations. Spring snowmelt peak flows can be greater than 50 times the mean annual streamflow. Figure IV-15 shows Musselshell River daily discharge at Mosby. The lowest year in 10 is barely visible at the bottom of the graph, as flows are actually non-existent during much of the year. The highest year in 10 shows a high range of flows that result from generous snow melt or rain events. There is an extreme difference in flows between the median year and the highest year in 10. The high flows were easily exceeded during the record flood events in 2011, which mainly resulted from heavy spring rains.



**Musselshell River at Harlowton Normal Range of Flow** 1,600 □ Highest Year in 10 1,400 □ Middle Year Lowest Year in 10 1,200 1,000 Discharge, cfs 800 600 400 200 0 1-Jan 1-Feb 1-Mar 1-Apr 1-May 1-Jun 1-Jul 1-Aug 1-Sep 1-Oct 1-Nov 1-Dec

Figure IV-15: Musselshell River at Mosby: 10-, 50-, 90-Percentile Daily Streamflows.

Musselshell River flows can be erratic during any given year and between years. For the gaged period of record, 1934 through 2012, the annual average flow is 156 cfs. In 2011, the annual average flow exceeded the period of record average by 1,715 cfs. But the following year, 2012, the river was short of the long-term average by 116 cfs. Figure IV-16 illustrates this range of variability of total annual runoff for the Musselshell River at Mosby, sequentially by year.







2011 was an extremely wet year in the sub-basin, and many records were set on the Musselshell River in terms of peak flow, annual yield, and high-flow duration. The 2011 flood peak at Roundup was estimated at over 25,000 cfs, flooding much of the town and far exceeding the 100-year return period event. Annual runoff in 2002 was a meager 6,000 acre-feet. Eight years later, in 2010, yield was slightly above the median at 202,000 acre-feet, and in 2011 the total yield was over 1.4 million acre-feet. In August of 2014, heavy rains produced a huge peak flow of about 20,000 cfs for the Musselshell River at Mosby.

The 1997 snowpack is generally regarded as the highest on record in western Montana. While the 1997 runoff in the Musselshell River was in the upper 10 percent of annual yields measured, the mostly rain-induced 2011 runoff was three times as large. In general, the late 1970s were the highest-yielding years for the Musselshell River at Mosby (blue columns), and the early 2000s were the lowest (red columns). 2009 is the median runoff year (green column), when 138,000 acre-feet passed the gage location.

### MIDDLE MISSOURI RIVER SUB-BASIN

The Middle Missouri River sub-basin includes the Missouri River downstream of the Marias River confluence, and a few major tributaries such as the Judith River, Arrow Creek, and Bullwhacker Creek. Several island mountain ranges delineate the upper reaches of this 14,100-square-mile area, including the Bears Paw, Little Rocky, Judith, and Moccasin Mountains. Fort Peck Dam impounds a reservoir that is the dominant feature of the sub-basin. This U.S. Army Corps of Engineers (USACE) project stores nearly 19 million acre-feet of Missouri River water in the 134-mile long, 245,000-surface-acre reservoir.



Figure IV-17: Middle Missouri River Sub-Basin

# Middle Missouri River Sub-Basin



Data Source: Montana Department of Natural Resources and Conservation, 2014

### **Surface Water**

The Missouri River enters this sub-basin near Virgelle and is soon joined by Arrow Creek and the Judith River. These are the two largest tributaries to the river main stem in this sub-basin. The Judith River is especially important as it adds 292 cfs of water and is much larger than Arrow Creek. Further downstream, the Musselshell River flows into the impounded water of Fort Peck Reservoir, adding another 190 cfs to the system. Table IV-5 provides details of the four continuous USGS stream gages in the Middle Missouri River sub-basin.

Site Name	USGS Site Number	Mean Annual Streamflow (AF)	Mean Annual Streamflow (cfs)	Period of Record	Drainage Area (sq. miles)
Judith River near Winifred	06114700	211,600	292	2000 - 2013	2,731
Missouri River near Landusky	06115200	6,505,000	8,979	1934 - 2013	40,987
Big Dry Creek near Van Norman	06131000	34,710	47.9	1939 - 2013	2,554
Nelson Creek near Van Norman	06131200	1,170	1.61	1975 - 2013	100

Table IV-5: USGS gages of the Middle Missouri River sub-basin.

Missouri River flows entering the Middle Missouri River sub-basin are somewhat less variable than those of its tributaries, the extremes being moderated by substantial storage facilities upstream, including Canyon Ferry, Hauser, and Holter Reservoirs. Figure IV-18 shows the normal range of flow for the Missouri near Landusky. Median daily flows are nearly double the 10<sup>th</sup> percentile flows, and 90<sup>th</sup> percentile flows are approximately double the median flows.





Figure IV-18: Normal Range of Flow for the Missouri River near Landusky.

Figure IV-19 shows annual yield of the river near Landusky, located just upstream of Fort Peck Reservoir near the middle of the Middle Missouri River sub-basin.

For the 1935-2011 period of record, the lowest yield was 3 million acre-feet in 1937 (red columns), and the greatest yield was almost 12 million acre-feet, in 1975 (blue columns). 1963 is the median runoff year (green column), with 6 million acre-feet passing the gage location. It is notable that the highest annual yield at this location was not produced by the widespread 2011 rain-influenced floods.







### LOWER MISSOURI RIVER SUB-BASIN

The 10,800-square-mile area below Fort Peck Dam is known as the Lower Missouri River subbasin. The Milk River immediately joins the Missouri River from the north and the river heads east. This is a prairie landscape, with the farthest northeast portions of the subbasin dotted with numerous pothole lakes and wetlands. There are only a few relatively major prairie tributaries, such as the Poplar River and Big Muddy Creek. Just downstream from the Montana-North Dakota state line, the Yellowstone River contributes substantial flow.





Medicine Lake National Wildlife Refuge is located in the northeast portion of the sub-basin. The refuge includes a large lake of the same name, which holds 67,000 acre-feet of water. Aside from the refuge and several small natural lakes, there are only small reservoirs in this vast sub-basin.

The Fort Peck Indian Reservation is located almost entirely within the Lower Missouri River sub-basin. The reservation has a population of 10,000 people over a land area of 3,290 square miles, comprising about one-third of the area of the Lower Missouri River sub-basin.

### Figure IV-20: Lower Missouri River Sub-Basin



### Lower Missouri River Sub-Basin

Data Source: Montana Department of Natural Resources and Conservation, 2014



# Surface Water Runoff

Although prairie tributary flows into the Missouri River are highly variable, flows of the Missouri River itself are relatively stable, because the river is regulated upstream by Fort Peck Dam. Annual water supply in the main stem is heavily influenced by snowpack conditions in the Upper Missouri River Basin, spring rainfall events in the Lower Missouri River Basin, and by the operations of the several large reservoirs in both the upper and lower basins. Figure IV-21 shows the normal range of flows for the Missouri River at Culbertson, downstream of Fort Peck Dam, near the Montana-North Dakota state line.



Figure IV-21: Normal Range of Flow for the Missouri River at Culbertson, MT.

The March and April peaks shown in Figure IV-21 result from reservoir operations in response to extreme precipitation or snowmelt events that sometimes impact the Lower Missouri Basin. The relative stability of flows through the entire year is also apparent. This is typical of a heavily regulated river system.

Similarly, the total annual volume yield of the Missouri River near Culbertson is not as variable as it would be on an undammed, unregulated system. Figure IV-22 shows the total annual runoff by year from 1942 through 2012. Not considering 2011, the variability of total annual yield was from about 4 million acre-feet in 1942 (red columns), to about 12.6 million acre-feet in 1975 (blue columns). The yield in 1975 is about three times the total yield during 1942. 1963 is the median runoff year (green column), with 6.5 million acre-feet passing the gage location.

Heavy precipitation combined with snowmelt during 2011 produced record flows in the Missouri River at some locations. Peak flow for 2011 is estimated at 94,000 cfs for the USGS gage near Wolf Point and 104,000 cfs for the USGS gage near Culbertson. Both peaks far exceeded the 100-year event benchmark.





Figure IV-22: Total annual runoff by year, Missouri River near Culbertson, MT.

During the gaged period of record, the Missouri River near Culbertson has experienced at least three extended drought periods. The early 1960s, late 1980s through early 1990s, and the period of 2000 through 2010 produced relatively low runoff at this gage site.

### OPPORTUNITIES FOR RESEARCH AND INVESTMENT

While the Milk, Musselshell and Missouri River main stems appear to be adequately gaged through a partnership agreement between the USGS and DNRC, flows of most tributary streams are not measured. Local water management efforts would benefit from additional gaging on tributaries such as the Judith, Frenchman, and Poplar Rivers, in addition to a large number of smaller tributary streams in the Lower Missouri Basin.

The amount of water diverted from streams is also not well known. Therefore, not much is known about water consumption within the basin. Measurement of water diverted from surface and ground sources would greatly enhance understanding of the resources, assist in local water management, and help to document changes in water use and consumption trends through time. Measurement of water use can help protect existing water uses from future uses that might infringe on senior water uses.

### **Groundwater Resources in the Lower Missouri River Basin**

The groundwater inventory for the Lower Missouri River Basin includes discussions of source aquifers and estimates of groundwater contribution to baseflow and storage for the Missouri River from the Marias River to Fort Peck Reservoir Dam (including Judith River watershed), Fort Peck Reservoir Dam to the North Dakota state border, Milk River, and Musselshell River sub-basins (Figure IV-2, Surface Water). Information and description of aquifers is based on review of reports published by the Montana Bureau of Mines and Geology (MBMG) and the



USGS, master's theses, and reports prepared by consultants for water right applications. Wells and springs yield water from aquifers in shallow alluvium, deeper semi-consolidated to consolidated basin-fill sediments, and bedrock.

### SHALLOW ALLUVIUM AND GLACIAL OUTWASH AQUIFERS

Alluvial aquifers comprised of river alluvium, terrace deposits, dune sand, and glacial outwash deposits that occur along floodplains of all the major streams and adjacent terraces are major sources of water for irrigation, municipal, industrial, household, and livestock purposes (Figure IV-23). Shallow alluvial aquifers are generally less than 150 feet thick and therefore, are accessible by shallow wells at relatively low expense. Terrace deposits are older floodplain or alluvial deposits that have been left behind after a stream shifts position. These sediments are unconsolidated or poorly consolidated and consist of sand, gravel, silt, and clay.

Figure IV-23: Lower Missouri Basin Shallow Aquifers.

# <figure><figure><figure>

# Lower Missouri Basin Surficial Aquifers

There are extensive alluvial terrace deposits throughout the Judith River watershed on benches extending from the Little Belt, Big Snowy, Judith, and North and South Moccasin Mountains. The gravels form a permeable layer that is commonly water bearing. Most of the small towns and farms located on terrace gravels obtain water from wells completed in the base of the gravel deposit.



The alluvial aquifers of the Musselshell River sub-basin are composed of approximately 20 feet of unconsolidated gravel, sand, and clay. The Musselshell River sub-basin has alluvial terrace deposits benches extending from the Little Belt, Big Snowy, Castle, Bull, and Crazy Mountains. This alluvium is predominately underlain by Cretaceous sedimentary units that have been eroded and faulted.

The alluvial and terrace aquifers of the Milk River sub-basin are composed of generally less than 60 feet of unconsolidated, discontinuous lenses of fine-grained sand, silt, sandy clay, and clay. The older alluvium is composed of deposits of the ancestral Missouri River (Lawlor, 2000). The Milk River sub-basin has alluvial deposits benches extending from the Continental Divide, Bears Paw Mountains, Sweet Grass Hills, and Little Rocky Mountains. Glacial deposits range in thickness from 20 to 100 feet of mostly till, but they can consist of unconsolidated gravel, sand, silt, and clay (Alverson, 1965).

Gravels of the Flaxville Formation are 40 to 100 feet thick and have been one of the more productive aquifers in parts of northeastern Montana, particularly in the Turner-Hogeland area. Well yields up to 1,200 gallons per minute (gpm) have been reported from the Flaxville gravels. Flaxville gravels has high permeability and generally contains shallow aquifer systems (<50 ft. deep); therefore, aquifers in the Flaxville gravels are susceptible to impacts from the application of agricultural chemicals (Nimick and Thamke, 1998). These aquifers are usually perched on shale of the Tongue River Member of the Fort Union Formation (Cannon, 1987).

In the Lower Missouri River Basin, there are numerous pre-glacial Missouri River channels that are overlain by glacial deposits, with the Clear Lake Aquifer being the most studied. The Clear Lake Aquifer is a complex aquifer system composed of sand and gravel deposited by the ancestral Missouri River and by later glacial meltwater streams. The permeable units are separated by fine-grained leaky confining sediments of variable thickness and leakage potential. In addition, not all sites within the boundaries are capable of producing adequate volumes for irrigation and other large demands. Figure IV-24 shows the seasonal recharge and trends in precipitation and runoff that are typical of shallow aquifer systems. Another trend in shallow wells is increasing water levels during irrigation season from irrigation or canal leakage. The green and red bars on the following groundwater hydrographs represent departures from the mean of the annual precipitation at the closest weather station.



Figure IV-24: Water level in a well (GWIC # 3773) completed in the Clear Lake Aquifer near Dagmar, Montana.



Recharge to the shallow aquifer systems is primarily derived from seepage from streams and rivers, stored during periods of higher stream flow and discharged back to the stream or river during low flows. Other recharge sources include infiltration of precipitation, irrigation water lost by percolation through fields, and leakage from ditches. Places where water discharges include springs and seeps along the valley bottom of the Missouri River and its tributaries.

### SANDSTONE AQUIFERS

The bedrock aquifers host rock type includes sandstone, siltstone, shale, and carbonate rock types of the Cenozoic, Mesozoic, and Paleozoic Eras (Figure IV-25). The most commonly used sources of groundwater in the Lower Missouri Basin are found in sandstone aquifers. Sandstone of the Tongue River Member of the Tertiary Fort Union Formation is the shallowest and the most utilized sandstone source of groundwater (MBMG, 1978; Slagle, 1983). The Tullock Member of the Fort Union Formation is semi-productive in the Lower Missouri Basin. Figure IV-26 shows the groundwater level response to trends in precipitation, but depending on depth of the aquifer and other factors (i.e., distance from the recharge source and areas where the aquifer is connected to surface water), the shape of the hydrograph varies throughout the Lower Missouri Basin.



Figure IV-25: Lower Missouri Basin Bedrock Aquifers.

Lower Missouri Basin Bedrock Aquifers





Figure IV-26: Water level in a well (GWIC # 4297) completed in the Fort Union aquifer near Scobey, Montana.



Another important sandstone aquifer is the lower portion of the Cretaceous Hell Creek Formation and the entire Cretaceous Fox Hills Formation. This is a regional aquifer and occurs at depths from 600 feet to 1,600 feet below land surface throughout most of the Lower Missouri Basin (Smith et. al., 2000). Flowing Fox Hills–lower Hell Creek aquifer wells are usually found in the valley bottoms of large streams and have potentiometric surfaces that are 50 to 100 feet above the land surface. Figure IV-27 shows a stable trend during average precipitation years, but an increase in groundwater levels occurred during 2010 and 2011 due to above average precipitation. These stable trends exist in other monitoring wells in areas where the Fox Hills crops out at land surface and near Fort Peck Reservoir. However, long-term monitoring wells closer to the Yellowstone River Basin show a decline of 1 to 3 feet a year (Reiten, 2013).



**Figure IV-27.** Water level in a well (GWIC # 221274) completed in the Fox Hills–lower Hell Creek aquifer near Vida, MT.



Sandstone aquifers in the Judith River Formation and Two Medicine Formation are greater than 700 feet thick at the western margin of the Great Plains Flowing Judith River aquifer wells are common along the Missouri River and Milk River valleys (Perry, 1931; Osterkamp, 1968). This aquifer has highly mineralized water where the Judith River Formation dips into the subsurface and is overlain by the Bearpaw Shale, which is up to 800 feet thick (Madison et al., 2014).

In central Montana, the Eagle Formation outcrops at Bull Mountains, Cat Creek anticline, Judith Mountains, Little Rocky, and Bears Paw Mountains. Flowing Eagle aquifer wells are common at these outcrop locations (Osterkamp, 1968; Reiten and Hanson, 2008). Where the Eagle Formation dips into the subsurface and is overlain by the Claggett Shale, the aquifer contains highly mineralized water that is not suitable for most uses. Both the Eagle and Judith River aquifers are a source of domestic and stock water, with well yields generally less than 50 gpm.

Sandstone aquifers in the Kootenai Formation and Swift Formation outcrop in the surrounding mountains, dipping gently beneath the relatively low permeability of the Colorado Shale across the Lower Missouri Basin. The Kootenai Aquifer is 330 to 400 feet thick and one of the most productive and widespread aquifers in the Judith River watershed where it generally flows at the surface and produces moderate volumes of water (Lindsey, 1982; Levings, 1983). Swift Formation sandstone thickness ranges from 40 to 150 feet in western Montana, to less than 50 feet in eastern Montana. Well yields can be as great as 50 gpm for the Swift Formation when thicknesses exceed 100 feet.



Recharge to sandstone aquifers is primarily derived from seepage from the streams, infiltration of precipitation, snowmelt in topographically high outcrop areas, and leakage through confining units. Other recharge sources include irrigation water lost by percolation through fields and leakage from ditches. On a regional scale, potentiometric surface mapping shows that groundwater in the bedrock often is in hydraulic communication with alluvial aquifers. Shallow aquifers discharge at springs and seeps along the valley bottom and in the active channel of rivers. Groundwater from the Fox Hills–lower Hell Creek aquifer and other sandstone aquifers discharge in topographically lower areas by upward leakage to shallower aquifers and streams (Smith et. al., 2000).

## LIMESTONE AQUIFERS

The Madison Group Aquifer is productive where geologically young karst and/or fracturing permeability associated with mountain uplifts are encountered. However, productivity is low where karst processes are absent outside recharge areas or in areas where the Madison Group limestone is largely structurally undeformed (Huntoon, 1993). The Little Belt and Big Snowy Mountains are the recharge area for the Madison Group Aquifer, and the aquifer discharges along fractures through overlying strata to the Missouri River. The Madison Group Aquifer is the source for Big Spring on the north flank of the Big Snowy Mountains south of Lewistown, Warm Spring between North Moccasin and South Moccasin Mountains north of Lewistown, and a flowing well near Hanover north of Lewistown. MBMG monitors three wells in the Madison Group Aquifer (GWIC # 257040; GWIC # 269262; GWIC # 275370). Figure IV-28 shows the groundwater level response to seasonal trends and recharge. Notice the large seasonal changes in water level related to the magnitude of recharge.



**Figure IV-28:** Water level in a well (*GWIC # 257040*) completed in the Madison Group aquifer near Utica, MT.



### BASE FLOW CONTRIBUTION

The contribution of groundwater to surface water base flow (Figure IV-29) is derived from Base Flow Index (BFI) information from Wolock (2003A). BFI values, representing the ratio of base flow to total annual flow, are estimated by the USGS by automated hydrograph separation and are available for many historic gage sites across the United States (Wolock, 2003B). Where no gage exists, or for sites that are influenced by reservoir effects, BFIs can be estimated from another USGS product, an interpolated grid of BFI values (Wolock, 2003C). To estimate the contribution of base flow in Montana, one gaged site was used to determine a representative BFI for each 8 Digit/4th Code HUC sub-basin. If a BFI specific to that site was estimated by USGS and that location was determined to be free of reservoir effects, then the BFI specific to that gage site was selected. Otherwise, the interpolated grid product was used to estimate a representative BFI. BFI values in Wolock (2003A) are based on surface water base flow estimates and, therefore, rely on assumptions that groundwater does not leave a basin through regional groundwater flow. BFI values are highest in the head waters of the Milk River, Judith River, and the Musselshell River.

Figure IV-29: Generalized map of base flow index.



Lower Missouri Basin Base Flow Index by 8 Digit Hydrologic Unit

# GROUNDWATER STORAGE

The groundwater storage capacity (Figure IV-30) of the upper 50 feet saturated thickness of alluvial and Tertiary basin fill aquifers is estimated from the areal extent of aquifers and their storage capacities. The areal extent of alluvium, alluvial terraces, and Tertiary basin-fill sediments with the primary rock type identified as coarse



grained is obtained from a digital geologic map available from the USGS (2005). Aquifer storage is assigned a uniform specific yield value of 0.20.

The value of 50 feet for saturated thickness used in calculations is representative of the typical thickness of coarse-grained unconfined portions of aquifers and the thickness that accounts for the majority of groundwater circulation. Although an alluvial aquifer may store a considerable quantity of water, pumping cannot remove groundwater in aquifer storage without reducing discharge or inducing recharge, often to the detriment of surface water flows and rights of surface water users. Removal of even small amounts of groundwater resulting in much less than 50 feet of drawdown will deplete flows and impact existing users, thereby limiting new appropriations of groundwater. Figure IV30 shows the variability of alluvial aquifer storage throughout the Lower Missouri River Basin.

**Figure IV-30:** Groundwater storage (acre-feet per acre) estimates in the upper 50 feet saturated thickness of alluvium/basin-fill aquifer.



Lower Missouri Basin Groundwater Storage by 8 Digit Hydrologic Unit



### **OPPORTUNITIES FOR RESEARCH AND INVESTMENT**

The following groundwater data gaps and areas of uncertainty were found.

- Groundwater/surface water interaction studies are needed in the Lower Missouri Basin to examine how groundwater production affects surface water flows in the Milk, Musselshell, Judith, and Lower Missouri Rivers.
- More information (baseline data of water levels and quality, additional long-term monitoring wells, and increased model accuracy) is needed for the development of deep groundwater sources for irrigation purposes and to understand the implications of such development on deep aquifers.
- Madison Group Aquifer studies collecting baseline data for groundwater model development near Big Springs/Judith River watershed and other localities in the Lower Missouri Basin.
- Ancestral Missouri River channels aquifer studies collecting baseline data for groundwater model development for the Lower Missouri Basin.
- Completing the groundwater model for the Fox Hills–Hell Creek aquifer for the entire areal extent of the aquifer in the state of Montana.
- Examine the correlation of the number of new Fox Hills–Hell Creek wells and their use to the groundwater declines estimated in the aforementioned model.
- Additional studies are needed to evaluate the changes in groundwater systems due to conversion from flood to center pivot irrigation.
- Examination of exempt wells effect on surface water and other groundwater users.

Addressing these data gaps will provide a wealth of knowledge that will be of great use to scientists, water users, and anybody responsible for water policy decisions.

### **Sources of Information**

Information on the distribution and properties of aquifers is based on review of reports published by the MBMG and the USGS, master's theses, reports prepared by consultants for water right applications, and other documents included in the references. Maps and reports published by MBMG under the Ground-Water Characterization Program (GWCP) summarize available information and present maps and cross-sections of aquifers, and maps and hydrographs of groundwater levels and water quality. Groundwater level and water quality data are housed in the Groundwater Information Center (GWIC) database developed and managed by MBMG or the National Water Information System (NWIS) housed with USGS.

The Groundwater Investigations Program (GWIP), also administered by MBMG, is a potential source of hydrogeologic information at the scale of a few square miles Current projects are ongoing in the Clear Lake aquifer in Sheridan county within the Lower Missouri Basin. Additional prospective GWIP projects can be proposed and are ranked for consideration by the Groundwater Assessment Steering Committee.



# V. Water Use in the Lower Missouri River Basin



### HISTORIC WATER USE

The earliest non-Indian settlers in the Montana territory were fur traders, prospectors, and those wishing to escape service in the Civil War. Irrigation began almost as soon settlers arrived in the area. Early irrigation was practiced beginning in 1841 at the St. Mary's Mission in the Bitterroot Valley. Farmers in the Missoula Valley began irrigating their lands in 1864, and along the Flathead River in western Montana, irrigation systems were constructed as early as 1885.

During the last 30 years of the 19th century, mining and smelting were the primary industries in much of Montana, with farming and ranching acting in a secondary economic role. But by the turn of the century, the silver boom had tapered off, and agriculture replaced mining as the region's primary industry. As agriculture increased in economic importance, irrigation became increasingly important to Montana.

The Milk River Valley in north-central Montana was one of the last areas in the West to be settled. During the 1880s, several small private irrigation systems had been constructed, diverting water directly from the Milk River. In the mid-1890s, several farmers joined together and constructed a small diversion dam to provide additional water to their system. Other dams soon followed, and before long, upwards of a dozen small dams where spread out along the river. While their systems functioned sufficiently during periods of high river flows, the inconsistent nature of the supply threatened the stability of the area. Unless a way could be found to ensure



a stable and reliable water supply, the future of the region would be in question. Establishment of the Reclamation Service in 1902 was the first step to providing a secure future for farmers of the Milk River Valley.

The initial plans for the Milk River Project were prepared by the Reclamation Service and submitted for approval by the Secretary of the Interior on July 8, 1902, only a few weeks following the formation of the Reclamation Service. This submission relied on information developed during ongoing work within the USGS. The initial approval authorized the allotment of funds for additional surveys and administrative costs. On March 14, 1903, the Secretary of Interior authorized construction of Reclamation's first five projects, including the Milk River Project. On March 25, 1905, \$1 million was allocated for construction of storage works on the St. Mary River and facilities to divert water from the St. Mary River to the head of the Milk River. This authorization was limited by the condition that, prior to the start of construction, a suitable agreement between the United States and Canada would have to be negotiated that would allow the stored waters of the St. Mary River to be transported through Canadian territory without interference.

By early 1906, even though the governments of the United States and Canada had been unable to reach an agreement, the Reclamation Service was authorized to draw up specifications and advertise for bids to construct the St. Mary Canal from the St. Mary River to the Milk River. It was believed that construction of the canal would help to solidify the United States' claims to the waters of the St. Mary River and, that if no agreement could be reached, the canal could be used to irrigate some 100,000 acres in the eastern part of the Blackfeet Indian Reservation and surrounding areas.

### WATER USE AND WATER CONSUMPTION

The term "water use" may mistakenly imply water consumption. However, water use and water consumption are not the same. Many beneficial water uses do not actually consume water or divert water from their source. For example, Figure V-1 shows that Fort Peck Dam used over four million acre-feet of water to generate hydropower, but consumed no water through that beneficial use. Irrigation uses or withdraws over 2 million acre feet annually, but only a small percentage of that is actually consumed.

**Annual Acre Feet** 3,621,500 (35%) **FWP** Instream Flow 4,072,000 (39.4%) Hydro Power 2,011,500 Generation (19.5%) Irrigation Diversion 26,500 (0.3%) Municipal 611,400 (6%) Industrial Reservoir Stock & Evaporation Domestic Diversion

Figure V-1: Water use in the Lower Missouri River Basin.

Lower Missouri River Basin Water Use



Figure V-2 shows consumptive totals for water uses in the basin. Storing water in reservoirs is a beneficial use that consumes water through evaporation. Irrigation consumes slightly less than one-quarter of the water volume it diverts. All other quantified uses in the basin total less than 2 percent of the total volume consumed, but they are no less important.

Figure V-2: Water consumption in the Lower Missouri River Basin.



### **Consumptive Water Use**

### **OVERVIEW**

DNRC first published summaries of water use by county and HUC in 1986. Since then the USGS published water use estimates in the document, Estimated Water Use in Montana (USGS, 2000. Scientific Investigations Report 2004-5223). Most recently, consumptive use of Montana water was calculated by DNRC for this report. An explanation of the methods used for this effort can be found in Appendix C – *MWSI Consumptive Use\_Methodology*. Figure V-3 shows water withdrawals by HUC in the Lower Missouri Basin. Greatest water withdrawal and consumption occur in the Musselshell River and Milk River sub-basins.



Figure V-3: Surface water withdrawal in the Lower Missouri River Basin.

Lower Missouri Basin Surface Water Withdrawal



About 2 million acre-feet of surface water and groundwater combined is diverted annually in the Lower Missouri Basin for irrigation, livestock watering, industrial, municipal, and domestic use (Figure V-4). The largest consumptive use is irrigation, which accounts for almost 99 percent of all water diverted in the Basin.



Figure V-4: Water diverted annually in the Lower Missouri River Basin.



Only a fraction of the diverted volume is actually consumed: about 474,000 acre-feet, which is about 23 percent of the originally diverted volume. Irrigation accounts for 96 percent of the total consumption of diverted water in the Basin (Figure V-5). Stock watering is the second largest consumptive use in the basin, amounting to 3 percent (15,000 acre-feet) of water consumed annually. Water consumed by municipal and domestic supply constitutes a very small amount in the basin, less than one percent of total diverted water.



Figure V-5: Water consumed annually in the Lower Missouri River Basin.


Most of the diverted water eventually returns to surface water sources or percolates deeper into groundwater aquifers. Some of the diverted irrigation water is consumed by plants through evapotranspiration, and some of the diverted water that is not consumed by plants is evaporated into the atmosphere during water application.

Following irrigation, livestock watering is the second largest use of water in the Lower Missouri Basin, although it accounts for a relatively small amount of the total. Most livestock water is diverted to tanks or ponds where it is retained for cattle to drink. The water that isn't actually consumed by livestock evaporates to the atmosphere, is consumed by surrounding plants, or returns to surface or groundwater sources.

Most water used for municipal or domestic purposes flows back through waste-water systems and may return to the original source or another downstream surface source or aquifer after treatment. There is currently very little water consumption by industrial uses in the Lower Missouri Basin.

Reservoir evaporation is another consumptive component of water budgets. Although evaporation is not a "diverted" water use, it is still a significant factor and loss in the water budget of the Lower Missouri Basin, and is one cost of storing water in reservoirs and ponds.

#### **Basin Water Budgets**

The following diagrams illustrate generalized annual water budgets for major sub-basins in the Lower Missouri Basin, as well as for water use in the basin as a whole. The water budgets are based on the flow during a median supply year: half of all years are wetter, and the other half of years are drier.

Figure V-6 displays the water budget for the entire Lower Missouri River Basin. This includes water use in all subbasins, which is the total land area contributing water flow downstream of the Marias River confluence, including the Milk and Musselshell River sub-basins. More than 75 percent of the Missouri River flow is not diverted, remaining in the river as it leaves the state.



Figure V-6: Lower Missouri Basin Annual Water Budget.

## Lower Missouri River Basin Generalized Median Annual Water Budget 8,410,461 Acre Feet Total



Not including reservoir evaporation, water consumed by beneficial uses within the Lower Missouri Basin is only about 5 percent of the total basin water budget. Only 23 percent of the amount diverted is actually consumed, leaving 77 percent of the diverted water to return to surface or groundwater sources. Fort Peck Reservoir evaporation is much greater than the amount of water consumed by all other beneficial uses in the Lower Missouri Basin, totaling over 611,000 acre-feet, or about 7 percent of the overall water budget.

For basins where irrigation is heavily developed and there are sizable water storage projects, such as the Musselshell River and the Milk River sub-basins, almost all of the water that is produced by the basin is captured or diverted more than once. This would especially be the case during dry years. Other streams, such as the Missouri River, have relatively less irrigation and the reservoirs are operated mainly for non-consumptive purposes, such as flood control or hydropower generation. Most flow in these basins is not diverted.

At the other end, some streams supplying significant irrigation development may have little or no storage capacity to capture high, early spring flows for release later in the irrigation season. Most of the water in these basins is therefore neither stored nor diverted since the bulk of the runoff does not correspond with intensive irrigation demands. The Judith River and Beaver Creek are examples of such streams, both watersheds having very limited water storage capabilities relative to water use demands.

#### MIDDLE MISSOURI RIVER SUB-BASIN

With the exception of reservoir evaporation, very little water is diverted and consumed in the Middle Missouri River sub-basin through beneficial use (Figure V-7). Only 75,000 acre-feet, or 1 percent of the sub-basin's total water budget is consumed. More than 90 percent of the water is not diverted and remains instream. Of the diverted amount, only 21 percent is consumed by beneficial uses and the remainder returns to the system.



Evaporation from Fort Peck Reservoir is a significant factor in the sub-basin and, at almost 8 percent of the total water budget, far outweighs other consumptive uses.

Figure V-7: Middle Missouri River Sub-Basin Annual Water Budget.



# Middle Missouri River Sub-Basin Generalized Median Annual Water Budget 7,381,675 Acre Feet Total

#### JUDITH RIVER WATERSHED

The Judith River watershed is located at the upstream end of the Middle Missouri River sub-basin and drains the north slope of the Little Belt Mountains, the Moccasin and Judith Mountains, and north slopes of the Big Snowy Mountains. Big Spring Creek runs through Lewistown. The Judith River is one of the few major tributaries to the Missouri River main stem in the Lower Missouri Basin.

The Judith River water budget (Figure V-8) shows that 28 percent of the water remains instream during the median water supply year. Reservoir storage is very limited in this watershed, and high springtime flows are therefore not retained by dams. High spring flows generally occur before the time of heavy irrigation demand, leaving a sizeable portion of the total water supply in the river.

With limited storage, reservoir evaporation amounts to a very small portion of the total Judith River water budget, about 350 acre-feet. In this 2,758-square-mile watershed, slightly more than 21 percent of all water diverted is actually consumed, with the remaining 79 percent returning to the system.



Figure V-8: Judith River Annual Water Budget.



#### MUSSELSHELL RIVER SUB-BASIN

The Musselshell River sub-basin is typically short of water due partly to the prairie nature of the system and the large amount of agricultural development in this sub-basin. Portions of the headwaters are mountainous and receive substantial snowpack, but this is mainly a prairie environment. It is estimated that there is a shortage of 110,000 acre-feet during the median water supply year (USBR, DNRC, 1998).

Figure V-9 shows more water "diverted and not consumed" than exists in the entire Musselshell River water supply. A substantial amount of the Musselshell sub-basin water is diverted more than once during the median (or lower than median) water year. Water is diverted for irrigation, a small portion is actually consumed, and the rest is returned to the stream. Farther downstream the water is again diverted for further use, and the pattern repeats. This may happen several times in sub-basins such as the Musselshell River and Milk River. Reservoir evaporation is a relatively small part of the overall Musselshell River water budget, although there is substantial storage in the sub-basin.



Figure V-9: Musselshell River Sub-Basin Annual Water Budget.



#### MILK RIVER SUB-BASIN

The Milk River sub-basin is also short of water during the median water year. Except for the extreme upper parts of the sub-basin and some isolated island mountain ranges, this is entirely a prairie environment that naturally lacks a dependable snowpack for water supply. Figure V-10 shows that about 24 percent of diverted water is consumed. As in the Musselshell River sub-basin, water in the Milk River sub-basin is diverted more than once during most years.

A substantial portion of water in the Milk River sub-basin is imported from the St. Mary River watershed, through a trans-basin diversion canal. This water amounts to approximately 178,000 acre-feet annually and is extremely important to the overall system. It has been estimated that the Milk River would dry up completely in 6 years out of 10 without this imported water (USBR, DNRC, 2012). Even so, there is an estimated shortage of 70,000 acre-feet annually in the Milk River sub-basin (Milk River International Alliance, USBR, 1999).

Reservoir evaporative loss amounts to almost 22,000 acre-feet per year, but constitutes a relatively small percentage of the total water budget. The majority of the evaporation occurs at Fresno and Nelson Reservoirs.



Figure V-10: Milk River sub-basin Annual Water Budget.



#### LOWER MISSOURI RIVER SUB-BASIN

Located at the downstream end of the Lower Missouri Basin in Montana, main-stem water supply in this subbasin represents the combined flows of the Milk, Musselshell, and Middle Missouri River sub-basins. Missouri River flow at Culbertson is water leaving Montana to North Dakota and other downstream states. There are a few locally important tributaries in the sub-basin, such as the Poplar River and Big Muddy Creek.

The vast majority of Missouri River flow remains instream through this sub-basin. Water that is not diverted accounts for 97 percent of the annual water budget (Figure V-11), which is about 7.4 million acre-feet during the median water supply year. Slightly more than 3 percent of the total water supply is diverted, and of that, about 30 percent is actually consumed, with the remainder returning to the system.

Storage facilities are very limited in the sub-basin, consisting mainly of small stock or irrigation ponds. There are a number of naturally occurring shallow lakes, typical of the prairie pothole environment. Medicine Lake, Homestead Lake, and Clear Lake are all examples of this type of water body. The lakes provide important habitat for waterfowl and wildlife, but are not used for irrigation purposes. Reservoir evaporation amounts to less than 1 percent of the total water budget in this sub-basin.



Figure V-11: Lower Missouri River Sub-Basin Annual Water Budget.



#### IRRIGATION

The majority of cropland in the Lower Missouri Basin is not irrigated (Figure V-12), and the vast majority of irrigated parcels receive water from surface sources, which supply 97 percent of irrigation water. Groundwater sources supply only about three percent of all irrigation water in the Lower Missouri Basin. But groundwater can be important locally, especially with the lack of major perennial streams or major storage projects in this basin, and surface water quality concerns.

Irrigated acreage is listed by sub-basin in Table V-1, and for the Lower Missouri Basin as a whole. Also shown are the volume of water diverted, the volume of water consumed, and the percent of diverted water that is consumed. For the basin as a whole, 23 percent of water diverted for irrigation is actually consumed. The Milk and Lower Missouri sub-basins exhibit the highest percent of consumption, while the Musselshell and Middle Missouri sub-basins exhibit the lowest.



Figure V-12: Irrigated lands of the Lower Missouri River Basin.

Lower Missouri Basin Irrigated Lands



**Table V-1:** Irrigation Water Use by sub-basin (DNRC, 2013). \*Figures include the Judith River watershed. Data sources include Water Conservation and Salvage Report for Montana (SCS, 1978), DNRC Water Resources Surveys, Montana Department of Revenue 2010 Revenue Final Land Unit (FLU), DNRC Historic Use Methodology (2010).

Sub-basin	Acres Irrigated	Volume Diverted (acre-feet)	Volume Consumed (acre-feet)	Volume Consumed (percent)
Musselshell River	84,968	433,792	80,688	19%
Milk River	267,812	970,159	228,585	24%
Middle Missouri*	62,057	363,952	74,562	20%
Judith River watershed	24,468	177,582	36,448	21%
Lower Missouri	74,745	243,559	70,544	29%
Lower Missouri Basin Total	489,582	2,011,462	454,379	23%



#### **IRRIGATED CROPS**

Climatic factors of Montana, including growing season, mean annual temperature, precipitation, frost-free days, and low humidity limit the types of crops that can be successfully grown here. At the upper reaches of the basin, Big Sandy experiences an average of only 97 frost-free days per year. At Malta, about mid-basin, there are 122 frost-free days, and farther downstream near the North Dakota border, Culbertson sees 117 frost-free days (Montana Agricultural Statistics, 2012).

Physical factors such as soils, geology, and water quality further restrict agricultural production in parts of the basin. Still, agriculture is economically the largest industry in Montana, and it is also the most water-consumptive industry in the state (Figure V-13).

Figure V-13: Water consumed by irrigation in the Lower Missouri River Basin.



Lower Missouri Basin Irrigation Consumption by 8 Digit Hydrologic Unit

Agriculture is a very important economic component of the Lower Missouri Basin. The basin contains five of the top ten agricultural revenue-generating counties in Montana: Choteau (ranked number 2), Richland (3), Hill (6), Valley (9), and Sheridan (10).

The vast majority of Spring Wheat grown in the Lower Missouri Basin is on non-irrigated lands. In 2011 in the north-central agricultural region (includes Glacier, Pondera, Toole, Teton, Liberty, Hill, Blaine, Choteau, Philips,



and Valley Counties) spring wheat was planted on 912,000 acres of non-irrigated land (95 percent of total), and on only 51,000 acres of irrigated cropland (5 percent of total).

#### LIVESTOCK

The number of livestock (cattle, sheep, hogs and pigs) was derived from National Agricultural Statistics Service (NASS) data for 2010. Water withdrawn for stock was estimated using the assumptions applied in the USGS 2000 Water Use report (USGS, 2004), and all water withdrawn for livestock was designated as consumed. Listed below are consumptive use figures for per day for a given livestock type:

- Beef Cattle: 15 gallons per day (gpd)/head
- Dairy Cattle: 23 gpd/head
- Hogs and Pigs: 5 gpd/head
- Sheep: 2 gpd/head.

Assignment of source was based on county percentages of groundwater and surface water originally assigned in the 1986 DNRC water use document. These percentages originated from water right permits issued at the time of the report.

Livestock consume about 14,720 acre-feet of water annually in the Lower Missouri Basin. About three-quarters of the water consumed is supplied by surface water, and the remainder is supplied by groundwater sources. Table V-2 summarizes livestock use by sub-basin.

**Table V-2:** Lower Missouri Basin Stock Water consumed by sub-basin. \*Includes Judith River watershed figures. Data sources: USGS (2004) and NASS (2010).

Sub-basin	Volume Consumed (acre-feet)
Milk River	3,761
Middle Missouri River*	4,667
Musselshell River	3,480
Lower Missouri River	2,811
Judith River	1,430
LMRB Total	14,719

#### PUBLIC AND DOMESTIC WATER SUPPLIES

Public water supplies (PWS) were identified by combining data from two sources: 1) the Montana Public Water System Sources database (MT-DEQ, accessed through the Montana GIS portal, data published 9/19/2012); and 2) the EPA Safe Drinking Water Information System (SDWIS). The resulting dataset identifies the number of users, source, county, and HUC for each PWS. Water withdrawn by each PWS was estimated using values of per capita day use reported by county in the USGS (2004) document multiplied by the number of resident users. An additional 10 gpd was applied to cover non-resident users of the PWS. Consumptive use by PWS was assumed to be 37 percent of withdrawals (DNRC, 1975; USGS, 1986).

In the Lower Missouri Basin, public water supply systems deliver water to about 49,268 people. Groundwater provides over 63 percent of the public water supply in the basin, which is much more than in the other Montana



planning basins. Lack of surface water supplies and poor water quality limit surface water use for domestic supply in the Lower Missouri Basin. Additionally, the basin is underlain by several high-quality aquifer units that produce favorable water supplies. Table V-3 lists public water supply use by sub-basin.

Sub-basin	Population Served	Volume Diverted (acre-feet)	Volume Consumed (acre-feet)
Milk River	22,806	3,359	1,243
Middle Missouri River	8,784	2,133	789
Musselshell River	4,327	993	367
Lower Missouri River	13,351	2,402	889
Lower Missouri Basin Total	49,268	8,887	3,288

Table V-3: Water Consumed through Public Water Supplies in the Lower Missouri Basin

#### SELF SUPPLIED DOMESTIC WATER

The number of self-supplied domestic users was calculated by subtracting PWS resident users from 2010 population estimates (U.S. Census Bureau). The amount of water withdrawn by domestic users was assumed to be 78 gpd per person (DNRC, 1986; DNRC, 1975). Per the 1986 document, this estimate of water use was originally derived from statistics of municipal systems serving fewer than 55 users. All self-supplied domestic water use was assumed to be from groundwater, and 50 percent of the water withdrawn is assumed to be consumed.

Assignment of domestic users to HUCs was performed by assuming uniform distribution of residential users, consistent with the 2010 USGS documentation. Self-supplied domestic water systems serve the needs of over 30,000 people in the Lower Missouri Basin, as summarized in Table V-4.

Sub-basin	Users Served	Volume Diverted (acre-feet)
Milk River	9,518	834
Middle Missouri River	6,281	550
Musselshell River	5,235	459
Lower Missouri River	9,252	811
Lower Missouri Basin Total	30,286	2,654

Table V-4: Water Diverted through self-supplied domestic water systems, by sub-basin

#### INDUSTRIAL

Direct estimates of uses considered "industrial" were not possible in 2010. Instead, past USGS estimates (1985 through 2000, where both HUC and county estimates were provided, and 2005, which provided only usage by county) were analyzed to determine HUC assignment of those counties where the majority of industrial water use occurred. Then, for those counties with the largest share (representing 90 percent of statewide industrial use), the 2005 USGS estimates were used as the best estimate for 2010 water use. All other industrial use estimates remain as reported in the 2000 water use document.



Other than for oil and gas exploration and production, there is very little industrial water use in the Lower Missouri Basin, and all water supplied for industrial uses in the basin is derived from groundwater sources. All industrial water use in the Middle Missouri sub-basin takes place within the Judith River watershed. Industrial water use in the Lower Missouri River Basin is summarized by sub-basin in Table V-5, and does not include uses for oil and gas exploration and production, which are treated separately.

Sub-basin	Volume Diverted (acre-feet)	Volume Consumed (acre-feet)
Milk River	79	12
Middle Missouri River	101	15
Musselshell River	0	0
Lower Missouri River	45	7
Lower Missouri Basin Total	225	34

Table V-5: Lower Missouri Basin Industrial Water Use summary.

#### OIL AND GAS DEVELOPMENT

Oil and gas exploration have been present in Montana for decades. Most recently, advancements in hydraulic fracture and horizontal drilling technology have allowed for increased, widespread exploration and development in the Lower Missouri Basin. The exploration for and production of oil wells require the use of fresh water, and subsequently produces water that must be disposed of or recycled. Concerns therefore center on both the volume of water needed and the quality of the water resulting from the operations. Both concerns may be serious factors that affect local water supplies in the Lower Missouri Basin.

In Montana, most oil exploration activity over the past decade has centered on the Bakken shale oil fields in the northeast part of the state. However, according to the Montana Board of Oil and Gas Conservation (BOAC) 2012 Annual Review, drilling permits and oil well completions have steadily decreased from a peak in 2006, even though total oil production has continued to increase. According to the Montana Petroleum Association, there were only 3 oil drilling rigs operating in the state as of January 2014. Figure V-14 shows the 2006 peak in oil well completions in Richland, Roosevelt, and Sheridan Counties. Note the smaller peak in completions during 2012. Roosevelt and Sheridan Counties are entirely within the Lower Missouri Basin, but Richland County spans part of Lower Missouri River and Lower Yellowstone River Basins.



**Figure V-14:** Oil well completions by year in Richland, Roosevelt, and Sheridan Counties, Montana.



The BLM estimates that hydraulically fracturing ("fracking") a Bakken formation oil well to the production stage typically requires 420,000 to 630,000 gallons of water, about 1.3 to 1.9 acre-feet of water (Judice, BLM 2010). An oil well in the Bakken shale typically requires a total of 2.2 million gallons of fresh water, or about 6.75 acre-feet, through its productive life of 20 to 40 years (Ceres).

During 2012 in the entire Bakken region, including both Montana and North Dakota, 5.5 billion gallons of fresh water were used for oil exploration and production purposes (Ceres). That amounts to about 16,900 acre-feet of water. One estimate of maximum oil well population suggests that water demand will continue to grow for oil field activities for another 10 to 20 years, to approximately double the 2012 water amount (Ceres). However, the majority of that development is expected to occur in North Dakota.

Oil activity just over the border in North Dakota is much more intense than in Montana, as the shale is more extensive there. However, the activity in North Dakota can affect local water supply in Montana in several ways. Due to the North Dakota permitting process, it is very difficult at this time to acquire the water necessary to meet oil field activities. As a result, several water depots have been developed in Montana to supply water to North Dakota oil activities. Domestic and municipal water supplies are also needed to meet the needs of an increasing worker population in the region.

Other locations in the Lower Missouri Basin may experience future oil exploration and production booms. Parts of the Musselshell Basin and the Judith watershed have seen recent oil exploration interest. However, production from these areas is not currently considered economically feasible.

#### SUMMARY OF CONSUMPTIVE WATER USE

Although the Milk and Musselshell River sub-basins contain substantial irrigation infrastructure, the Lower Missouri River Basin as a whole is not overly developed. Contained within the basin are vast expanses of badlands and wildlife refuges, and the three largest cities (Havre, Lewistown and Glasgow) have a combined



population of less than 20,000 people. Agricultural irrigation is the major beneficial consumptive use of water in the Lower Missouri Basin, diverting over 2 million acre-feet, of which over 450,000 acre-feet are consumed. Still, the vast majority of agricultural lands in the basin are not irrigated, relying solely on natural precipitation for moisture.

Livestock watering is second to irrigation in terms of water consumption in the basin. About three percent of all diverted water is consumed by livestock. In fact, more water is consumed by livestock than is consumed by humans. Municipal and industrial water consumption in the basin is very low. The population served by Public Water Supply systems is an estimated 50,000 people. The remaining 30,000 residents rely on self-supplied (typically groundwater) sources for domestic water use.

Reservoir evaporation, at over 600,000 acre-feet, is a large part of the lower basin water budget, and is considered a consumptive component of the beneficial use of reservoir storage.

# Non-Consumptive Water

# Use

#### RECREATIONAL AND ENVIRONMENTAL USES

# Montana Department of Fish, Wildlife and Parks

#### **Murphy Rights**

In 1969, the Montana Legislature authorized the Montana Department of Fish, Wildlife and Parks (FWP) to file for instream rights to protect flows on blue ribbon trout streams for fish and wildlife habitat. FWP filed on only one stream in the Lower Missouri Basin, Big Spring Creek near Lewistown. These "Murphy rights," named after their legislative author, have December 1970 priority dates and are therefore subordinate to the many senior water rights.

Big Spring Creek has a year-round Murphy right of 110 cfs, enforceable from the State Fish Hatchery downstream to the confluence with the Judith River. Figure V-15 illustrates the Murphy right in relationship to the normal range of flows in Big Spring Creek. Typical of a groundwater or spring origin, Big Spring Creek does not experience great variability within its normal flow range.





**Big Spring Creek near Lewistown FWP Murphy Right Compared** to Normal Range of Flow 160 140 120 100 Flow in cfs 80 FWP Murphy Right 60 Median Daily Flow 90th Percentile Flow 40 10th Percentile Flow 20 0 1-Aug 1-Jan 1-Feb 1-Mar 1-Apr 1-May 1-Jun 1-Jul 1-Oct 1-Nov 1-Dec 1-Sep

Figure V-15: Big Spring Creek Murphy right compared to normal flow range.

#### INSTREAM FLOW WATER RESERVATIONS

The Montana Water Reservations process granted instream flow rights to FWP in two separate proceedings; the Upper Missouri Basin Reservations (1992), and the Lower Missouri Basin Reservations (1994). In this case, the upper basin was defined as all the drainage area upstream of Fort Peck Dam, including the Musselshell River sub-basin. The lower basin was defined as the drainage area below the dam, including the Milk River sub-basin.

FWP was granted reservation water for minimum instream flows for several streams or stream reaches in the Upper and Lower Missouri Basins. Both sets of reservations have a priority date of July 1, 1985. For a complete listing of FWP instream flow reservations in the Lower Missouri River Basin, see Appendix D.

Most of the FWP reservations are based on flow rates required to minimally cover riffle areas of streams, therefore they may be considered a "base flow" level, providing just enough water for species survival. Figures V-16 and V-17 compare FWP water reservations to the normal range of flows of the Missouri River in the lower basin.



**Figure V-16:** FWP Instream Flow Reservation compared to normal range of flows for the Missouri River below Fort Peck Dam to the Milk River confluence.





**Figure V-17:** FWP Instream Flow Reservation compared to normal range of flow for the Missouri River below the Milk River confluence, to the state line.



#### LAKES AND RESERVOIRS

#### Physical Characteristics

The Lower Missouri Basin in Montana generally lacks the snowmelt fed tributary streams that are so numerous in the Upper Missouri Basin. As a result, the lower basin possesses only a few major storage reservoirs over its large area. The reservoirs that do exist are vital to the variable water supply in this mainly prairie basin. In addition, there are hundreds of smaller private stock water and irrigation ponds of local importance.

Dams in the lower basin are



typically multipurpose and provide several benefits, although they are usually constructed and operated for one



or more primary purposes. Some of the dams were built to divert river flow into irrigation canals or for offstream storage projects. Other purposes include waterfowl habitat, irrigation water storage, recreation, flood control, municipal supply, electric power generation, and water quality mitigation. Table V-6 summarizes the larger facilities in the basin.

Dam	Stream	Approximate Total Reservoir Capacity (AF)	Owner	Primary Purposes
Fresno	Milk River	91,000	Bureau of Reclamation	Flood control, irrigation, recreation, municipal
Beaver Creek	Beaver Creek	8,700	Bureau of Indian Affairs	Irrigation
Nelson	Milk River	79,000	Montana DNRC	Irrigation
Frenchman	Frenchman River	3,750		Irrigation
East Fork	East Fork Spring Creek	1,100	City of Lewistown	Flood control recreation
Ackley	Judith River	5,800	Montana DNRC	Irrigation, recreation
Fort Peck	Missouri River	18,500,000	US Army Corps of Engineers	Flood control, hydropower, recreation
Bair	North Fork Musselshell River	7,300	Montana DNRC	Irrigation
Martinsdale	South Fork Musselshell River	23,348	Montana DNRC	Irrigation, recreation
Deadman's Basin	Musselshell River	72,000	Montana DNRC	Irrigation, recreation
Yellow Water	Yellow Water Creek	3,842	Montana DNRC	Irrigation, wildlife
Petrolia	Flatwillow Creek	14,000	Montana DNRC	Irrigation, recreation

Table V-6: Summary of larger dams in the Lower Missouri Basin.

The combined storage capacity of these larger dams totals 18,850,740 acre-feet, which includes the huge capacity of Fort Peck. Not including Fort Peck, the storage capacity is only 350,740 acre-feet. That is only about 6 percent of the average annual Missouri River flow volume measured at Virgelle, which is the dividing point between the Upper and Lower Missouri River Basins. Figure V-18 displays storage facilities within the Lower Missouri River Basin.



Figure V-18: Water storage facilities of the Lower Missouri River Basin.

# Lower Missouri Basin Water Storage



#### RESERVOIR MANAGEMENT AND OPERATIONS

#### Middle Missouri River Sub-Basin

Fort Peck Dam is the only Missouri River main-stem dam in the Lower Missouri Basin. The dam and the reservoir it impounds are significant features of the state. This huge reservoir stores 18.5 million acre-feet and is 130 miles long. Storage is roughly three times the annual inflow to the reservoir as measured near Landusky. Fort Peck is operated by USACE and was constructed originally as a flood control facility during the 1930s.

Each year, USACE develops an operating plan based on forecasted snow and precipitation conditions. The operating plan must also consider the Missouri River Basin downstream of Montana because of the system of USACE dams operated through North and South Dakota, and because of further downstream concerns. Fort Peck Reservoir is a very important recreational center for fishing, boating, hunting, and other outdoor recreation. Fort Peck Dam also generates 185 megawatts of electricity.

Figure V-19 illustrates Fort Peck Reservoir month-end stored water contents for the past 25 years. Large swings in storage are evident through the severe drought periods of the late 1980s and the mid-2000s, and during high



water episodes of the late 1990s and in 2011. A reservoir of this capacity can take years to stabilize stored contents after extremely dry or wet periods.





Figure V-20 displays a typical Fort Peck Reservoir annual operating pattern, from 1995 through 1997. Storage typically peaks in June or July and is then gradually reduced to an annual low volume in January or February. The record snowpack for Montana occurred in 1997, and Figure V-20 shows that the stored contents grew from a January low of 15.3 million acre-feet to a July high of 18.7 million acre-feet.



Figure V-20: Fort Peck Reservoir Storage Contents, 1995 through 1997.

There are also a few small but locally important impoundments in the Middle Missouri River sub-basin. Ackley Lake, located in the upper Judith River watershed, is owned by DNRC and is leased for recreational use by FWP.



The lake supplies water for irrigation, fish and wildlife, and recreation. East Fork Dam, located a few miles south of Lewistown, provides some flood control capacity and recreation benefits, but its storage capacity has been diminished by natural siltation.

#### Lower Missouri River Sub-basin

There are no artificial water impoundments of significant size in the Missouri–Poplar sub-basin below Fort Peck Dam. North of Culbertson, the mainly natural Medicine Lake is a component of the National Wildlife Refuge system, holding 67,000 acre-feet of water for waterfowl and wildlife habitat. There are many small, locally important ponds and wetlands scattered throughout the sub-basin that supply stock water.

#### **Milk River Sub-basin**

Fresno Dam has a recently mapped capacity of about 93,000 acre-feet, and is the only main-stem impoundment in the Milk River sub-basin. Nelson Reservoir is another large off-stream reservoir, with a capacity of about 72,000 acre-feet. Sherburne Dam is not actually located in the Milk River sub-basin, but is an impoundment of Swiftcurrent Creek in the St. Mary River drainage, which flows north into Canada from Glacier National Park in Montana. Sherburne Dam has a storage capacity of 68,000 acre-feet, some of which is combined with St. Mary River flow and sent via pipeline as a trans-basin diversion into the North Fork Milk River. Sherburne, Fresno, and Nelson Dams are all part of the Bureau of Reclamation (USBR) Milk River Project.

Fresno Dam was originally built for purposes of water quality mitigation and flood control. The dam has been partially rebuilt with augmented storage capacity. Figure V-21 graphically demonstrates the effect that dams can have on streamflow timing and water supply.

Before Fresno Dam construction in the late 1930s, high flows occurred in March through June, during times of snow melt and spring rains. Streamflows rapidly decreased after June through the rest of the irrigation season.



**Figure V-21:** Milk River at Havre, Average Monthly Flows, before and after Fresno Dam construction.



Fresno Dam allows water to be stored during naturally high flow periods before irrigation season for use later in the summer when it is most needed. The post-construction hydrograph shows highest river flows below the dam during May, June, July, and August: the heart of the irrigation season. Fresno is also a good example of a multi-purpose impoundment, as the stored water provides the City of Havre with municipal supply, and is a regionally important recreational fishing and boating destination.

Figure V-22 graphically compares Fresno Reservoir storage contents between a relatively normal water year (2009), an extremely dry water year (2001), and a very wet water year (1997). Typical operation calls for storage of high spring inflows, May through July, with peak storage usually occurring in July. Storage content drops through the remainder of the irrigation season as releases are made to satisfy downstream demands.

A recent USBR study examined the loss of storage capacity in Fresno Reservoir from sediment deposition over the past 80 years (Ferrari, 2013). According to the study, which employed state-of-the-art bathymetric technology, the reservoir capacity has declined by about 26,000 acre-feet since its original construction.



Figure V-22: Comparison of Fresno Reservoir Stored Contents.

**Fresno Reservoir Comparison of Stored Contents** 

#### **Musselshell River Sub-basin**

In the Musselshell River sub-basin, DNRC operates a well-developed system of reservoirs, used in coordination to provide contract water throughout the sub-basin. At the upper end of the sub-basin, Bair Reservoir stores more than 7,000 acre-feet on the North Fork Musselshell River. Across the valley on the South Fork Musselshell River, Martinsdale Reservoir stores an additional 23,000 acre-feet off-stream.

Downstream of Harlowton, Deadman's Basin Reservoir is an off-stream facility, filled directly from the mainstem Musselshell River by a 600-cfs-capacity supply canal (DNRC, 2008). This reservoir has a storage capacity of 72,000 acre-feet and provides much needed contract water to the middle portion of the Musselshell sub-basin.

These three reservoirs are operated as part of the Musselshell River Distribution Project. The project was ordered by the U.S. District Court as a means of more effectively distributing decreed and contract water within



the water-short Musselshell River sub-basin. The effort requires that water users have properly installed water measuring devices so that the water can be properly apportioned. Several water commissioners and water user associations are involved in this effort, which is generally regarded as an overall success.

Figure V-23 shows the stored contents of Martinsdale and Deadman's Basin reservoirs over the past 20 years. Together the reservoirs have a capacity of about 95,000 acre-feet. Bair Reservoir adds another 7,000 acre-feet to the system, for a total of 102,000 acre-feet. This is almost equivalent to the average annual yield of the Musselshell River at Harlowton, which is 111,000 acre-feet.



Figure V-23: Upper Musselshell Basin Reservoirs storage patterns.

The two reservoirs generally follow the same annual pattern, storing water during winter and spring for release during the summer. The peak of stored contents is typically in May, declining through June and July, and often out of water before August begins.

The drought of the early 2000s was severe in the Musselshell sub-basin, as evidenced by the large trough of depleted storage in both reservoirs. Martinsdale Reservoir storage also dropped to zero in 2007 and 2008 when DNRC completed a rehabilitation of Martinsdale Dam (DNRC State Water Projects Bureau, 2009).

Located further downstream in the Musselshell sub-basin, Petrolia Reservoir is privately owned and has a capacity of 14,000 acre-feet of storage on the South Fork of Flatwillow Creek. This is an extremely important resource to the lower sub-basin, and enters the main stem just upstream from Mosby.

Yellow Water Reservoir is owned by DNRC and managed by the Yellow Water Water-Users Association. This small reservoir has a storage capacity of 3,800 acre-feet and is located on Yellow Water Creek, an upstream tributary to Petrolia Reservoir.

Wild Horse Lake and Warhorse Lake are two large lakes in the upper reaches of Box Elder Creek near Winnett. Although these lakes formerly provided some local irrigation water, they are no longer used as storage



reservoirs. These lakes are important for migratory waterfowl production and are part of the National Wildlife Refuge System.

#### **Reservoir Evaporation**

Evaporation is a considerable loss to the hydrologic system of the Lower Missouri Basin, and could be considered a cost of storing water for later use. As part of the permitting process, evaporation from small reservoirs and ponds is usually considered a consumptive component. The prairie or grassland environment is conducive to high evaporation because of persistent winds and a semiarid climate.

In the Milk River sub-basin, Fresno Reservoir has a full-pool surface area of 5,757 acres and evaporates an average of 35 inches per year. Twelve inches of the evaporated amount are offset by the average annual precipitation, leaving a net evaporative loss of 23 inches, or 1.92 feet. For this surface area then, annual evaporative loss totals 11,034 acre-feet from Fresno Reservoir (Cannon and Johnson, 2004).

Similarly, Nelson Reservoir receives equivalent annual precipitation and evaporates the same amount per acre. Having a surface area of 4,560 acres, Nelson Reservoir loses 8,740 acre-feet annually to evaporation (Cannon and Johnson, 2004).

With 245,000 acres of surface area, Fort Peck Reservoir experiences a huge evaporative loss of approximately 571,670 acre-feet per year (Cannon and Johnson, 2004). Most of the loss occurs during the summer months, which are warm, dry, and breezy.

Higher elevation reservoirs within the Lower Missouri Basin receive more precipitation annually and typically experience less evaporation than their prairie counterparts. Air temperatures are usually cooler, and warm weather is more intermittent at higher elevations. For example, in the Musselshell River sub-basin, Martinsdale and Bair reservoirs receive 16 inches of precipitation annually, and evaporate 30 inches annually for a net loss of 14 inches, or 1.17 feet. This is quite a bit less than the 2.33 feet evaporated at Fort Peck Reservoir or the 1.92 feet at Fresno Reservoir.

#### Hydropower

Fort Peck Dam is operated by USACE and is the only hydroelectric facility within the Lower Missouri Basin. Total generating capacity of the five units at Fort Peck is 185 MW, however the primary purpose of Fort Peck Dam is flood control.

#### Existing Water Quality Impairments in the Lower Missouri Basin.

#### MONTANA WATER QUALITY LAW

In areas of Montana, the ability to put water to a beneficial use is limited as much by water quality as physical availability. Water quantity and water quality are closely intertwined and the Montana Water Use Act recognizes this relationship (§85-2-311 MCA). However, this document offers limited guidance regarding water quality issues because DNRC has no authority to regulate water quality and the state water planning statute does not explicitly address water quality. The Department of Environmental Quality has primary authority over the regulation of water quality in Montana. For more information on water quality regulation in Montana, please reference DEQ's Montana Nonpoint Source Management Plan (Link) at

http://www.deq.mt.gov/wqinfo/nonpoint/nonpointsourceprogram.mcpx. Another good source of information is the Clean Water Act Information Center (Link) at http://deq.mt.gov/wqinfo/CWAIC/default.mcpx. These sites provide information, strategies and goals and reports that address water quality issues generally as well as water quality as it is affected by water quantity.



Numerous laws and regulatory programs in Montana control activities to protect water quality. There are laws that regulate discharges to surface water, discharges to groundwater, streambed disturbance, mining operations, hazardous waste, underground storage tanks, septic systems, and almost every other activity that poses a threat to water quality. Most of these laws are administered by DEQ, with a handful administered by other state and local entities.

The Montana Water Quality Act (75-5-101, MCA) is the primary water pollution control authority in Montana. The act states that it is public policy to:

Conserve water by protecting, maintaining, and improving the quality and potability of water for public water supplies, wildlife, fish and aquatic life, agriculture, industry, recreation, and other beneficial uses; [and] provide a comprehensive program for the prevention, abatement, and control of water pollution; and balance the inalienable rights to pursue life's basic necessities and possess and use property in lawful ways with the policy of preventing, abating, and controlling water pollution.

Water quality standards, adopted by the Montana Board of Environmental Review, establish the level of water quality necessary to support existing and future beneficial uses of rivers, lakes, and groundwater resources. The standards establish a basis for limiting discharges of pollutants.

The 1972 federal Clean Water Act (CWA) established a national framework for protecting and improving water quality. Sections of CWA passed in 1987 (303(d) and 305(b)), require states to monitor and assess statewide water quality conditions, identify and list water bodies that fail to meet water quality standards, and prepare Water Quality Improvement Plans (WQIPs) for restoring water quality. These WQIPs must include quantitative limits, known as Total Maximum Daily Loads (TMDLs), for each of the pollutants of concern. Most of Montana's water quality impairments reflected on the 303(d) list are a result of nonpoint source (NPS) pollution.

#### SURFACE WATER QUALITY PROTECTION

Nonpoint water pollution comes from contaminants (originating from a variety of land-use activities over generally large areas) that are transported to streams, lakes, wetlands, and groundwater by precipitation, snowmelt, and stormwater runoff. Nonpoint pollution also comes from substances that erode directly into surface waters or from aerially transported substances deposited on land and water. Common nonpoint pollutants include sediment, nutrients (nitrogen and phosphorus), temperature changes, metals, pesticides, pathogens, and salt.

Nonpoint pollution is a significant problem in Montana, constituting the single largest cause of water quality impairment on a statewide basis (Figure V-24). More than 75 percent of Montana's assessed rivers and streams and 45 percent of its lakes, reservoirs, and wetlands fail to meet state water quality standards largely as a result of the effects of NPS pollution (from Table 4-1, DEQ, 2012). DEQ estimates that 37 percent of the state's perennial river and stream miles, and 72 percent of lake and reservoir acres have been assessed.



Figure V-24: Water Quality Impaired 303d Listed Streams in the Lower Missouri Basin.



Lower Missouri Basin Water Quality Impaired 303d Listed Streams

The NPS management program is a voluntary program of land, soil, and water conservation practices designed to prevent pollution from land-use activities. DEQ works with conservation districts, watershed groups, nonprofit organizations, local/state/federal agencies, and individual Montanans to provide training, monitoring support, and project funding. For those waters not meeting standards, TMDLs are developed, followed by voluntary implementation of best management practices for nonpoint sources, and potentially, point source permit waste load allocations (Figure V-25). The TMDL program establishes the maximum amount of a pollutant that a water body may receive and still be expected to achieve applicable water quality standards. TMDLs are designed to achieve and protect designated beneficial uses.



Figure V-25: Montana TMDL Project Area and Completion Schedule.



Besides nonpoint pollution, there is point source pollution. Point source pollution comes from a single point, commonly thought of as an end-of-pipe discharge. DEQ maintains a point source pollution control program, known as the Montana Pollutant Discharge Elimination System (MPDES), which is aimed at protecting water quality in water bodies receiving point source discharges from sewage, industrial, or other wastes.

Other water quality protection laws include Section 310 of the Montana Stream Protection Act, which requires conservation districts to regulate private activities that disturb the bed or banks of rivers and streams. Similarly, government activities that disturb the bed or banks of streams are regulated by FWP. Such activities include temporary disturbances, such as construction or maintenance activities for irrigation diversions. In addition, the legislature provided for creation of local water quality protection districts. Such districts have limited regulatory authority, and are primarily intended to provide funding to locally monitor and plan for the protection of water quality resources of particular concern to the people within the district.

#### GROUNDWATER QUALITY PROTECTION

The Montana Ground Water Pollutant Control System (MGWPCS) (Chapter 17.30, subchapter 10, ARM) is a regulatory program to control all otherwise unregulated sources of groundwater pollution. Important aspects of



the MGWPCS rules are groundwater quality standards, a non-degradation requirement, and a discharge permit system. A wide variety of activities are exempt from having to obtain MGWPCS permits (see 75-5-401 MCA and 17.30.1022, ARM). Discharges from the exempted activities are typically covered under other permitting programs or regulations.

Groundwater quality is also addressed in the Agricultural Chemical Ground Water Protection Act. Under this act, DEQ is responsible for developing and enforcing groundwater quality standards for agricultural chemicals. DEQ is also charged under this act with monitoring, promoting research, and providing public education in cooperation with universities and other state agencies. The Montana Department of Agriculture (DOA) is charged with developing and enforcing agricultural chemical groundwater management plans aimed at preventing groundwater contamination from agricultural chemicals. Both DEQ and DOA have rules to implement their respective responsibilities under this act.



# VI. Administration

## Institutional and Legal Framework for Water Use in Montana

### PRIOR APPROPRIATION DOCTRINE AND THE MONTANA WATER USE ACT

In order to legally put water to a beneficial use in Montana, a person must have a water right. The elements of a Montana based water right - the right to the beneficial use of water – are dictated by the prior appropriation doctrine. In its simplest form, the prior appropriation doctrine provides that a person's right to use a specific quantity of water depends upon when that use began – the first in time, is the first in right. A water right consists of a priority date, a purpose of use, point of diversion, a source, place of use, period of use, and a quantity reflected in a flow rate, volume or both. There are no preferences among beneficial uses other than priority date. A water right does not create ownership in the water itself. Rather, it creates a property interest in the right to beneficially use a quantity of water for a specific purpose. Accordingly, actual historical beneficial use constitutes the basis, measure, and the limit of a water right.

Prior to July 1, 1973, Montana's prior appropriation system provided two primary methods for acquiring a water right: 1) a water user could simply construct a diversion and put the water to beneficial use (known as a use right); or 2) a water user could comply with the statutory notice of appropriation requirements (known as a statutory right). No prior authorization was required and the state had no control over use of this state-owned natural resource. As demands and conflicts over water increased, it became increasingly difficult to administer water rights because the rights were not recorded in a central location.

The 1972 Montana Constitutional Convention sought to remedy Montana's antiquated system while at the same time preserving the fundamental prior appropriation principles of first in time, first in right and beneficial use as the basis, measure and limit of a water right. To accomplish this goal the Article IX Section 3(1) of the Montana Constitution recognized and confirmed "existing rights" to the "use of any waters for useful or beneficial purpose." The Constitution also confirmed, in Article IX Section 3(3), that all waters within Montana are the property of the state for the use of its people and are subject to appropriation for beneficial uses as provided by law. Finally, in order to provide the necessary tools to better manage use of Montana's water resources, Article IX Section 3(4) of the Constitution charged the legislature with providing for the administration, control, and regulation of water rights and establishing a system of centralized records.

The Legislature responded to these constitutional charges by passing the Montana Water Use Act (Act), effective July 1, 1973. In order to fulfill the constitutional mandates of Article IX, the Act established an adjudication system to adjudicate pre-July 1, 1973 water rights, a permit system to control and regulate post-July 1, 1973 water appropriations, changes in use of existing water rights, and a centralized system of recording water rights.

The Act confirmed the fundamental principles of Montana's prior appropriation doctrine, including the following:

- 1. Montana's water belongs to the state for the beneficial use of its people. Therefore, water right holders do not own the water; they possess the right to use the water.
- 2. Doctrine of Prior Appropriation (first in time, first in right).
- 3. "Use it or lose it." A water right holder must use the water or risk losing the right to it.
- 4. The water diverted must be for a beneficial use, and all beneficial uses are equal under the law.
- 5. A water right is a property right and can be separated from the land.



- 6. One must have a water right to beneficially use water, and after July 1, 1973, new water rights can be obtained only from the DNRC, generally through the permitting process.
- 7. Any change in the purpose, place of use, place of storage, or point of diversion of a water right may not adversely affect other water rights and must first be approved by the DNRC

Over time the Act has refined elements of the permitting and change process to reflect increased understanding of water use and resources in the state. The Act has also evolved to provide for state-based water reservations, temporary changes and leases including for instream flows, and permits and change authorizations for marketing and mitigation. However, these refinements continue to be subject to the fundamental principles of the prior appropriation doctrine.

#### WATER RIGHTS ADJUDICATION AND THE WATER COURT

The Act set forth the framework for Montana to embark upon a state-wide general stream adjudication of pre-July 1, 1973, existing water rights. The adjudication serves to recognize and confirm existing water rights as required by the Constitution (Figure VI-1). The adjudication involves examining, litigating and decreeing claims to water with priority dates prior to July 1, 1973 through the Water Court (§85-2-2 MCA).

The first phase of the adjudication process involved the examination of each water right claim for factual and legal issues in accordance with Montana Supreme Court Claim Examination Rules. Over 220,000 claims for pre-1973 water use were received. This phase of examination was performed by the DNRC and completed in 2014. Additionally, the Water Court issued an order for DNRC to re-examine certain elements of claims in 45 basins that were not examined according to the current and more rigorous Montana Supreme Court Claim Examination Rules. The second phase of the adjudication involves issuance of temporary and/or preliminary decree, public notice, litigation of objections, and resolution of issue remarks. Following the resolution of objections and issue remarks, the Water Court will issue final decrees for each of Montana's 85 river basins which will define pre-July 1, 1973 water rights by owner, purpose, priority date, source, place of use and other elements of the water right. The current target date for the Water Court to issue final decrees is 2028.

Montana's water rights adjudication process will not be complete until all Federal and Tribal reserved water right compacts have been decreed by the Water Court. Prior to review by the Water Court, all compacts must be ratified by the Montana Legislature, approved by appropriate federal authorities, and in the case of Tribal compacts approved by Tribes. Where federal authorization or federal appropriations are needed to implement provisions of the settlement, congressional approval is required.

To date seventeen compacts have been negotiated and approved by the Montana Legislature. A negotiated compact with the Confederated Salish and Kootenai Tribes (CSKT) is awaiting approval by the Montana Legislature. If the legislature does approve not the proposed CSKT compact, the Tribes must file their claims with the Water Court prior to July 1, 2015.



Figure VI-1: Adjudication Decree Status of Lower Missouri Basin Watersheds

## Lower Missouri Basin Adjudication Decree Status



NEW BENEFICIAL WATER USE PERMITS, CHANGE IN USE AUTHORIZATIONS, AND THE DNRC Under the Act, the DNRC has jurisdiction over all changes in use and new appropriations occurring after July 1, 1973. The DNRC has the authority to enforce against illegal water use, and performs a number of other responsibilities related to post July 1, 1973 water use, planning and management in Montana.

In exercising its jurisdiction over new appropriations, the DNRC evaluates the proposed use pursuant to the §85-2-311, MCA, permit criteria. These criteria require the applicant prove that water for a proposed appropriation is both physically and legally available, and that existing appropriators will not be adversely affected. The applicant must also prove that the proposed use is a recognized beneficial use of water, that the proposed diversion is adequate, and that the applicant has a possessory interest in the place of use.

Similarly, DNRC exercises its jurisdiction over changes in use for existing water rights pursuant to the Act's change criteria found at §85-2-402, MCA. A water user can change the place of use, purpose of use, point of diversion, and place of storage for a water right. While these elements of a water right are subject to being changed, a water user may not expand the extent of the underlying water right. Therefore, evaluation of the change criteria focuses on the historic beneficial use of the underlying water right, alteration of return flows,



and a determination of whether the change in use will adversely affect other water users (senior and junior) on the source. The change provisions of the Act are discussed in more detail under Section IX of this plan.

The permit and change provisions of the Act reflect a fundamental shift from pre-July 1, 1973, water appropriation in that they require prior approval from the DNRC before water is appropriated or a change in use occurs. The Act provides the DNRC with the authority to condition, revoke, or modify permits and change authorizations as necessary to ensure compliance with the Act through administrative proceedings. §85-2-311, 312, and 314, MCA.

Over the past 40 years, DNRC has developed and refined the permit and change procedures in an effort to maintain the balance between authorizing new water uses and changes while at the same time protecting water users from adverse effects. The DNRC has developed specialized expertise and adopted rules on various aspects of water availability and water use throughout the state. See Title 36, Chapter 12, Mont. Rules Admin. For example, DNRC's rules include information regarding accepted methods for measuring water availability in gauged and un-gauged sources, estimating historic consumptive use, and modeling groundwater aquifer characteristics and properties.

#### BASIN CLOSURES IN THE LOWER MISSOURI BASIN

Montana has closed some of its river basins to certain types of new water appropriations because of diminishing water availability, over-appropriation, and a concern for protecting existing water rights. Section 85-2-319, MCA, legislatively authorizes the closure of basins to certain new appropriations through the adoption of administrative rules and negotiation of reserved water rights compacts. The law also provides for the closure of highly appropriated basins through the adoption of administrative rules.

A person wanting to appropriate groundwater in a closed basin must complete a hydrogeologic assessment and must meet requirements of §85-2-360, §85-2-361, and §85-2-362, MCA. If the hydrogeologic assessment predicts that the appropriation would have no net depletion of surface water, the application moves through the permitting process. If the assessment predicts net depletion of surface water, it must be determined if net depletion would have an adverse effect on prior appropriators. If not, the application moves through the permitting process. If there would be an adverse effect, the applicant must submit a plan for mitigation or aquifer recharge.

There are two DNRC-designated basin closures in the Lower Missouri Basin: the main stem of the Milk River and the southern tributaries of the Milk River. The main-stem Milk closure extends from the eastern crossing at the Canadian border to the Vandalia diversion dam and prohibits new direct diversions without storage for any consumptive uses and provides varying periods of closure. The southern tributaries of the Milk closure include Miners Coulee, Halfbreed Coulee, Bear Creek, and their respective tributaries in Toole and Liberty Counties. The southern tributaries closure prohibits new appropriations for direct diversions without storage for any consumptive uses accept for applications up to 3 acre-feet per year for domestic or stock. Applicants for groundwater greater than 35 gpm up to 10 acre-feet annually in any basin closure area must prove criteria for issuance of a permit under §85-2-311, MCA, and are subject to the requirements of HB-831 found in §85-2-360, §85-2-361, and §85-2-362, MCA.

#### CONTROLLED GROUNDWATER AREAS IN THE LOWER MISSOURI BASIN

In addition to basin closures for surface water, controlled groundwater areas may be designated to protect water quality or quantity (section §85-2-506, MCA). An area for designation may be proposed by DNRC on its own motion or by petition of a state or local public health agency, municipality, county, conservation district, or local water quality district. An area also may be proposed upon petition of at least one-third of the water right



holders in the proposed controlled groundwater area. Currently there are no controlled groundwater areas in the Lower Missouri River Basin.

### Federal Agencies with a Role in Managing Montana's Water Resources

Below is a list of Federal Agencies with a role in managing Montana's water resources.

#### **Department of Agriculture**

**Farm Service Agency** – administers cost share programs for farmers that improve water quality, soil stabilization, and irrigation systems. www.fsa.gov

**Natural Resources Conservation Service** – assists private landowners with watershed protection, flood prevention, soil and water conservation, snow surveys and soil inventories; conducts land-use inventories, cropland studies, and wetland assessments. www.nrcs.gov

**Forest Service** – conducts watershed management within ten national forests in Montana, and manages three wild and scenic river reaches within its forest boundaries. www.usfs.gov

#### Department of the Army

**Corps of Engineers** – authorizes permits for private projects affecting navigable waters; administers large multipurpose reservoirs for navigation, flood control, hydroelectric generation, and flood damage reduction. www.usace .army.mil

#### **Department of Commerce**

**Economic Development Administration** – provides public works grants for community water development. www.eda.gov

**National Oceanic and Atmospheric Administration** – issues information on weather, river, and climactic conditions; maintains a flood warning system. The National Weather Service at NOAA forecasts weather and issues weather warning and watches. www.noaa.gov

#### **Department of Energy**

**Bonneville Power Administration** – markets electric power for the 31 hydroelectric projects of the federal Columbia River Power System, including the Libby and Hungry Horse dams in Montana, and mitigates loss of fish and wildlife caused by this system; operates transmission systems. www.bpa.gov

Western Area Power Administration – distributes and markets hydro power from federal facilities outside of the Columbia River basin in a 15 state region, including Montana; operates transmission lines. www.wapa.gov

#### **Department of Homeland Security**

**Federal Emergency Management Agency** – delineates flood plains, publishes maps, and administers the National Flood Insurance Program, a Federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding. www.fema.gov

**Department of Housing and Human Development** – Provides financial aid for local water resource projects such as water and wastewater improvements through Community Development Block Grants for "entitlement communities" with populations of over 50,000. www.hud.gov

#### **Department of Interior**

**Bureau of Indian Affairs** – protects water rights of Indian tribes and promotes productive water use. www.bia.gov



**Bureau of Land Management** – administers federally-owned lands and use of natural resources, including water, on these lands. www.blm.gov

**Bureau of Reclamation** – designs, constructs, and operates water projects; conducts river basin water management studies; coordinates water conservation efforts. www.bor.gov

**National Park Service** – protects water resources (reserved water rights) and conducts water resource studies in Montana's national monuments, battlefields, and national parks. www.nps.gov

**U.S. Fish and Wildlife Service** – reviews comprehensive water plans and projects for impacts on fish and wildlife habitat and populations; works to recover endangered fish and wildlife species; manages hatcheries; studies fish disease. www.fws.gov

**U.S. Geological Survey** – researches the source, quantity, distribution, movement, and availability of surface and ground water for national water data network and technical reports. www.usgs.gov

**Environmental Protection Agency** – Works with states to establish and enforce standards for water quality and drinking water; provides grants for drinking water and water pollution control facilities. www.epa.gov

**Federal Energy Regulatory Commission** – Issues licenses for hydroelectric projects and transmission lines. www.ferc.gov

#### State Agencies with a Role in Managing Montana's Water Resources

Below is a list of State Agencies with a role in managing Montana's water resources.

#### Montana Department of Natural Resources and Conservation -

- Administers the portions of the Act that relate to water uses after June 30, 1973 such as Permits and Change Authorizations;
- Provides training for court appointed water commissioners;
- Provides technical information and assistance to the Water Court on water rights claims (pre-July 1, 1973) including examining those claims;
- Maintains a central water rights record system;
- Investigates complaints of illegal water use; and
- Other duties related to Water Operations, Water Management, and State Water Projects.

#### Montana Water Court -

- Adjudicates water rights as they were protected under the laws pre-July 1, 1973;
- Decides any legal issues referred from the District Court on pre-July 1, 1973 water rights; and
- Assists District Courts with enforcement.

#### **District Courts –**

- Can issue injunctive relief while it certifies water rights issues to the Water Court;
- Appoints Water Commissioners for enforcement; and
- Manages the enforcement of water rights and handles complaints by dissatisfied water users.

#### Reserved Water Rights Compact Commission (Commission) -

• Negotiates settlements with federal agencies and Indian tribes claiming federal reserved water rights within the State of Montana; and



Negotiates on behalf of the Governor's Office and represents the interests of the State water users.
Attorney General – The Water Court may join the Attorney General to intervene, on behalf of the state, in the adjudication of water right claims that are being decreed by the Water Court.

**Legislature** – Provides policy direction and laws for the administration of waters. When the Legislature is not in Session, two interim committees have oversight of water related issues:

- *Water Policy Interim Committee (WPIC)* permanent, joint bipartisan committee that studies water issues in order to develop a clear policy direction and necessary legislation to guide Montana's water policy.
- **Environmental Quality Council** contributes policy oversight to the administration of state water rights by advising and updating the legislature and overseeing institutions dealing with water, and communicates with the public on matters of water policy

# Local Government and Non-Governmental Organizations with a Role in Managing Montana's Water Resources

Montana's geography and communities are diverse. No uniform approach to water management dictated from above would be appropriate across the state. Consequently a large number of decisions that directly or indirectly affect water resources have devolved to local government. Some are legal requirements; for example, conservation district boards review proposals for activities that would affect streams, and issue "310 permits" under state law. Other local actions are more discretionary. In adopting their growth policies, for example, county commissions can choose to incorporate various kinds of measures to protect water resources in the development process. Water management is an important responsibility for local governments. The information below is a synopsis of local government or local group responsibilities over water.

**Local Health Departments** are responsible for protecting public health from communicable disease, including water-borne disease that can be transmitted through surface and groundwater. Local health departments assess potential public health problems, adopt policies and practices to prevent pollution, and clean up contamination. They enforce public health standards, including some regarding drinking water and wastewater.

**City & County Commissions and Boards** direct local water management through shaping and administering county growth policies, subdivision regulations, and other land-use and protection measures.

**Conservation Districts (CD)** exist in all Montana counties to address local water resource needs. Guided by locally elected boards of directors, conservation districts address special water problems, regulate stream management, issue 310 Permits, and educate citizens about land-use practices and pollution prevention (http://www.macdnet.org).

**Local Water Quality Districts (LWQDs)** serve to protect, preserve, and improve the quality of surface and groundwater within the district. LWQDs operate with a board of directors and funding from county fees. LWQD's research local water quality, answer citizen inquiries, and conduct public outreach programs. Under some circumstances, they can take on regulatory authority.

**County Water and Sewer Districts** have taxing authority, operate under the authority of county government, and are established for the purpose of developing and operating public water or sewer systems, or both.

**Water Commissioners** ensure that daily water allocations in the basin occur in accordance with the water users' rights. Local water users can petition for a water commissioner after the water rights in a basin have been decreed by the court. The local district court appoints the commissioner, and oversees his work.



**Irrigation Districts** are subdivisions of government that supply water to irrigators within a specified region. Citizens may establish one by petitioning the district court. Members of the district elect a board of directors to make policy, hire, and manage based on legal regulations and self-adopted bylaws. All district members pay taxes to construct and maintain the water project, usually a storage reservoir or canal system, supplying their district. Most federal irrigation projects are managed by irrigation districts.

**Water User Associations** are non-profit corporations that manage mostly state or local irrigation projects. If they manage state-owned projects, they are bound to terms of water-use contracts prepared by DNRC. The State of Montana holds the water rights of these projects. If not associated with state-owned projects, water user associations (sometimes called ditch or canal companies) develop their own operating rules.

**Ditch or Canal Companies** are private companies set up by local irrigators to share the cost and maintenance of the ditch system servicing their collective lands. Ditch companies vary greatly in membership and acreage, and often address the water needs of many individual water rights holders.

#### **Non-Governmental Organizations**

In addition to legal processes and government agencies, less formal efforts bring a variety of people together to resolve conflicts over water and to explore creative solutions to problems of quality and flow.

**Coalitions for Local Watershed Planning**: People across Montana have created coalitions of local governments, state and federal agencies, businesses, and local citizens to deal with water quality and quantity issues. One example is The Blackfoot Challenge, a forum that promotes cooperative resource management of the Blackfoot River, its tributaries, and adjoining lands.

**Watershed Groups**: These citizen groups are as diverse as the communities they serve, and they participate directly in watershed-level decision-making and problem solving, as well as initiating local cleanups, conservation and watershed education, and data gathering and ecosystem research projects.

- Montana Watershed Coordination Council: This council serves to build and unite watershed communities by bringing people and information together. The council is comprised of private organizations and staff from many local, state, and federal natural resource agencies
- Montana Wetland Council: This advisory group, whose membership is open to the public, agencies, and interest groups, seeks to direct the development and implementation of a Montana wetlands strategy. Its mission is to conserve and restore Montana's wetlands and riparian ecosystems through the cooperation of public and private interests http://www.deq.mt.gov/wqinfo/wetlands/wetlandscouncil.mcpx
- Special Interest Groups: Agriculture, recreation, industry, and fisheries have a stake in how water is managed. Reflecting this diversity, a variety of special interest groups develop creative solutions related to issues that affect Montana's water.

#### Water Reservations

When the Montana Water Use Act was passed in 1973, the option to reserve water became a major component of the law. Policy makers recognized the need to create a mechanism for preserving the potential for future diversionary uses and for maintaining instream flows to protect aquatic life, recreation, and water quality. The law established a process for the reservation of waters by public entities for beneficial uses that serve the public interest. The reservation process is unique since it allows the claimant to appropriate water for future use. The reservation establishes a current priority date even if the water is not actually used until a later time. Three classes of water reservations emerged from the 1973 legislation: municipal reservations to serve domestic and


industrial needs, conservation district reservations to serve irrigation and stockwater demands, and instream flow reservations to protect fish and aquatic wildlife habitat, recreation, and water quality.

In 1985, the Montana Legislature directed DNRC to initiate a water reservation proceeding for the Missouri River Basin. The legislature felt that implementation of water reservations would encourage more coordinated development of the basin's water resources and help form a stronger and more unified basis for protecting Montana's share of the Missouri River from downstream states. Due to the size of the basin, DNRC split the Missouri reservation process into upper and lower basins. The upper basin encompassed the area above Fort Peck Dam, and the lower basin encompassed the area below Fort Peck Dam, which included the Milk River and Little Missouri sub-basins. The reservation process in the Upper Missouri Basin was completed in June, 1992. Shortly thereafter, DNRC began preparation of a draft environmental impact statement to consider the applications in the Lower Missouri River Basin.

DNRC received 26 applications for reservations in the lower basin. Fourteen municipalities applied for 46,167 acre-feet of water per year to meet future growth demands. Eleven conservation districts requested 276,407 acre-feet for 472 proposed irrigation projects covering 157,994 acres. FWP applied to reserve instream flows on 21 streams or stream reaches to protect fish, aquatic habitat, recreation, and water quality.

On December 30, 1994, the Board of Natural Resources and Conservation (BNRC) published the order establishing water reservations in the Lower and Little Missouri River Basins. The BNRC granted all of the municipal applications except those applications for surface waters in the Milk River sub-basin (Chinook, Harlem, Havre, and the Hill County Water District), which were summarily denied. BNRC did approve a groundwater reservation for the city of Havre. Reservations in the Lower Missouri Basin received a priority date of July 1, 1985. Reservations in the Little Missouri River Basin received a priority date of July 1, 1989. Contrary to most water rights that have a priority date and do not reflect any relative preference to other water rights, BNRC subordinated the reservations for instream flows. Even though all of the reservations in the Lower Missouri Basin carry the same priority date, BNRC explicitly gave a preference to the municipal, irrigation, and stockwater reservations over instream flow in the event of conflicts among the rights secured through the reservation process in the future. Table VI-1 below provides a comprehensive list indicating the status of the development of the conservation district reservations in the Lower Missouri Basin.



Table VI-1: Status of CD Water Reservations in the LMRB

LOWER MISSOURI RIVER BASIN							
CONSERVATION DISTRICT WATER RESERVATION BALANCE							
	as of December 31, 2012						
		PROJECTS	VOLUME	VOLUME	REMAINING	FLOW	FLOW
CONSERVATION DISTRICT	SOURCE OF WATER SUPPLY	APPROVED	GRANTED (AF)	ALLOCATED (AF)	VOLUME (AF)	GRANTED (cfs)	ALLOCATED (CFS)
LOWER BASIN							
BLAINE	Battle Creek, Little Coulee	0	18,934.00	0.00	18,934.00	0.00	0.00
	Little Missouri River & tribs, Little Beaver Creek & tribs, Boxelder Creek						
CARTER	& tribs, 1 groundwater well	0	4,684.00	0.00	4,684.00	26.30	0.00
	South Fork Whitetail Creek,						
	Groundwater, Poplar River, UT						
	Middle Fork Poplar River, Pit, Police						
	Creek, East Fork Poplar River,						
	Sprinks, Olson Coulee, Coal Creek,						
DANIELS	UT of Butte Creek	0	3.047.00	0.00	3,047.00	16.90	0.00
	Beaver Creek & named tribs, Named				,		
LITTLE BEAVER	tribs of Little Beaver Creek	0	1,548.00	0.00	1,548.00	0.00	0.00
LIBERTY	Lost Coulee	0	310.00	0.00	310.00	0.84	0.00
McCONE	Mainstem Missouri River	7	14,299.00	3,793.30	10,505.70	99.50	62.11
RICHLAND	Mainstem Missouri River	22	25,349.00	9,392.00	15,957.00	186.90	107.50
ROOSEVELT	Mainstem Missouri River	21	73,115.00	9,475.60	63,639.15	558.80	101.83
SHERIDAN	Groundwater	20	15,479.00	5,648.00	9,831.00	0.00	0.00
VALLEY	Groundwater	0	7,668.00	0.00	7,668.00	54.10	0.00
WIBAUX	Beaver Creek & named tribs	0	1,509.00	0.00	1,509.00	0.00	0.00
TOTAL		70	165,942.00	28,308.90	137,632.85	943.34	271.44

Of the 10 municipal reservations approved in the process, only the city of Culbertson has utilized its reservation. The Dry Prairie Rural Water System (DPRWS) temporarily used Culbertson's water reservation pending approval of its own application for a water right from the Missouri River. With the town of Plentywood set to receive water from DPRWS, it is unlikely that the Plentywood groundwater reservation will be developed in the future.

In the 20 years since the water reservations in the Lower Missouri River were established, FWP has never made a call against a junior claim. With a 1989 priority date, the number of junior users on the affected stream reaches is extremely limited. These reservations are more important for the limitations they may create for future claims. In keeping with the larger policy goals of protecting instream flows, these reservations are important for establishing a minimum that protects fish, wildlife habitat, recreational values, and water quality from depletions caused by new consumptive uses.

## Federal and Tribal Reserved Water Right Compacts

The doctrine of reserved water rights evolved to ensure that Indian reservations and public lands set aside by the federal government would have sufficient water to fulfill the purposes for which they were established. Whereas most western water rights (state-based appropriative rights) have a priority date based on when water was first put to beneficial use, federal reserved water rights have a priority date that goes back at least as far as the date on which the lands were set aside (Figure VI-2).



Figure VI-2: Tribal and Federal Reserved Water Right Compacts in the Lower Missouri Basin.

## Lower Missouri Basin Reserved Water Rights Compacts



The reserved water rights doctrine is rooted in a number of judicial decisions, beginning with a 1908 U.S. Supreme Court decision now known as the Winters Doctrine. The case of *Winters vs United States* involved a dispute between Native Americans of the Fort Belknap Reservation and homesteaders over the use of the Milk River. The water use of the settlers upstream from the reservation diminished water supplies for agriculture on the reservation. The dispute eventually made it to the U.S. Supreme Court. The Court sided with the Tribes, holding that the 1855 treaty establishing the Reservation had implicitly reserved an amount of water necessary to fulfill the purposes for which the Reservation was established. Therefore, although the homesteaders had perfected their water rights under Montana state law, the water right of the Indians of the Fort Belknap Reservation was prior, or senior in use.

The rationale used in the Winters decision on behalf of Native Americans also applies to public lands held by the federal government for national parks, wildlife refuges, national forests, military bases, wilderness areas, or other public purposes. It holds that when Congress authorized the establishment of federal land, it implicitly intended to reserve enough water to fulfill congressional purposes. This idea of "implied rights" serves as the basis and foundation for tribal and federal claims to state waters embodied in the many compacts negotiated by the state of Montana and its many tribal and federal partners.



## **Tribal Compacts in the Lower Missouri River Basin**

#### FORT PECK COMPACT

## The Fort Peck Tribal Executive Board and Montana Legislature ratified the Fort Peck Montana Compact in April 1985.

#### Introduction

The Fort Peck Reservation is located in northeastern Montana. It is about 110 miles long (east to west) and 40 miles wide (north to south) encompassing slightly over 2 million acres. More than 5,000 tribal members live on the reservation, as well as several hundred Indians belonging to other tribes. Reservation lands were allotted to the Indians beginning in 1908, and then opened to settlement by non-Indian homesteaders. Today, about half the lands of the reservation are owned by non-Indians. About 550,000 acres are held in trust by the United States for Indian allottees, and another 400,000 acres are held in trust for the tribes. Trust and fee lands are commonly interspersed in a "checkerboard" pattern.

The southern boundary of the reservation is the Missouri River, the major interstate stream system of the northern Great Plains. The western boundary is the Milk River and, farther north, its tributary, Big Porcupine Creek. The northern boundary of the reservation is about 30 miles south of the U.S.–Canada border. The reservation's eastern boundary, Big Muddy Creek, joins the Missouri River about 20 miles west of the North Dakota state Line.

The climate is semiarid, with average annual precipitation between 12 and 13 inches. The major water resource of the reservation is, of course, the main-stem Missouri, with an average annual flow of over 7 million acre-feet. Fort Peck Dam, a major Missouri Basin hydroelectric project constructed by the U.S. Army Corps of Engineers, lies about five miles upstream of the reservation, on the Missouri. Its Reservoir, about 100 miles long, holds over 20 million acre-feet. A number of much smaller tributaries of the Missouri originate on or flow through the reservation in a generally north to south direction. The major runoff in these streams occurs in March and April; flows are often intermittent in late summer, and the water quality is poor.

#### **Summary of provisions**

#### Protection of Existing Uses in Missouri River Tributaries

The Tribes agree in the compact to make no use of the main-stem Milk River, which is the western boundary of the reservation for only a few miles above its confluence with the Missouri. This is because their engineers advised the tribes that the lands in this area could better be served from the Missouri, which is a dependable, high-quality source.

The compact also protects all existing Indian and non-Indian uses on the other streams that flow through, and the groundwater basins that underlie, the reservation. About 33,000 acres are presently irrigated from these streams or groundwater basins, mostly by non-Indians. About half the irrigation utilizes groundwater. Most of the acres irrigated from surface flow are by means of "water spreading"—capturing high stream flows during the early spring runoff. These irrigation uses are protected, as are present and future domestic uses and future stock watering impoundments not in excess of 20 acre-feet per year. All new non-Indian uses, however, will be subordinate to future exercise of the tribes' reserved rights.

Had the controversy been litigated, the tribes could of course have "cut off" these junior uses on the tributaries, since the tribes enjoy a much earlier priority date. The tribes, however, agreed to protect those uses in return for the state's agreement to the quantification determined by the tribes' experts, tribal jurisdiction, resolution of disputes by a compact board, and tribal water marketing.



#### Quantification

The compact determines finally and forever the quantity of water reserved for the Assiniboine and Sioux Tribes by federal law as 1,050,472 acre-feet of diversions, or a consumptive use of 525,236 acre-feet, per year. A maximum of 950,000 acre-feet may be diverted and 475,000 acre-feet may be used from surface water each year. The rest would have to come from groundwater, and the compact recognizes the tribes' groundwater rights.

The tribes can use this water for irrigation, or for any other purpose determined by them on the reservation. Part of the tribes' water rights may be used to establish instream flows to protect fish and wildlife resources on various tributary streams on the reservation.

The compact provides that nonuse of the tribal water right does not abandon or forfeit the tribes' right, which is a standard component of reserved water rights.

#### Jurisdiction Over Tribal Water Rights and Resolution of Disputes

The United States will continue to administer and settle disputes concerning water use on the Fort Peck Irrigation Project, which presently serves less than 20,000 acres of Indian and non-Indian lands on the reservation with water from the Missouri River. The tribes administer all other uses or water of the reservation by itself, by Indians, or by non-Indians who either lease water from the tribes or claim a water right under federal law because they purchased a former trust allotment. The tribes will eventually adopt a water code, and resolve all water disputes among these persons. The Interior Department has approved the tribal water code. The state administers all water rights established pursuant to state law, including by non-Indians on the reservation, and resolve all disputes among state water users.

These separate administrative systems were intended to make it less likely that a dispute will arise between the tribes and the state, or between tribal and state water users. If a dispute does occur, it will be addressed by a Joint Tribal-State Board established by the compact. This board has one representative from the state, one from the tribes, and a third selected by neutral means. It has the power to subpoena witnesses, hold hearings, and take testimony. All decisions must be by majority vote.

Appeals of the board's decisions may be had in a court of competent jurisdiction, but the scope of review is limited in a fashion very similar to that of an award in binding arbitration. Decisions of the board must be enforced by any court of competent jurisdiction unless an appeal is timely filed.

#### Tribal Water Marketing

The compact recognizes that the tribes may market water within the reservation to non-Indians without complying with any state law or administrative regulation. The permanent sale of tribal water is not authorized. The compact also provides that the tribes may market their water outside the reservation by leasing or otherwise transferring it for up to 50 years, so long as the following requirements are met.

- Water must be diverted from Fort Peck Reservoir or the main stem of the Missouri River downstream from Fort Peck Dam.
- Outside the reservation, water must be used for a beneficial purpose as that term is defined by valid state law at the time the tribes propose the use.
- Any export of the tribal water right outside Montana must comply with the valid state laws at the time the export is proposed. The U.S. Constitution imposes limits on state restrictions against exporting water.



- Industrial facilities or pipelines using or transporting water marketed by the tribes or constructed by the tribes outside the reservation must comply with valid state laws, such as Montana's Major Facilities Siting Act, that regulate the construction or operations of such facilities.
- The quantity of water marketed by the tribes outside the reservation in any year is limited in a complex fashion by reference to the amount of water authorized to be transferred by the state. If the state is authorized to market 50,000 acre-feet or more, the amount the tribes can market is a varying percent of the state total. If total state water marketing is less than 50,000 acre-feet per year, the tribes can market any quantity permitted by federal law or—if federal law has no limits—any quantity state law allows private water users to market. In all events, the tribes may market at least 50,000 acre-feet per year.
- The tribes must give notice to the state showing that:
  - a. the means of diversion and construction and operation of diversion works for tribal water marketing are adequate,
  - b. the diversion will not adversely affect any federal or state water right actually in use at the time the diversion is proposed,
  - c. the proposed use does not cause any unreasonable significant environmental impact, and
  - d. that certain large diversions will not be made that significantly impair the quality of water for existing uses, use high-quality water where low-quality water is legally and physically available to the tribes for the use, create or contribute substantially to saline seep, or substantially injure fish or wildlife populations.
- In a unique provision, the tribes agree to offer the state the opportunity to participate in any marketing proposal the tribes develop outside the reservation. The state in return must do the same for the tribes for opportunities in Fort Peck Reservoir or the main-stem Missouri River below Fort Peck Dam.

Although tribal water marketing is not limited by state law, the above criteria do somewhat resemble present state law.

#### FORT BELKNAP WATER RIGHTS COMPACT

#### INTRODUCTION

The Fort Belknap Reservation was established in north central Montana for members of the Gros Ventre and Assiniboine Tribes. Historically, the area was part of the large territory north of the Missouri and Musselshell Rivers designated in the treaty of 1855 for the Blackfeet Nation, including the Gros Ventre. On May 1, 1888, this large reserve was split into the smaller separate reservations of the Blackfeet, Fort Peck, and Fort Belknap. On October 9, 1895, 14,900 acres on the southern boundary of the Fort Belknap Reservation was ceded and the Reservation took the form we see today. Land outside of the southwest boundary of the Reservation has been purchased for the Tribes and is held in either trust or fee status. The Fort Belknap Reservation lies partially within four water court sub-basins: the Milk River, Peoples Creek, Beaver Creek, and a small tributary to the Missouri River. Within the Milk River Basin is a large Reclamation Project built after establishment of the Reservation. The Milk River Project includes the diversion of water from the St. Mary River to the Milk River.

The 2013 Montana Legislature completed the State's financial commitment to the settlement with an appropriation of \$3 million, bringing the total cash contribution to \$13.5 million along with \$4 million of in-kind contributions. Senator Tester introduced Federal legislation in the US Senate to approve and fund the water rights settlement on May 21, 2012, and re-introduced that legislation on July 30, 2013. The current bill, S.1394 – the Gros Ventre and Assiniboine Tribes of the Fort Belknap Indian Community Water Rights Settlement Act of 2013, was referred to the Committee on Indian Affairs where it is awaiting a hearing.



The Compact Commission sent a claim filing notice to the United States on behalf of the Fort Belknap Indian Community (FBIC) on April 1, 2014. This notice formally advised the United States of the statutory deadline of June 30, 2015 for filing the FBIC's clams in the Montana Water Court Adjudication in the event the Compact is not approved by the FBIC prior to that date. The notice was copied to the FBIC President and the FBIC's attorney of record.

#### SUMMARY OF PROVISIONS

Quantification of the tribal water right is summarized below.

#### Milk River

- 645 cfs of water from the Milk River main stem, limited by:
- 125 cfs of natural flow for direct use to irrigate a maximum of 10,425 irrigated acres;
- 520 cfs of direct use and/or off-stream storage up to 60,000 acre-feet a year, for historic and future irrigated acres and non-irrigation uses;
- Tributary water for irrigation use;
- Small impoundments for stockwater use;
- Existing non-irrigation use.

Water use on tributaries upstream from the reservation is protected from the seniority of the tribes' October 17, 1855, priority date by an agreement with the tribes to seek satisfaction of their water use from the Milk River Project when upstream water use affects tribal ability to divert water. The project will be made whole through mitigation measures discussed below.

#### Peoples Creek

The tribes are entitled to all the water in the stream after satisfaction of upstream water rights. A reservoir proposed on Peoples Creek on the reservation is proposed to help keep water in the stream for stockwatering, fisheries, and recreation.

#### Beaver Creek

The tribes are entitled to historical senior irrigation of 2,241 acres, which uses 8,024 acre-feet a year, plus new small impoundments for stock watering and 180 acres of new irrigation.

#### Missouri River Basin

The tribes are entitled to historical senior stock and domestic uses and new small impoundments for stock watering on the reservation. The tribes have the right to divert up to 1,135 acre-feet a year for irrigating 297 historically irrigated acres and 18 acres of other land. The tribes may divert 1,290 acre-feet a year for conveyance to Peoples Creek basin. Water rights acquired with land purchased off the reservation are recognized and will be administered pursuant to state law.

#### Groundwater

- Development of groundwater that is connected to surface water is counted within the limits on surface water use as listed above.
- Existing groundwater use is recognized.
- Groundwater that is not connected to surface water may be developed without adverse effect on other water uses
- Small wells of 35 gpm or less may be developed.



#### IMPLEMENTATION

- The tribes administer the tribal water right
- The tribes establish a process for recognizing water rights allocated to allotted land.
- The tribes establish a process for recognizing water use on fee land within the reservation.
- The U.S. Bureau of Indian Affairs administers BIA Projects. Irrigation companies administer BIA projects quit claimed to them.
- USBR administers its contracts in the Milk River Project.
- The state administers state-based water rights.

To coordinate between these entities in the Milk River Basin, the compact establishes the Milk River Coordinating Committee composed of representatives of the tribes, the Milk River Joint Board of Control, USBR, the U.S. Bureau of Indian Affairs, and DNRC. The purpose of the Milk River Coordinating Committee is to:

(1) coordinate storage and release of water between the various entities; and

(2) implement a grant and loan program for funding of watershed and efficiency improvements in the Milk River basin and establishment of a water bank during periods of extreme drought.

The parties will seek appointment of water commissioners in state court for the distribution of water from the main stem of the Milk River to ensure enforcement of water rights.

The compact establishes a process for assuring that change in use of either a portion of the tribal water right or a state-based right, does not adversely impact any other water right in the basin.

A Compact Board is established to resolve disputes within the Milk River basin that are not within the authority of the water commissioner, and within the other three basins.

#### DEVELOPMENT OF THE TRIBAL WATER RIGHT

The compact contemplates new development of water by the tribes. Funding and authorization for specific projects must occur in federal legislation.

#### MITIGATION

To keep the Milk River Project "whole" after development of the tribal water right, the compact contemplates improvements to the project, including increased storage and improved utilization of existing storage. The Milk River Project is a federal project, thus Congressional authorization is necessary to accomplish mitigation. State and tribal approval of a compact is necessary prior to drafting of a federal bill. Cost share between the state and federal government cannot be negotiated until that time. The compact allows the governor, on behalf of the state, to withdraw from the compact if mitigation measures are not ultimately agreed to, authorized, funded, and built.

The importation of water from the St. Mary River as part of the Milk River Project is recognized as key to continuation of the project and to the ability of the project to satisfy the tribal water right. The St. Mary diversion is in need of rehabilitation. It is not clear that compact legislation is the best means to accomplish rehabilitation of the St. Mary diversion. The parties to the compact have agreed to work together and with the Blackfeet Tribe and the Milk River Irrigation Districts to determine the most appropriate means to ensure the integrity of the St. Mary diversion.



#### BLACKFEET WATER RIGHTS COMPACT

#### Introduction

The Blackfeet Indian Reservation is located east of Glacier National Park and borders the Canadian province of Alberta. Cut Bank Creek and Birch Creek make up part of its eastern and southern borders. The reservation contains 3,000 square miles, half again the size of the national park and larger than the state of Delaware. It is located in parts of Glacier and Pondera Counties.

Elevations in the reservation range from a low of 3,400 feet to a high of 9,066 feet at Chief Mountain. The eastern part of the reservation is mostly open hills of grassland, while a narrow strip along the western edge is covered by forests of fir, spruce, and aspen. Free-ranging cattle are present in areas throughout the reservation.

Several waterways drain the area, with the largest being the St. Mary River, Two Medicine River, Milk River, Birch Creek, and Cut Bank Creek. There are approximately 175 miles of streams and eight major lakes on the reservation.

After 20 years of negotiations, a compact settlement between the Blackfeet Tribe, the United States, and the Montana Reserve Compact Commission passed the Montana Legislature in 2009. The 2013 Montana Legislature completed the state's financial commitment to the settlement with an appropriation of \$14 million, bringing the total cash contribution to \$54 million. The compact will provide water and economic development for the Blackfeet while protecting the rights of water users locally and downstream on the Milk River. The compact was first introduced in Congress in 2010. More recently, Montana Senator Max Baucus introduced SB 434 to the Senate Committee on Indian Affairs on March 4, 2013. On May 8, 2013, a hearing was held to consider the bill, but no action has occurred since that time. The parties continue to work on the details of the final settlement bill.

- Provides water for the existing and future needs of the Blackfeet Tribe.
- Protects all current holders of non-irrigation water rights, such as domestic and stockwater uses, from the Tribe's future exercise of its water right.
- Provides protection for all current irrigation and non-irrigation uses in Birch Creek and the Badger Creek and Two Medicine River basins and a grace period before tribal development in Cut Bank Creek and Milk River drainages.
- Provides a process for the tribe to lease a portion of its water right to off-reservation water users.
- Settles tribal claims in the St. Mary River basin by providing the tribe with an allocation of 50,000 acre-feet of water with protections for the Milk River Project downstream.
- Closes on-reservation portions of streams to new water appropriations under state law.
- Provides for tribal administration of the tribal water right, and state administration of water rights arising under state law.
- Creates a compact board with an administrative process for the resolution of any future disputes between tribal and non-tribal water users.
- Provides for an allocation of water stored in Tiber Reservoir (in an amount to be determined by Congress) for the tribe to use or market.
- Mitigates the impacts of the tribe's water rights on Birch Creek water users through a separate Birch Creek Agreement that commits the state to pay the tribe \$14.5 million in exchange for the tribe deferring new development of its Birch Creek water rights for 15 years and providing 15,000 acre-feet of water per year to



Birch Creek water users from on-reservation storage for at least 10 more years, the total deferral and provision of water not to exceed 25 years.

#### BIRCH CREEK

- 100 cfs from the natural flow of Birch Creek for irrigation use in the Upper Birch Creek drainage.
- Instream flow of 25 cfs from April 1 to September 1 and 15 cfs from October 1 to March 31.
- Any additional water remaining after satisfaction of existing rights arising under state law.
- A management plan is attached as an appendix to the compact, which provides for coordinated management of Birch Creek tribal and non-tribal water use.

#### BADGER CREEK/TWO MEDICINE RIVER

- The tribe has a water right to all currently unappropriated surface water and groundwater. Current nontribal water uses are not subject to a call from new Tribal development.
- Instream flow of 20 cfs in both Badger Creek and Two Medicine River.
- Blackfeet Irrigation Project will be supplied water from the tribal water right and will be administered by the Bureau of Indian Affairs (or as otherwise provided by Congress).

#### CUT BANK CREEK AND MILK RIVER

- The tribe has a water right to all currently unappropriated surface water and groundwater. Current non-tribal non-irrigation water uses are not subject to a call from any new tribal development.
- Irrigation uses on Cut Bank Creek and the Milk River are subject to a call from tribal water uses. The tribe will not develop new irrigation uses on Cut Bank Creek or the Milk River, except projects using exclusively stored or imported water, for 10 years from the effective date of the compact.
- Instream flow of 2 cfs in the on-reservation portions of both Cut Bank Creek and the Milk River.

#### St. Mary River

- 50,000 acre-feet from the United States' share of the St. Mary River.
- The tribe also has a right to all unappropriated water from the U.S. share of Lee Creek, Willow Creek, and groundwater in the St. Mary River drainage on the reservation and any additional water remaining after satisfaction of existing rights arising under state law.
- Current non-tribal water uses within the basin are not subject to a call from new tribal development.

#### **Contributions to the settlement**

The 2013 Montana Legislature completed the state's financial commitment to the settlement with an appropriation of \$14 million, bringing the total cash contribution to \$54 million.

• Federal cost share will be determined during Congressional ratification of the settlement.

## Federal Compacts in the Lower Missouri River Basin

#### BOWDOIN NATIONAL WILDLIFE REFUGE COMPACT

#### INTRODUCTION

Bowdoin National Wildlife Refuge, located in Phillips County near Malta, was established in 1936 and expanded in 1940 to be a refuge and breeding ground for migratory birds. The 15,551-acre refuge is used by nearby communities as an environmental education resource and it draws in tourist dollars for sightseeing and hunting. Most refuge lands were originally part of USBR's Milk River Project.



The lands comprising the refuge sit in a low-lying area along the floodplain of Beaver Creek in what is thought to be an old oxbow of the pre-ice age Missouri River. Historically, these lands were fed by large floods that spilled out of the banks of Beaver Creek, creating wetlands. With the development of the Milk River Project, these lands began to receive irrigation return flows from the project, along with some direct deliveries via the Dodson Canal. Dikes installed after the creation of the refuge reduced the ability of refuge lands to receive flood flows from Beaver Creek.

At the same time, water development upstream has contributed to a reduction of those flows on Beaver Creek, further diminishing the supply of fresh water available to the refuge. In the early years of the refuge, USFWS managers tried to conserve the water supply by limiting the volume of water released from the refuge. This in turn caused a buildup of salts, which, for a time, was desirable because it created a saline ecosystem that was very good for waterfowl. But as salts continued to increase and water quality laws became more stringent, the refuge was prohibited by law from releasing any water at all. Irrigation return flows have also become a source of additional salt, which continues to accumulate in the refuge. Currently, the only way salts can escape the refuge is when winds blow salt crusts away, or when large Beaver Creek floods enter the refuge wetlands and push some of the saline water downstream into Beaver Creek.

Neither of these are sustainable management strategies, especially as large salt/dust storms and occasional releases of saline water have caused problems on neighboring properties. The refuge is presently embarking on a comprehensive planning process to determine how best to address its long-term management options. Quantifying the refuge's federal reserved water rights in the proposed compact is a first step toward ensuring the sustainability of the refuge as positive rather than negative part of its community.

#### **Summary of Provisions**

The compact recognizes federal reserved water rights for Bowdoin National Wildlife Refuge from three sources: surface flows from Beaver Creek, surface flows that drain naturally into the refuge (predominantly from Black Coulee), and groundwater. These water rights may be used for the purposes of the refuge, including wildlife maintenance and enhancement, stock watering, and administrative, institutional, dust suppression, and emergency fire suppression uses. These federal reserved rights are subordinated to all water rights existing under state law as of the effective date of the compact, as well as to all future development excepted from state permitting law (such as small domestic and stock uses). The refuge's federal reserved rights are also conditioned on the execution of a memorandum of understanding (still being developed) that will establish additional restrictions on the use of these rights to ensure that they do not exacerbate the refuge's salt problems. It is also worth bearing in mind that the water court basin in which the refuge is located (Basin 40M) was closed to new surface appropriations by the legislature in 2001 as part of its ratification of the Fort Belknap Water Rights Compact. Below is a summary of the key provisions of the compact.

Subject to the subordination requirement, the compact assigns USFWS federal reserved water rights for:

- 24,714 acre-feet per year from Beaver Creek;
- Surface flows in Basin 400 that drain naturally into the refuge;
- 223 acre-feet per year of groundwater extracted from any source from wells located on the refuge;
- 5,300 acre-feet per year of deep groundwater extracted from wells located on the refuge that must be drilled into geologic formations dating to the Jurassic Period or older.

#### Deep Groundwater

A relatively unique aspect of this compact is the manner in which it addresses the refuge's groundwater rights. In negotiations, USFWS made a request for recognition of a significant groundwater right. The Reserved Water



Rights Compact Commission was concerned about the potential impacts of such a right for two reasons. First, the commission wanted to ensure that any such right would not harm existing users. Second, the commission worried about the risk to those who might develop a groundwater right in the future who could potentially still be displaced by the USFWS by virtue of the senior priority of an undeveloped federal reserved right. At the same time, the commission recognized that the introduction of new water into a water short area would be of benefit to both the USFWS and the off-Refuge community.

The compact's subordination provisions addressed the commission's first concern. The second concern is addressed by requiring that the bulk of USFWS' groundwater right may only be satisfied with water extracted from such a deep aquifer that USFWS would not to be able to deplete it unilaterally. For legal purposes, this depth requirement is defined in the compact as a requirement that USFWS may only exercise the right by drilling wells into geologic formations of the Jurassic Period or older. Such formations are likely located at least 2,600 feet beneath the refuge's surface, and are relatively straightforward for a well driller to identify. The compact also requires USFWS to comply with state permitting requirements (including water quality standards) prior to developing its deep groundwater right.

The compact settles all federal reserved water rights of USFWS on behalf of the refuge.

#### Upper Missouri National Wild and Scenic River

The compact between the State of Montana and the U. S. Department of the Interior, Bureau of Land Management (BLM) settles the reserved water rights for the Upper Missouri National Wild and Scenic River and the Bear Trap Canyon Public Recreation Site. The compact passed the Montana legislature in 1997 and was signed by federal officials on September 10, 1997 (§85-20-501, MCA, 2007). Designated by Congress as a component of the Wild and Scenic River System on October 12, 1976, the designation includes 149 miles of the Missouri River corridor from Fort Benton downstream to Fred Robinson Bridge.

The Reserved Water Rights Compact Commission and BLM were unable to agree on primary purposes for quantification of the reserved water right, but agreed that when Congress designated the Wild and Scenic River it anticipated that future state development would occur.

- The compact sets aside a large volume of water by month to meet future state demands. This volume is sufficient to irrigate approximately 100,000 acres of new direct-flow full-service irrigation and municipal and industrial needs plus approximately 500,000 acre-feet of new storage. Domestic, small groundwater, non-consumptive, supplemental, lawn and garden, instream stock uses, late claims, and other federal and Indian reserved water rights are not counted against the state's available water supply. Once the state has exhausted the available water supply, the basin above the downstream boundary of the Upper Missouri National Wild and Scenic River will be closed to new appropriations for that month. The reserved water right for instream flow is limited to the water left after the state's future development.
- The compact protects all existing water rights, permits, and water reservations.
- No new impoundments are allowed on the Missouri River main stem without federal consent.
- BLM does have not standing to object to new appropriations or changes in appropriation.
- No appropriations prior to October 12, 1976, will have terms, conditions, or limitations as result of this agreement.
- BLM cannot make a call on the Missouri River to require junior users to let water pass.



#### UPPER MISSOURI BREAKS NATIONAL MONUMENT COMPACT

### INTRODUCTION

In January 17, 2001, the Upper Missouri River Breaks National Monument was officially added to the Department of the Interior's National Landscape Monument System. This national monument includes an ecosystem that parallels the Upper Missouri National Wild and Scenic River through north-central Montana. Much of the land in this area (375,000 acres) is public land managed by the Bureau of Land Management. In some areas, these BLM acres are intermingled with State of Montana lands and private property. This designation applies only to the BLM managed lands.

The monument contains essential winter range for elk, pronghorn, and sage grouse as well as habitat for prairie dogs. The lower reach of the Judith River, just above its confluence with the Missouri, contains one of the few remaining fully functioning cottonwood gallery forest ecosystems on the Northern Plains. Arrow Creek, originally called Slaughter River by Lewis and Clark, contains important spawning habitat for the endangered pallid sturgeon and is a critical seed source for cottonwood trees for the floodplain along the Missouri.

The BLM submitted a proposal from which to commence negotiations in January of 2011. The Compact for the Monument was agreed to by the Parties following four negotiation sessions and three public meetings. The Compact was approved unanimously by the Commission in December of 2012. It was ratified by the 2013 Montana Legislature as SB 88. The draft abstracts have been prepared by Commission technical staff. The Commission is awaiting final signatures from the U.S. Department of Justice.

- There shall be no reduction in the amount of water available for future development in the Judith Basin as a result of this compact.
- The exception to permitting will continue for domestic wells, stock ponds, and other uses that meet the requirements for exception to permitting as listed in 85-2-306, MCA. These uses will not be subject to call by BLM under the specifications of this compact.
- Water Right: In settlement of the monument's reserved water right claim, a water right is granted on both the Judith River and Arrow Creek.
  - a. <u>Judith River:</u> The Judith River water right is in the amount of 160 cfs measured at the USGS gaging station near the confluence of the Judith River with the Missouri River. The period of use is January 1 through December 31 of each year. This right shall run concurrently and junior in priority to a Montana Fish, Wildlife & Parks right for the same source, flow rate, and period of use.
  - b. <u>Arrow Creek:</u> The Arrow Creek water right is in the amount of 5 cfs measured where the Monument boundary intersects with Arrow Creek. The period of use is March 1 through July 31 of each year. A proportionally lower flow rate at the may be determined at an alternate measurement point.
- **Priority Date:** The reserved water right will have a priority date of January 17, 2001, but this reserved right will be subordinate to state-based permits with a priority date before June 1, 2012.
- **Restriction on Main-stem Impoundments:** New main-stem impoundments under this compact not otherwise excepted from permitting requirements under Montana law will not be permitted on the following reaches of the Judith River and Arrow Creek. Off-stream impoundments will continue to be permitted under DNRC permitting procedure.



- a. <u>Judith River</u>: from the confluence of the Middle and South Forks of the Judith River downstream to its confluence with the Missouri River.
- b. <u>Arrow Creek:</u> from its confluence with Hay Creek downstream to its confluence with the Missouri River.
- **Ramped Diversion Requirement:** Flows on both the Judith River and Arrow Creek that have not already been appropriated as of the date of this compact will be available for future state-based development, subject to the reserved water right and applicable permit restrictions. New permits issued after the date on which this compact is ratified will be subject to a ramped diversion requirement for diversions greater than 20 cfs capacity. Direct from source diversions from the Judith River and Arrow Creek that have a diversion capacity greater than 20 cfs will be allowed an increase in diverted water of no more than 20cfs per 24-hour period.

#### CHARLES M. RUSSELL NATIONAL WILDLIFE REFUGE COMPACT

#### Introduction

Extending 125 miles up the Missouri River from Fort Peck Dam in north-central Montana, the Charles M. Russell National Wildlife Refuge (CMR) is approximately 1.1 million acres in size and includes the 245,000-acre Fort Peck Reservoir. The refuge was established in 1936 and sharp-tailed grouse and pronghorn were identified as the primary species in need of conservation. The overall management goal at the CMR Complex is to promote biological diversity and maintain the natural abundance of native flora and fauna.

The Compact was approved unanimously by the Commission in January of 2013 and ratified by the 2013 Montana Legislature as SB 278. The Commission is awaiting final signatures from the U.S. Department of Justice. The ratified compact quantifies a federal reserved water right consisting of base flows in 69 streams draining onto the refuge, and implements limitations on larger on-stream impoundments on selected streams.

- **Priority Date** The ratified compact subordinates the United States' 1936 priority date to 2013.
- Water Right. In settlement of the refuge's federal reserved water right, the following rights will be recognized:
  - a. A quantified right of 0.5 cfs or 1 cfs in 68 named streams draining onto the refuge for instream use to benefit stock, wildlife, and wildlife habitat. The place of use is from the point where the Refuge boundary crosses each named stream to its confluence with Fort Peck Lake or the Missouri River. The period of use is March 1 to June 30.
  - b. A minimum instream flow right of 70 cfs in the Musselshell River measured where the main-stem river enters USFWS owned land within the refuge. The place of use is from the point where the main-stem river channel enters USFWS land on the refuge to its confluence with Fort Peck Lake. The period of use is from March 1 to June 30. This right shall run coextensively with and junior to the Montana Fish, Wildlife & Parks right for the same source and flow rate. This right will be enforceable when the flow on the Musselshell falls below 70 cfs for 5 consecutive days.
  - c. Filed rights to wells, ponds, and developed springs. The claims that are consistent with the purposes for which the refuge was established will be incorporated into the reserved water right and withdrawn from the adjudication.
- **Conditions to be applied to permits issued after the effective date of the compact**. On streams with a quantified right, DNRC may issue new permits subject to the reserved water right. On the stream reaches identified in Appendix 5 on the map titled "Article IV.C. Protected Reaches for On-Stream Impoundment



Limitations," no new on-stream impoundments may be constructed after the effective date of this compact, with the following exceptions:

- a. On-stream impoundments less than 15 acre-feet capacity allowed;
- b. On-stream diversion works to serve off-stream impoundment 15 acre-feet or larger allowed;
- c. On-stream impoundments 15 acre-feet or larger allowed upstream of restricted reach;
- d. On-stream impoundments 15 acre-feet or larger allowed on tributaries of restricted reach.

#### INTERSTATE COMPACTS AND INTERNATIONAL TREATIES

#### **Boundary Waters Treaty of 1909**

The Milk River originates in the Montana foothills and flows northeast into Alberta. Once in Alberta, the Milk River parallels the Montana border for over 200 miles before turning south east and crossing back into Montana. The St. Mary River originates in the high mountain areas of Glacier Park in Montana and flows north into Alberta. The St. Mary continues north for about 60 miles before emptying into the Oldman River and becoming part of the Saskatchewan River system.

The St. Mary and Milk Rivers both originate in western Montana and flow north into Alberta. The origin and path of the flow means that water negotiations concerning the two rivers have international bearing. When the Boundary Waters Treaty of 1909 between Canada and the United States was signed the division of the flow of the St. Mary and Milk Rivers between Canada and the United States was specified in Article VI.

The treaty also established the International Joint Commission (IJC) composed of three members from Canada, and three from the United States, to examine and report on any issues referred to it by the member nations.

#### 1917 Diversion of the St. Mary River

In 1917, the United States constructed a canal to divert water from the St. Mary River in western Montana to the Milk River. The diverted water flows in the Milk River channel into Alberta and is conveyed across southern Alberta for irrigation in eastern Montana. The project's objective was to provide a stable source of water for irrigation in the lower Milk River Valley. The plan to divert water from the St. Mary River to augment flows in the Milk River emerged to become the largest and most ambitious trans-basin diversion project of the time.

#### 1921 Order of the International Joint Commission (IJC)

The United States and Canada could not agree on how Article VI of the Treaty of 1909 should be interpreted, nor could they agree on how water was to be measured or apportioned with regard to the St. Mary and Milk Rivers. The Canadian position was that the prior apportionment specified in the treaty should be subtracted from the total flow of the two rivers prior to their equal sharing and river flow to be shared should be based on the flow at the mouth of the two rivers.

In 1921, after six years of hearings in Canada and the United States, and a legal reconstruction of intent, the IJC issued an order with rules clarifying how measurement and apportionment would take place.

- Prior appropriations could be excluded from being shared equally.
- The flow to be shared is the flow at the final border crossing of each river.

#### St. Mary River and Milk River: Ongoing issues

In 2003, Montana wrote to the IJC, stating the 1921 order was unfair and requesting that it be opened for review. In 2004, IJC held public hearings to determine if the 1921 order should be reviewed regarding the interpretation of how the water from the two rivers is shared.



- In 2005, IJC established a joint task force of technical staff from Canada and the United States, as well as specifically from Alberta and Montana, to review administrative measures. These measures are the actual calculation methods used to determine each country's' share of water based on the entitlement defined in the 1921 order.
- Because the joint task force was unable to reach consensus, it recommended that Alberta and Montana work together at a watershed level to address the issue. The IJC then approached the governments of Alberta and Montana with the request they work together to address how each country could get better access to their respective entitlements.

#### Montana – Alberta Water Management Initiative

The purpose of the initiative is to explore and evaluate options for improving Alberta's and Montana's access to their respective share of the water of the St. Mary and Milk Rivers and make a joint recommendation on preferred options to provincial and state governments for their consideration and approval. The premier of Alberta and the governor of Montana have approved the terms of reference for the initiative. A joint initiative team has been appointed to explore options and make recommendations to the premier and governor. As of 2014, the issues addressed in the Montana/Alberta Water Management Initiative remain unresolved.



# VII. Potential Future Demands for Water in the Lower Missouri River Basin

Estimates of water demand for public water supplies and self-supplied domestic for the 20-year planning period ending in 2035 are based on population trends extrapolated from the 1990 and 2010 censuses and percapita use rates. Population projections are provided at the state, county, planning basin, and sub-basin (4thcode, 8-digit HUC) levels. In those HUCs where negative growth was historically observed (54 HUCS, primarily located in the Lower Missouri and Yellowstone planning



basins), zero population growth is assumed for planning purposes.

The intent of these projections is not to predict or forecast precise population levels at particular points in time and locations in Montana. The purpose, rather, is to offer reasonable estimates of magnitudes of population growth that would presumably relate to the supply and demand for water in various ways over the course of the planning period. Extrapolating statewide population growth at the average annual rate of population change for the period between 1990 and 2010 would result in 302,923 additional residents in 2035. If Montana's rate of growth were to continue at this rate, the state's population would reach 2 million in 2077.

Another set of population projections developed by the Montana Department of Commerce (MT Commerce) are available for comparison to the extrapolated census values. The MT Commerce projections are at the state and county levels developed using eREMI, a population projection product of Regional Economic Models, Inc. (REMI). Rather than extrapolate recent trends, the MT Commerce projections forecast declining rates of population increase through 2035, reflecting assumptions about Montana's age structure, natality and survival rates, and migration patterns over the period.

Population increases forecast by the MT Commerce population are about half of the projections obtained by extrapolating census trends from 1990 to 2010. While the courses of population change in Montana and in particular parts of the state are highly uncertain from the perspective of the present, these projections offer two distinct scenarios for consideration when regarding prospects for future water use in Montana. They should be



viewed as potentially useful tools in examining various factors affecting—and consequences affected by— the supply and demand of Montana's waters.

Scenarios of future demand for agricultural irrigation are based on trends in irrigation water use and agricultural production statistics.

- Projections of future irrigated acres, by watershed, are developed using extrapolation of historical trends from National Agricultural Statistics Service (NASS) data, and possibly other sources
- Future crop-type trends are also assessed using trends from NASS data; water-use characteristics will vary as crop-type ratios change
- Trends in irrigation system types (for instance: sprinkler versus flood) are also used to predict future
  irrigation efficiencies, and resulting required per-acre diversions and per-acre water consumption rates.
  Irrigation system types will also affect return flow patterns and potential changes to these patterns are also
  taken into consideration
- Changes in the timing of irrigation demands and monthly crop irrigation requirements are estimated for future scenarios and compared to historic conditions. Modeled temperature and precipitation projections are used along with crop consumptive use equations to project future per-acre irrigation demands

## **Agricultural Demand Projections**

Agricultural irrigation is the largest consumer of water in the Lower Missouri River Basin and in Montana. Changes in irrigation water demand may therefore have the largest impact on water supplies. Changes in demand over the next two decades will likely occur from acreage being added or removed from irrigation service. While the feasibility of developing irrigation on previously non-irrigated acreage may be low, the potential for expanded irrigation is possible.

To estimate possible future irrigation demands, DNRC considered two scenarios on lands identified in the 1990's during the Missouri River Water Reservation process. A first scenario is based on the projection of historical irrigation development trends, and a second scenario is based on full development of the approved water reservations.

The water reservation process in the Missouri Basin included substantial efforts to identify lands most likely for future irrigation expansion, based on project feasibility. Volumes of water granted through reservations totaled 256,994 acre-feet for the Lower Missouri Basin with priority dates of either 1992 or 1994.

As of 2013, only 28,546 acre-feet (about 11 percent) of the water reserved for irrigation was put to use. Extrapolating the allocation trends for each conservation district through 2035 would result in an additional 33,027 acre-feet diverted to serve 17,614 new acres under irrigation, consuming an additional 26,422 acre-feet. The largest increases in acreage and irrigation water demand (Table VII-1) would occur in Roosevelt and Richland counties using this historic development trend.



**Table VII-1:** Projected new irrigated acreage and agricultural demand for CD water reservations in the Lower Missouri River Basin, based on historic trend.

Conservation District	Additional Acres	Additional Withdrawals (AF)	Additional Consumption (AF)
Fergus	132	248	199
McCone	2,343	4,392	3,514
Richland County	5,800	10,875	8,700
Roosevelt County	5,852	10,972	8,777
Sheridan County	3,488	6,540	5,232
Lower Missouri Basin	17,614	33,027	26,422

Full development of conservation district reservations on all lands identified through the reservation process would result in an additional 139,195 acre-feet of water diverted to serve 74,237 new acres of irrigated land, consuming an additional 111,356 acre-feet (Table VII-2).

The reservation process assumed new irrigation projects would be served by highly efficient center pivot sprinkler systems and would have zero conveyance loss. Consequently, the estimates in Tables VII-1 and VII-2 include a much higher overall efficiency than the statewide average of less than 30 percent. The projected water volume diverted under the full development scenario is less than the 256,994 acre-feet reserved because the authorized limit of 81,887 additional acres was reached first because of the assumed high level of project efficiency.

Any decline in irrigation demand on acreage displaced by future municipal and residential development would be somewhat offset by the increase in demand for water for those new uses. More importantly, any water not diverted for irrigation of displaced lands would likely be diverted by other irrigators in water-short basins and would result in no decline in irrigation demand and potentially an overall increase in consumption.

district water reservations.				
Conservation District	Additional Acres	Additional Withdrawals (AF)	Additional Consumption (AF)	
Blaine	6,141	11,514	9,212	
Daniels	1,439	2,698	2,159	
Fergus	1,961	3,677	2,942	
Judith Basin	390	731	585	
Liberty	50	94	75	
Lower Musselshell	320	600	480	
McCone	4.526	8.487	6.789	

10,952

**Table VII-2:** New irrigated acreage and agricultural demands at full build out of conservation district water reservations.

5,841

**Richland County** 

8,762



Conservation District	Additional Acres	Additional Withdrawals (AF)	Additional Consumption (AF)
Roosevelt County	19,232	36,059	28,847
Sheridan County	5,243	9,831	7,865
Valley	28,269	53,005	42,404
Lower Missouri Basin	73,411	137,647	110,118

The water volume granted during the reservations process in the early 1990's is four times greater than the development trend over the past 20 years. This suggests that if the trend slowly continued with no deadline date, full use of the authorized irrigation water might take an additional 60 years.

#### **Virgelle Diversion**

The Upper Missouri River Reservations included a Bureau of Reclamation project that would send Missouri River water into the Milk River basin via pipeline. The BOR was ultimately granted a flow rate of 230 cfs and a volume of 68,000 acre feet, with a priority date of July 1, 1985. Of this volume, 47,100 acre-feet would be used for supplemental and new irrigation in the Milk River Basin and on the Rocky Boys and Fort Belknap Indian reservations. The remaining 20,900 acre-feet would be used for Lake Bowdoin National Wildlife Refuge, BLM stock ponds, and the town of Chinook water supply.

The project would include a pumping station located just upstream of Virgelle and construction of a 46 mile long canal to transport the water into the Milk River basin. This water reservation has a completion sunset date of December 31, 2025, however there has been no activity towards its development.

#### Modeled Future Evapotranspiration Rates and Increases in Irrigation Consumption

A changing climate could affect irrigated agriculture in several ways. Perhaps most importantly, evapotranspiration, the consumption of water by plants, is expected to increase if air temperatures warm in the future. For this report, 112 climate projections based on 16 different climate models were used to forecast future changes in evapotranspiration in the Milk River Valley. Figure VII-1 shows the resulting forecasted changes to evapotranspiration. The heavy central line represents the ensemble mean forecast value of all projections, by year. The thinner outer lines represent the highest and lowest forecasts of the 112 projections by year. The lines illustrate a forecasted increase in evapotranspiration through the end of the current century.



**Figure VII-1**. Modeled potential evapotranspiration for irrigated lands of the central Milk River valley.



Three different climatic scenarios were modeled to estimate possible changes in evapotranspiration in the Milk River valley. Scenario 1: a lower range of warming combined with wetter conditions. Scenario 2: a middle range of warming combined with a small precipitation increase. Scenario 3: the upper range of warming combined with drier conditions.

In the Milk River valley, the projected evapotranspiration increases by future climatic scenario are, Scenario 1: 0.4 inches (2.1 percent increase); Scenario 2: 1.1 inches (5.5 percent); and Scenario 3: 1.5 inches (7.1 percent). Applied to projections of future increased irrigated acreage, the increased evapotranspiration could result in additional demands for irrigation ranging from a slight increase of 9,542 acre-feet under the current level of irrigated acreage and climatic scenario 1, to an increase of 153,414 acre-feet under full development of the water reservations and climatic scenario 3. Table VII-3 compares projected increases in evapotranspiration and agricultural water consumption centered on 2035 for these three future-climate scenarios.



**Table VII-3:** Lower Missouri River Basin projected increases in irrigation water consumption for three future scenarios by subbasin.

	Increase in Potential Evapotranspiration for 2010-2059 period compared to 1950-1999 period (acre-feet per year).				
	Current level of agricultural irrigation consumption.				
	Scenario 1	Scenario 2	Scenario 3		
Subbasin	2.1% ET Increase	5.5% ET Increase	7.1% ET Increase		
Milk River	4,800	12,572	16,230		
Musselshell River	1,694	4,438	5,729		
Middle Missouri River	1,566	4,101	5,294		
Lower Missouri River	1,481	3,880	5,009		
Lower Missouri Basin Total	9,542	24,991	32,261		
	Current level of agricultural irrigation consumption combined with future full development of Missouri River irrigation reservations.				
	Scenario 1	Scenario 2	Scenario 3		
Subbasin	2.1% ET Increase	5.5% ET Increase	7.1% ET Increase		
Milk River	57,577	67,106	71,591		
Musselshell River	2,185	4,944	6,243		
Middle Missouri River	5,167	7,822	9,071		
Lower Missouri River	57,046	61,295	63,295		
Lower Missouri Basin Total	123,337	143,789	153,414		

The percentage increases are based on a modeled test area in the Milk River Basin, extending approximately from Chinook to Vandalia on irrigated lands of the valley bottom. The three scenario groupings are more highly detailed in the Climate Change section of this document (section VII - D). The projected increases in irrigation consumption were based on estimates of existing consumption, as presented in the Consumptive Water Use section of this report (section V - A), multiplied by the projected percentage increase in evapotranspiration. More details on projected increases in evapotranspiration and other hydrologic considerations can be found in the Climate Change section of this document.

## **Municipal and Domestic Demand Projections**

Population growth projections correspond directly to increased (or decreased) demands for domestic and municipal water uses. To estimate future domestic water demands, population projections were created for the Lower Missouri Basin to the year 2035. The projections were made for each HUC and were based on population trends during the period 1990-2010.



Much of the Lower Missouri Basin has exhibited a declining population. Nevertheless, to avoid underestimating future domestic water demand, stable populations were assumed and negative growth trends were eliminated. Because negative growth trends (declining populations) were replaced with zero loss or zero growth figures, the 2035 population projections, and therefore domestic water use, should be considered a maximum.

The Lower Missouri Basin contains 34 HUCs, with a total 2010 population of 79,030 people. This represents only 8 percent of the total population of Montana, within a land area of about 34 percent of the state. Of the 34 HUCs, 27 lost population and only 7 gained population between 1990 and 2010. Based on these trends, total basin population is projected to drop to 70,871 people by 2035; a reduction of more than 8 percent (U.S. Census Bureau).

The seven HUCs showing projected population increases are:

Battle Creek: a Milk River tributary located just north and east of Chinook.

**Big Sandy Creek**: a Milk River tributary located south of Havre on the west slope of the Bears Paw Mountains. This HUC includes a large portion of the Rocky Boy's Indian Reservation.

Flatwillow Creek: a major tributary of the Musselshell River in the lower basin.

Box Elder Creek: a tributary of Flatwillow Creek east of Lewistown.

Milk River Headwaters: located on the Blackfeet Indian Reservation, north of Browning.

**Peoples Creek**: drains part of the Bears Paw and Little Rocky mountains and joins the Milk River near Dodson. This HUC contains a large portion of the Fort Belknap Indian Reservation.

Upper Musselshell River: this large HUC contains the towns of Harlowton, Ryegate, and Lavina.

Figure VII-2 shows the projected population growth for HUCs with increasing populations in the Lower Missouri Basin. The Big Sandy and Peoples Creek HUCs show the largest increases in population at the year 2035. Both of these HUCs contain large portions of Indian reservations, for which reserved water compacts have been completed.

The Big Sandy Creek projection shows a gain of 2,654 people, which represents a 67 percent population increase by 2035. The Peoples Creek projection shows a gain of 317 people, representing an increase of 23 percent. In the Upper Musselshell River HUC, the projected increase is 252 people, or a 5 percent gain above the 2010 population.



**Figure VII-2:** Projected Population Growth for HUCs gaining population in the Lower Missouri River Basin.



Based on the 2035 population estimate, the following assumptions were used to estimate future water demand in the Lower Missouri River Basin:

- 1. Percentages of population by HUC served by Public Water Supply (PWS) and individual wells were assumed to be constant over time.
- 2. Percentages of PWS supplied by groundwater in each HUC are assumed to be constant over time.
- 3. Gallons per Capita Daily (gpcd) for PWS users in each HUC is assumed to be constant over time.
- 4. 37 percent of water diverted for PWS is consumed. This is consistent with present day (2010) estimates.
- 5. Self-Supplied Domestic Water (SSD) users equals the total population in a HUC minus those served by PWS.
- 6. New SSD water use is assumed to be supplied entirely by groundwater.
- 7. SSD water use equals 75 gpcd, of which 50 percent is assumed to be consumed. This is consistent with present day (2010) estimates.

Figure VII-3 shows the current (2010) Public Water Supply demand, the projected increase in demand and the total demand of PWS at 2035 in LMRB HUCs that have a positive population growth trend. The figures are in acre-feet annually.



Figure VII-3: Projected PWS Demand in 2035.



# Effects of New or Increased Depletions on the Availability of Future Surface Water Supplies.

### CLIMATE VARIABILITY

Climate may be defined as a prevailing set of environmental conditions in a region over a relatively long period of time. Meteorological variables, such as temperature, precipitation, wind, and snowfall describe average regional climatic conditions and their variability over time. Weather, on the other hand, may describe these same climatic conditions, but over the much shorter time scale of days, weeks or months. Atmospheric records indicate that the Lower Missouri River Basin experiences large changes of weather in the short term and significant climatic variability over the long term.

A regional climate may be influenced by factors at the global scale, including climatic fluctuations connected to Pacific Ocean temperatures. Phenomena such as the El Niño Southern Oscillation (ENSO) can affect regional air temperature and precipitation for a series of years. Other dynamics, such as the Pacific Decadal Oscillation (PDO) can have effects that persist for decades. All of these factors can lead to variability in air temperatures and precipitation patterns, which affect regional water supply and demand. Drought cycles and periods of excessive moisture in Montana and in the Lower Missouri Basin are affected by these large-scale factors.



The El Niño Southern Oscillation (ENSO) can influence the timing and extent of wet and dry cycles in Montana. ENSO is attributed to changes in the near-surface ocean temperature of the South Pacific off the coast of South America, and can be characterized by warm, cool, and neutral phases. The oscillation of these ENSO phases generally affects Montana and the Lower Missouri Basin as follows: (1) El Niño or warm phases are characterized by below average precipitation; (2) La Niña or cool phases are characterized by above average precipitation; and (3) ENSO neutral conditions have about an equal chance of above or below average precipitation. The Lower Missouri River Basin is highly dependent on snowfall and streamflow conditions in the upper basin, which are in turn influenced by ENSO.

The Multivariate ENSO Index (NOAA) presented in Figure VII-4 below uses several oceanic parameters to create an index of El Niño, La Niña or neutral conditions. In general, positive numbers (red) represent the warm El Niño conditions and the negative numbers (blue) represent the cold La Niña conditions. The strength of the El Niño or La Niña is indicated by a greater positive or negative number. Neutral conditions are indicated by values near zero.



Figure VII-4: NOAA Multivariate ENSO Index.

The Pacific Decadal Oscillation (PDO) is described as changes in water temperature of the North Pacific Ocean, north of about 20 degrees latitude. The warm and cool phases of the PDO occur on an inter-decadal time scale, typically lasting 20 to 30 years. During the warm or positive phase, the west Pacific Ocean (near Japan and Korea) becomes cool, and the eastern Pacific (near the west coast of the United States) warms. During the cool or negative phase, the opposite is true. The PDO index is shown in Figure VII-5 (JISAO). The strength of the warm or cool phase is indicated by the magnitude of the positive or negative index.

For the Lower Missouri River Basin, the warm phase (positive) of the PDO generally results in drier conditions and the cool (negative) phase typically results in wetter conditions. The data indicate that the PDO recently changed to the cool negative phase, which may suggest cooler, wetter conditions for the coming year (2015).







#### DROUGHT

Montana has experienced several periods of drought over the past century. Drought is a prolonged period of dryness or lack of precipitation that causes extensive damage to crops, forest and range resources, urban water supplies, and other water-dependent resources. Duration is an important measure of drought severity, as the negative effects are magnified with longerlasting droughts. Drought duration can range from a year or two to several continuous years, or even several years interrupted by a high water year. Aerial



extent is also an important measure, since some droughts may be fairly localized while other droughts affect huge land areas.

Non-irrigated croplands, which are widespread in the Lower Missouri Basin, are highly susceptible to moisture shortages. Rangelands and irrigated croplands are less susceptible to short-term droughts, but all moisture related resources are eventually affected by longer moisture deficits.

Depending on location within the Lower Missouri Basin, recent drought periods include several years within the 2000s, the 1980s, the 1960s, the 1950s, and of course the 1930s Dust Bowl, which is regarded as the most severe, widespread, and longest-lasting drought of recent history. But drought severity and duration during these time periods was not uniform across the state.

Figure VII-6 shows total annual precipitation at Culbertson for the 1930s, 1980s, and 2000s, compared to the period-of-record annual average of 13.39 inches (WRCC, 2014). At Culbertson, several years during the 1930s received near-average precipitation, but four years were well below normal, and in 1934 only 4.63 inches fell. During the drought of the 2000s, which harshly affected much of western Montana, Culbertson actually received above-average precipitation in all but two years.



**Figure VII-6:** Comparison of Drought Period Annual Precipitation at Culbertson, Montana



In the Lower Missouri Basin, it is difficult to compare the 1930s drought to that of more recent periods, especially in terms of surface water supply. The basin lacks stream gaging records from the 1930s. Reservoirs and other drought-mitigating infrastructure, as well as additional irrigation and other water-depleting uses, have been developed in the interim. However, an examination of existing precipitation records, reservoir operations, and limited stream gage records may provide some insights.

Figure VII-7 compares the period of record monthly average flows against monthly average flows of the Poplar River at the international boundary for the severe drought years of 1934, 1988, and 2003. The graph shows that 1988 was possibly the worst year on record in terms of summer water supply, and was much worse in this area than in the summers of 1934 and 2003. However, the drought in this area only lasted one or two years.



**Figure VII-7.** Comparison of average monthly flows for Poplar River at International Boundary.



A limited drought of even one year can be quite harmful to crops, forest resources, cattle, or wildlife. Multi-year droughts compound the damaging effects by further reducing soil moisture and groundwater supplies. Groundwater that is hydrologically connected to the surface supply is strongly influenced by climate and may take years to recover to normal levels following an extended drought.



Figure VII-8 shows a more complete picture of Poplar River drought conditions over prolonged periods. In this graph, monthly flows are averaged over each decade.



Figure VII-8: Poplar River flows during assorted drought decades.

The 1930's and 1980's drought periods show depleted flows during the spring and summer months, resulting from a lack of precipitation in the watershed. But except for a few years during the decade, the 2000's experienced relatively close to normal conditions at this location.



Prolonged drought can be very disruptive to reservoir management and to stored water contents. Figure VII-9 shows month-end contents at Fresno Reservoir for the 1980s and 2000s droughts, compared to the period of record average month-end stored contents. For each decade, the averaged storage figures were well below the long-term normal. Total deficit below normal stored content for the 1980s amounted to 195,000 acre-feet, a shortfall of about 25 percent. The storage deficit for the 2000s totaled 236,000 acre-feet, a shortfall of about 30 percent.



Figure VII-9: Comparison of Fresno Reservoir Contents during drought periods.

More revealing is the monthly record of stored contents for the reservoir. Figure VII-10 shows the monthly record for the 1980s compared to the historical average storage pattern. Storage deficits can be seen in the early 1980s, mainly during August through February. With the drought progressively worsening, the mid-1980s were especially dry. Fresno Reservoir has a newly mapped capacity of about 90,000 acre-feet. But in February 1990, stored contents dropped to only 5,124 acre-feet. After recovering during the generally water-rich late 1990s, the reservoir again receded, dropping to 3,699 acre-feet in March of 2002 (Figure VII-11).



**Fresno Reservoir Storage Contents** 1980 - 1989 140,000 End-of-Month Average 1980's 120,000 End Of Month Contents, Acre Feet 000'00 000'00 20,000 0 Jan July 1987 1988 1980 1981 1982 1984 1986 1983 1985 1989

Figure VII-10: Fresno Reservoir Stored Contents, 1980 thru 1989.







According to the USBR reservoir allocation diagram (Figure VII-12), stored water contents below 59,898 acrefeet are allocated to the active conservation pool, and are used to satisfy a variety of needs including fisheries, recreation, irrigation, and municipal uses. The worst drought years of the mid 1980s and early 2000s saw stored contents much below 30,000 acre-feet, and impacts on supply were compounded by consecutive drought years.

Figure VII-12: USBR Fresno Reservoir Allocation diagram.



## FRESNO RESERVOIR ALLOCATIONS

Larger storage projects, such as Fort Peck Reservoir, can exhibit massive impacts from prolonged drought. With a full pool of 18.5 million acre-feet, drought effects may not be as immediate, and may take a longer time to recover from. Figure VII-13 shows monthly storage at Fort Peck for the 1980s through the 2000s, compared to the average monthly storage for the period 1967-2013.

Drought effects from the late 1980s are obvious in the graph, showing a large deficit of storage well into the 1990s. Storage recovered with high water years in the mid and late 1990s, then steadily and drastically declined during the 2000s drought. The largest stored water deficit shown during this time was in July 2007, with a stored water shortfall of 5,742,000 acre-feet; about 38 percent below the normal stored content for July.

The drought of the 2000s was severe and prolonged throughout western Montana, and heavily impacted the main stem Missouri River, all its tributaries, and reservoirs in the Upper Missouri River Basin above the reservoir. Fort Peck Reservoir, located downstream, inherited drought effects from the upper basin. Water shortages such as these typically reduce power generating capacity at hydroelectric facilities such as Fort Peck.



Figure VII-13: Fort Peck stored water contents from 1980 through 2009.



## Effects of Drought on Groundwater Supplies and the Role of Groundwater in Sustaining Base Flow during Droughts

In general, groundwater is an important storage reservoir that supports base flow during dry years and in the early years of extended droughts. Prolonged drought slows aquifer recharge, so less groundwater storage is available to support base flow and water levels decline.

Groundwater sensitivity to drought varies throughout the Lower Missouri Basin and is correlated to the groundwater system's ability to transmit and store water, location to surface water (recharge), and depth below the ground surface. The GWIC statewide monitoring network provides long-term water-level records that show change in groundwater storage or pressure. Upward trends (increasing elevation and decreasing distance to water) show increased groundwater storage or pressure. Hydrographs portray short and long term trends. The overall patterns are related to seasonal/annual precipitation trends, while the seasonal or annual fluctuations are characteristic of wells that are more sensitive to climate (Patton, 2014). The green and red bars on the following groundwater hydrographs represent departures from the mean of the annual precipitation at the closest weather station.

The water levels in the alluvium well (GWIC # 3766) near Plentywood show water level responses to climate variability such as the 2000s drought. Figure VII-14 shows water level changes in the alluvium that are related to extended periods of dry and wet cycles. The hydrograph shows the impact of annual water level fluctuations superimposed on a low-frequency cycle that is likely climate related.

Monitoring wells in the Flaxville gravels near Turner (GWIC # 3977) show yearly fluctuations superimposed on a declining long-term cyclic trend in response to multi-year trends in climate variability (Figure VII-15). For example, water levels fell a 7 feet from 1985 to 2010. Water levels rose during the start of this decade due to a wetter period.



A monitoring well (GWIC # 1575) in the Fort Union Formation near Roundup shows annual changes and multiyear trends related to climate variability. Figure VII-16 shows a declining cyclic trend with water levels falling approximately 6 feet from 1981 to 2006. Since 2006, water levels have risen 4 feet.

**Figure VII-14:** Groundwater levels in the alluvium aquifer near Plentywood showing the effects of drought in the 2000s and recovery during wetter periods (*GWIC* # 3766).





**Figure VII-15:** Groundwater levels in the Flaxville gravels near Turner showing the effects of wet periods, dry periods, and long-term cyclic decline (*GWIC* # 3977).




**Figure VII-16:** Fort Union Formation groundwater levels near Roundup showing multi-year trends and responses to above average years of precipitation (*GWIC* # *1575*).





## Potential Effects of Climate Change on Future Water Supplies and Demands

INTRODUCTION Water planning assessments have typically assumed that future water supply conditions will be similar to past water supply conditions, within a familiar range of annual fluctuation. The sequencing of past flow patterns cannot be exactly repeated. Recent analysis of climate information suggests that the future limits of streamflow variability may differ from the historical record.



Analysis of climatic

records shows that much of the United States has experienced warming during the 20<sup>th</sup> century, and projections indicate that warming is likely to continue in the 21<sup>st</sup> century. This warming will affect the amount, distribution, and form of precipitation as either rain or snow. Warming will also affect evaporation rates and evapotranspiration rates by natural vegetation and irrigated crops. Streamflow is likely to change in volume, timing, and distribution.

This section discusses climate change in the Musselshell River sub-basin, focusing on how these projected changes might affect water supplies and demands. This information can be used to evaluate the ability to meet future water demands within the basin, and to identify adaptation strategies to solve future supply challenges.

#### **METHODS**

The general procedures used in this section are similar to those described in the US Bureau of Reclamation (USBR) West-Wide Climate Risk Assessments (2011). Future temperature and precipitation projections were obtained from the USBR Downscaled Coupled Model Intercomparison Project, CMIP3 and CMIP5 Climate and Hydrology Projections archive site at: http://gdo-dcp.ucllnl.org/downscaled\_cmip\_projections/. The root climate data sources for this archive are the World Climate Research Program Coupled Model Intercomparison Project3 (WCRP CMIP3) phase 3 multi-model climate projections (Meehl et al., 2007). The CMIP3 dataset consists of results from coupled atmosphere and ocean general circulation models, which simulate global climate responses to future greenhouse gas emissions (primarily carbon dioxide). A range of modeled scenarios were available, based on how potential greenhouse gas emission rates and atmospheric concentrations might vary with global technological and economic developments during the 21<sup>st</sup> Century.

A total of 112 climate projections, based on projections by 16 different CMIP3 models, were used for this analysis. The CMIP3 and CMIP5 Climate and Hydrology Projections archive site contains statistically down-scaled global-scale climate projections to a 12-kilometer (km) square grid (1/8° latitude by 1/8° longitude), which were



used because raw CMIP3 dataset and climate models projections are too coarse for basin-scale water resources planning.

Hydrology projections were also downloaded from the same Reclamation Downscaled CMIP3 and CMIP5 Climate and Hydrology Projections archive website, for the same 112 CMIP3 projections. The projections were developed using the University of Washington Variable Infiltration Capacity (VIC) hydrology model (Liang et al., 1994; Liang et al., 1996; Nijssen et al., 1997) to translate climate data to streamflow runoff, and the VIC model also produces evapotranspiration and snow water equivalent output data. Input data to the VIC model is spatially downscaled precipitation, temperature, and wind speed data. Output includes runoff (both surface and subsurface runoff), evapotranspiration, and snow water equivalent over a grid corresponding to the selected watershed area. The model solves the water balance for each grid cell; the gridded runoffs are then linked and hydraulically routed to a watershed outflow point.

The 112 downscaled CMIP3 temperature, precipitation, and hydrologic projections were obtained from the USBR website for the period 1950-2099. Since the Montana State Water Plan is updated each 20 years, discussions here will generally compare model results that represent the recent past (1950-1999), to those for a future period centered on the year 2035 (years 2010-2059).

#### TEMPERATURE

Figure VII-17 displays simulated mean annual temperatures for the Musselshell River sub-basin, which is within the Lower Missouri Basin. The central heavy line represents the median predicted average annual temperature provided by the entire ensemble of 112 projections. The thin black lines represent the upper and lower limits of variability for the individual model projections. All of these projections agree that temperatures in the Musselshell River sub-basin will continue to warm into the future, although the rate of the projected warming varies among models and scenarios.

For the period 2010-2059, the increases in average annual temperature above the period 1950-1999 ranged from 1.3° to 4.6° Fahrenheit with the median increase being 2.8°F. According to model output, the 2014 mean annual temperature for the Musselshell River Basin is 44.8°F. The median ensemble projection line indicates that the mean annual temperature will increase 1.5°F between 2014 and 2035, to 46.3°F.



**Figure VII-17:** Musselshell River Sub Basin, mean annual temperature simulations based on downscaled projections from 112 GCM models.



## PRECIPITATION

Precipitation projections are more mixed, with scenario trends varying from somewhat wetter to slightly drier, with most depicting a slight wetting trend but perhaps increased variability over time (Figure VII-18). For the Musselshell River sub-basin, only 18 of the 112 projections indicated precipitation would decline in 2010-2059 compared to 1950-1999.

The median projected increase in precipitation for the period 2010-2059 above the period 1950-1999 was 0.67 inches or 4.4 percent. The maximum projected increase was 3.26 inches (21.5 percent), and the maximum projected decrease was for -1.50 inches less precipitation (-9.9 percent).

The ensemble median estimate for 2014 Musselshell Basin precipitation is 15.5 inches. The estimate climbs to 15.6 inches by 2035, to 15.9 inches by 2059, and to 17.0 inches by 2099. An increase to 17.0 inches of average annual precipitation would represent a 9.7 percent gain above current precipitation conditions.



**Figure VII-18:** Annual precipitation simulations for the Lower Missouri Basin based on downscaled projections from 112 GCM models.



## **EVAPOTRANSPIRATION**

Only about 4 percent (about 0.6 inches) of the precipitation that falls in the Musselshell River Sub Basin ultimately leaves the basin as streamflow. Most precipitation infiltrates into the soil profile and is consumed by plants, or is evaporated from the soil surface through the process of evapotranspiration.

Evapotranspiration is projected to increase under most scenarios as air temperatures increase and growing season lengthens. However, some of the modeled scenarios projected a decrease in evapotranspiration due to projected drier conditions. Figure VII-19 depicts modeled evapotranspiration by natural vegetation in the Musselshell River sub-basin for the period 1950-2099. Evapotranspiration is projected to increase under most modeled scenarios for the 2010-1959 period compared to the 1950-1999 period. The modeled median increase in annual evapotranspiration was 0.59 inches (4.1 percent). The maximum modeled increase in annual evapotranspiration was 1.5 inches (10 percent), and the maximum decrease was -0.10 inches (-0.7 percent).

The model ensemble lists the Musselshell River Basin 2014 evapotranspiration at 14.56 inches. By 2035, the median forecast is 14.86 inches (2.0 percent), and by 2099, projected evapotranspiration has risen to 16.13 inches (10.8 percent).



**Figure VII-19:** Annual evapotranspiration by natural vegetation simulations for the Musselshell River Sub-basin, based on VIC model results and downscaled projections from 112 GCM models.



## RUNOFF (ANNUAL VOLUME)

Annual total runoff produced in the Musselshell River sub-basin is dependent on several, or perhaps all, other climatic factors. Annual runoff is the volume of water that is not consumed by evaporation and evapotranspiration and is then exported from the basin as surface outflow. This runoff or outflow is also dependent on annual precipitation, and therefore fluctuates annually.

Figure VII-20 depicts the modeled annual runoff volumes for the Musselshell River Basin at the basin outflow point, at the confluence of the Musselshell River with the impounded waters of Fort Peck Reservoir. For this graph, the heavy, central line depicts the ensemble median projection. Although most scenarios project modest increases in precipitation for the Musselshell River Basin, the projected evapotranspiration increases seem to offset these. Annual runoff volume is projected to be similar under most modeled scenarios for the 2010-2059 period compared to the 1950-1999 period.

The modeled annual runoff ensemble median was an increase of 24,218 acre-feet (6.2 percent). The maximum modeled runoff increase was an additional 81,011 acre-feet (20.6 percent), and the maximum decrease was - 15,889 acre-feet (-4.0 percent). These runoff volumes are for "natural" flow, before irrigation depletions and other consumptive uses, including reservoir operations and evaporation. The median scenario projection therefore shows more water than is currently measured at the basin outflow point, because it does not account for these human derived depletions.



**Figure VII-20:** Simulated annual natural flow volumes for the Lower Missouri Basin based on VIC model results and downscaled projections from 112 GCM models.



#### SNOW

The snow accumulation season at mountainous, higher elevation areas of Montana is October through May. Warming temperatures affect the accumulation of mountain snow by shortening the accumulation period. Warmer air temperatures occurring earlier in the spring season further affect the timing of the snowmelt, and the availability of snowmelt to sustain runoff later into the summer season.

The hydrology of the Upper Missouri Basin is snow-melt dominated and warmer temperatures would likely lead to proportionally more rain and less snow, a shorter snow accumulation period, and an earlier spring snow melt runoff. The Lower Missouri River Basin is strongly influenced by factors and occurrences in the upper basin, and will generally inherit these effects on the Missouri River main stem.

However, the Milk River and Musselshell River sub-basins are not directly linked to the Upper Missouri River Basin, and are therefore not influenced by conditions in the upper basin. Both of these basins have limited snow accumulation zones and so rely heavily on stored snowmelt water to provide for summer season irrigation water. Even with storage, both basins experience chronic shortages of supply. Because existing facilities store snowmelt water in the spring before irrigation season, increasing air temperatures may have less effect in these



basins in terms of water supplied by snowmelt. A bigger concern with warmer temperatures might be less snow water, and therefore a reduction in water volume available to store in reservoirs.

April 1 Snow Water Equivalent (SWE) is a valuable index for assessing snowpack conditions and forecasting spring—summer runoff volumes in snowmelt dominated basins. SWE is a parameter computed and used by the VIC hydrology model for each grid cell in a defined basin area. Figure VII-21 depicts modeled April 1 SWE conditions for the Musselshell River sub-basin above Roundup, for the 112 simulations.

The Musselshell sub-basin is a large area, but with limited snowpack accumulation zones. Therefore, SWE numbers are very small when averaged over the entire basin. Since snow water contributions are almost entirely limited to the basin above Roundup, the model runs and resultant projections of SWE were limited to this upper portion of the basin, thus distributed over a smaller, yet still large, area. Doing this provides an easier look at the very small numbers, yet retains the relative differences between them.

The goal of the models is to illustrate projected changes in April 1 SWE, relative to past and current conditions. April 1 SWE was averaged over all grid cells in the area above Roundup to calculate the basin-wide SWE for each simulation year from 1950–2099. The model results show an obvious decreasing trend.

From 2014 to 2035, the model-predicted ensemble median SWE drops by 3.3 percent. From 2014 to 2059, the ensemble median indicates a SWE reduction of 58 percent; about 58 percent less SWE in the April 1 mountain snowpack that currently supplies the Musselshell River sub-basin. A best-fit curve through the ensemble median data points (Figure VII-21, black line) illustrates a slightly less alarming long-term trend in SWE, and would forecast a 2035 SWE reduction of 20 percent below 2014, and a reduction of 37 percent by 2059.

Of the 112 model scenarios, only 16 of them show a trend of increasing April 1 SWE for the years 2010-2059 relative to the 1950-1999 base period. The median SWE decrease was 0.06 inches, or 38 percent. The largest decrease for the 2010-2059 period relative to the 1950-1999 base was 0.12 inches of SWE, a 68 percent decrease. The vast majority of modeled scenarios indicate increased precipitation overall, mostly in the form of rain. The increased rain may offset snow water declines.



**Figure VII-21:** Modeled April 1 Snow Water Equivalent for the Musselshell River Basin based on VIC model results and downscaled projections from 112 GCM models.



## STREAMFLOW

Figure VII-22 compares simulated median Musselshell River streamflow for the 2010-2059 period to the historic 1950-1999 period. The results shown are for groupings of VIC modeled runoff using the 112 CMIP3 climate scenarios and methods similar to those described by the BOR (2010). The groupings partitioned the 112 scenarios into four quadrants that bracketed the climate-change scenario range based on relative changes in mean annual temperature and precipitation, with a fifth "central tendency" grouping. For ease of comparison, the graph shows only the results for the quadrant groupings that produce the highest runoff values, the lowest runoff values, and the "central tendency" grouping. The graph shows modeled "natural" flow produced within the basin, and does not include the effects of water development activities, such as reservoirs and irrigation.

Model results indicate that future flow volume produced in the Musselshell River Basin will be greater than in the past, with a shift in the timing of peak streamflow. High flows appear earlier in the springtime because warm air arrives sooner in modeled future, causing an earlier melt of the mountain snowpack. Projections also show an increase in precipitation as rain instead of snow in late autumn and early spring, which is also due to warmer air temperatures and a reduced snow accumulation season.

The baseline scenario, "1950 to 1999 Median Flow", shows the classic springtime peak flow occurring in June, while the projected future central tendency scenario, "2010 to 2059 Median Flow", shows the peak flow shifted one month earlier, during May. This future scenario also shows somewhat higher flows occurring earlier in the late winter and spring seasons, and slightly lower flows than baseline occurring during autumn months.



**Figure VII-22:** Modeled median monthly flow for the Musselshell River under historic conditions and future projected climate scenarios.



## FUTURE WATER DEMANDS

All of the 112 simulations project increased air temperature in the Lower Missouri River Basin and most show modest precipitation increases. The temperature increase could result in increased water demands, especially for irrigation. Figure VII-23 depicts modeled potential evapotranspiration for natural vegetation for the Musselshell River Basin. Potential evapotranspiration is the maximum amount of water that could be evaporated and transpired from the landscape at a given temperature, given a sufficient supply of water. Although this graph depicts potential evapotranspiration for natural vegetation, it may also indicate changes to future water requirements for irrigated crops. The VIC model uses a Penman-Montieth formulation to compute Potential, which can be used to predict evapotranspiration for agricultural crops (Maidment, D.R., 1993).

Potential evapotranspiration is projected to increase in the Musselshell Basin during the 2010-2059 period when compared to the 1950-1999 historic period. The maximum projected increase was 1.9 inches (9.1 percent); the minimum was no increase, and the median modeled increase was 1.2 inches (5.7 percent). Increased potential evapotranspiration would result in increased water consumption and increased diversion requirements for irrigated crops. The projected increase in irrigation requirements may suggest increased crop production, if the greater water demand could be satisfied. This might be the case during wetter years when sufficient irrigation water is available to supply crop demands.



Evaporation from open water surfaces, such as reservoirs, lakes and stream channels, was not modeled, but is also expected to increase with warmer air temperatures. Wetter conditions projected for some climate change scenarios would partially offset the increased evaporation.

**Figure VII-23:** Simulated annual Potential Evapotranspiration for natural vegetation for the Musselshell River Basin, based on VIC model results and downscaled projections from 112 GCM models.



## UNCERTAINTIES

The current scientific understanding of climate and the physical and perhaps biological processes that govern climate is incomplete. Atmospheric circulation, ocean circulation, deep ocean heat assimilation and heat storage, ice sheet dynamics, changes in sea level elevation, vegetative and other biological changes are some important factors in climate modeling that are not fully understood. There are uncertainties related to statistically down-scaling global-scale climate models to a finer scale used in basin planning. For this investigation, global-scale model results were downscaled using temperature and precipitation patterns from historic weather-station data. Projections of future conditions assume that historic local climate patterns at a finer-scale, and their relationships to the climate at the larger scale, will be applicable in the future, although this uncertain.



# VIII. Options for Meeting New Water Demands

## **Basins with Unallocated Water**

Water availability and appropriation of water are very important, and often contentious, issues in Montana and other western states. Montana has the authority to restrict or close river basins and groundwater aquifers to future withdrawals, based on concerns to protect existing uses, water quality issues, and additional water shortages. Montana is a "prior appropriations" state, and must first protect existing senior water uses before allowing additional demands on water resources. Legal water availability, if any, is based on surplus water above and beyond existing, valid water uses. An applicant for water use must prove that their proposed future use of water does not impact existing users surface or groundwater uses.

Applicants for a new groundwater appropriation that depletes surface water and adversely affects existing water users may need to implement a mitigation or aquifer recharge plan in order to obtain a new permit. "Mitigation" means the reallocation of surface water or ground water through a change in appropriation right or other means that does not result in surface water being introduced into an aquifer through aquifer recharge to offset adverse effects resulting from net depletion of surface water. "Aquifer recharge" means either the controlled subsurface addition of water directly to the aquifer or controlled application of water to the ground surface for the purpose of replenishing the aquifer to offset adverse effects resulting from net depletion of surface waters effects resulting from net depletion of surface adverse effects resulting from net depletion of surface waters effects resulting from net depletion of surface adverse effects resulting from net depletion of surface waters effects resulting from net depletion of surface waters effects resulting from net depletion of surface water.

The purpose of mitigation and aquifer recharge plans is to offset net depletion to surface water from a groundwater appropriation in order to provide water for legal demands by senior water users and to prevent adverse effects. Mitigation plans involve a change of an existing surface water or groundwater right whereas aquifer recharge plans involve infiltration of surface water to groundwater in addition to a water use change. Mitigation by changing a surface water right is accomplished by stopping the existing use (for example, drying up irrigated acreage) and leaving water that was previously diverted instream and possibly protecting it through a depleted stream reach. This type of mitigation is appropriate where net depletion and adverse effects are predicted to occur within the period of historic use of the existing water right which may occur where a well is located very close to a stream or where water shortages are limited to the irrigation season. Simple mitigation with surface water generally requires a water right with an early priority date.

In contrast, changing an existing groundwater right by stopping use of another well and eliminating its associated purpose may mitigate adverse effects outside the historic period of use of the existing right. This occurs because wells that are not very close to a stream typically have year-round depletion effects; therefore, eliminating an existing well is essence provides year-round mitigation effects. The feasibility of a mitigation plan involving a change of a ground water right depends on consumption of the historic and new uses and on whether the adverse effects of the new use are similar to the historic effects of the retired use.

An aquifer recharge plan or project accomplishes essentially the same thing as retiring use of a well by diverting surface water and allowing it to infiltrate ground water through a well or other means. Again, the viability of a plan depends on a comparison of the historic and new consumptive uses, and an evaluation that indicates whether mounding from aquifer recharge offsets drawdown from the new use. The existing water right may be relatively junior if recharge is conducted in early summer.



Table VIII-1 summarizes the general legal availability of surface water available for appropriation in the Lower Missouri Basin. The summary is based on experience with past permitting records. New appropriations from aquifers hydraulically connected to these streams and rivers also may be subject to limitations.

Lewistown Region			
Water Source	Legally Available	Not Legally Available	Comments
Judith River	Lower reaches	Upper reaches	Judith is chronically dewatered above the confluence of Big Spring Creek. Only potential ability to get water above Big Spring is during high spring flows AND if heavy conditions could be met (lack of a gauge decreases chances of new permitting). Below Big Spring and Warm Spring Creek, water is legally available most of the time. Surface water permits could be issued with minor trigger flow conditions.
Big Spring Creek	Potentially – During non- irrigation and runoff season, and in lower reaches after irrigation return flows	Not likely during irrigation season.	There could be potential for new permitting subject to trigger flow conditions, however, since no gage exists on Big Spring Creek, there is no way to monitor streamflows. The lack of a gauge decreases chances for new permitting.
Musselshell River	Only during high spring flows on lower half of river	Most of year water is not legally available (Legislative Closure during irrigation season)	Water only legally available during high spring flows, and from a practical standpoint, probably only in the lower reaches of the river. River is administratively closed during irrigation season. DFWP water reservation exists on entire river, complicating legal availability. Any new permit would be heavily conditioned with trigger flow points.
Warm Spring Creek	Potentially – During non- irrigation season and in lower reaches after irrigation return flows	Not likely during irrigation season	There could be potential for new permitting subject to trigger flow conditions, however, since no gage exists on Warm Spring Creek, there is no way to monitor streamflows. The lack of a gauge decreases chances for new permitting.



Lewistown Region			
Water Source	Legally Available	Not Legally Available	Comments
Flatwillow Creek	Potentially, with trigger flow conditions	No – Much of the time	Petrolia reservoir exists on lower Flatwillow Creek. If Petrolia is not full, then water is not legally available. FWP water reservation exists on entire river, complicating legal availability. The lack of a gage decreases chances for new permitting.
McDonald Creek	Not Likely	Water probably not legally available	USGS records from 1930-1956 yield a maximum median monthly flow of 13.1 cfs in June. With the exception of July at 5.7 cfs, every other month has less than 2.17 cfs physically available. Legal demands likely exceed flow.
Havre Region			
Water Source	Legally Available	Not Legally Available	Comments
Battle Creek		No Basin Closure	No new water rights issued since the state ratification of the Fort Belknap Compact. Basin closure became effective April 06, 2001. No water rights issued since 1995. Exceptions to this closure are small groundwater developments and small impoundments for stockwatering purposes
Big Sandy Creek and tributaries		Basin Closure	No new water rights issued since the Rocky Boy's compact became effective December 9, 1999. No water rights issued since 1995. Exceptions to this closure are small groundwater developments or larger appropriations of groundwater that is not hydrologically connected to surface water and small impoundments for stockwatering purposes.
Cut Bank Creek		No Basin Closure	No water rights issued since 1995 Blackfeet Reservation Boundary stream. No new water rights issued since the state ratification of the Blackfeet Compact. Closure became effective April 08, 2011. Exceptions to this closure are small groundwater developments and small impoundments for stockwatering purposes



Havre Region					
Water Source	Legally Available	Not Legally Available	Comments		
Milk River		Basin Closure	Subject to DNRC ordered main-stem basin closure authorized under §85-2-321, MCA. No water rights issued since 1995 in addition to the basin-wide For Belknap Compact Closure effective April 06, 2001. Exceptions to this closure are small groundwater developments or larger appropriations of groundwater that is not hydrologically connected to surface water and small impoundments for stockwatering purposes.		
Missouri River		Tributaries limited to small uses	Wild and Scenic Compact has large in-stream rights below Fort Benton, but there is substantial remaining water beyond their rights. Tributaries are limited to small uses due to limited and fluctuating flows.		
Sage Creek		Basin Closure	Rocky Boy's compact. No water rights issued since 1995. Exceptions to this closure are small groundwater developments or larger appropriations of groundwater that is not hydrologically connected to surface water and small impoundments for stockwatering purposes.		
Southern Tributaries of the Milk River		Basin Closure	Department ordered surface water closure of Miners Coulee, Halfbreed Coulee (aka Breed Creek), Bear Creek, and all their respective tributaries in Toole and Liberty Counties. This closure became effective on September 1, 1991.		
Glasgow Region					
Water Source	Legally Available	Not Legally Available	Comments		
Beaver Creek		Basin Closure	Fort Belknap Compact Closure		
Big Muddy Creek		Compact restriction	Fort Peck Compact		
Big Dry Creek		No	No water rights issued since 1995		
Charlie Creek			Permitting possible on intermittent and ephemeral tributaries.		



Glasgow Region			
Water Source	Legally Available	Not Legally Available	Comments
Fort Peck Reservoir	Yes		CMR compact only effects the tributaries surrounding the reservoir by having restrictions
Frenchman Creek		Basin Closure	Fort Belknap Compact Closure
Milk River		Basin Closure	Fort Belknap Compact Closure
Missouri River	Yes		
Poplar River and tributaries		Compact Restriction	Fort Peck Compact
Porcupine Creek		Compact Restriction	Fort Peck Compact, No water rights issued since 1995
Redwater Creek			Permitting possible on intermittent and ephemeral tributaries.
Rock Creek		Basin Closure	Permitting possible on intermittent and ephemeral tributaries. Fort Belknap Compact Closure
Whitewater Creek		Basin Closure	Permitting possible on intermittent and ephemeral tributaries. Fort Belknap Compact Closure



## CONSERVATION DISTRICT WATER RESERVATIONS

Conservation districts in the Lower Missouri Basin also have a significant volume of reserved water allocated for future project use. Table VIII-2 lists water volume available by conservation district.

Table VIII-2 Water volume available by conservation district in the Lower Missouri River Basin.

#### MISSOURI RIVER BASIN

#### CONSERVATION DISTRICT WATER RESERVATION BALANCE

as of December 31, 2012

as of Dece	mber 31, 2012						
		VOLUME	VOLUME	VOLUME	FLOW	FLOW	FLOW
CD	SOURCE OF WATER SUPPLY	Granted (AF)	Allocated (AF)	Remaining (AF)	Granted (CFS)	Allocated (CFS)	Remaining (CFS)
Choteau	Mainstem Missouri River, Shonkin Creek, Highwood Creek, Big Sag Spring, Marias River, Teton River	33,123.00	2,481.00	30642.00	218.80	34.84	183.96
Fergus	Main stem Missouri River, Wolverine Creek, Lincoln Ditch, E Fork Big Spring Creek, Little Casino Creek, Olsen Creek, UT of Olsen Creek, UT Ross Fork Creek, Warm Springs Creek	3,914.00	237.00	3677.00	33.70	2.23	31.47
Judith Basin	Louse Creek, Otter Creek, Little Otter Creek, Running Wolf Creek	731.00	0.00	731.00	6.04	0.00	6.04
Lower Mussel- shell	Groundwater Mines	600.00	0.00	600.00	90.00	0.00	0.00
Valley	Fort Peck Reservoir	92,000.00	0.00	92000.00	499.00	0.00	499.00
Blaine	Battle Creek, Little Coulee	18,934.00	0.00	18934.00	0.00	0.00	0.00
Daniels	South Fork Whitetail Creek, Groundwater, Poplar River, UT Middle Fork Poplar River, Pit, Police Creek, East Fork Poplar River, Sprinks, Olson Coulee, Coal Creek, UT of Butte Creek	3,047.00	0.00	3047.00	16.90	0.00	16.90
McCone	Main stem Missouri River	14,299.00	3,793.30	10505.70	99.50	62.11	37.39
Richland	Main stem Missouri River	25,349.00	9,392.00	15957.00	186.90	107.50	79.40
RICHIAHU		25,549.00	9,392.00	13937.00	100.90	107.50	79.40



#### MISSOURI RIVER BASIN

#### CONSERVATION DISTRICT WATER RESERVATION BALANCE

as of December 31, 2012

		VOLUME	VOLUME	VOLUME	FLOW	FLOW	FLOW
CD	SOURCE OF WATER SUPPLY	Granted (AF)	Allocated (AF)	Remaining (AF)	Granted (CFS)	Allocated (CFS)	Remaining (CFS)
Roosevelt	Main stem Missouri River	73,115.00	9,475.60	63639.15	558.80	101.83	456.97
Sheridan	Groundwater	15,479.00	5,648.00	9831.00	0.00	0.00	0.00
Valley	Missouri River, Milk River, Groundwater	7,668.00	0.00	7668.00	54.10	0.00	54.10
TOTAL		288,259.00	31,026.90	257,231.90	1,763.70	308.50	1,365.20

Note: AF = Acre Feet; CFS = Cubic Feet per Second; volume and flow amounts granted to Conservation District by the Board of Natural Resources

## **Basins With Hydrology That Could Potentially Support New Storage**

The storage of water for future use can be an invaluable component of water management. In Montana, greatest water demand typically occurs during July and August when irrigation is at its seasonal peak. The time of greatest natural water supply, however, occurs in May and June, when rivers are highest with snowmelt runoff. Storing water for times of future use changes the dynamics of supply and demand.

The Lower Missouri Basin contains hundreds of small impoundments that are locally important for stock watering, fish and wildlife habitat, and some irrigation. However, there are very few large reservoirs within the basin. Absence of large storage in the Lower Missouri Basin is likely due to several factors, including lack of water demand, lack of major streams to provide firm water yield for storage, high reservoir siltation rates, and the economics of building water storage projects.

Most streams in the Lower Missouri Basin are prairie streams at relatively low elevations; they exhibit erratic flow characteristics. These streams are more often supplied by rainfall than by snowmelt, and typically do not produce a large yield. Most other Lower Missouri River Basin streams are dependent on upstream inflows from more water rich areas, such as the Upper Missouri River Basin. However, there are streams which drain snowmelt from the limited mountainous areas of the lower basin which could possibly support additional storage.

#### MIDDLE MISSOURI RIVER SUB BASIN

The Judith River is an example of a snow-dominated stream that drains part of the Little Belt and Big Snowy Mountains, near Lewistown. Figure VIII-1 shows the median daily flow of the Judith River near its mouth, downstream of almost all water use in this watershed, and downstream of tributary inflows from Big Spring Creek and Warm Spring Creek. The period of record for this gage site is 2001 through 2013 and therefore includes the 2000s drought era. The diagram shows a conceptual example of when water might be stored (high



flows during May and June), and then released for use (July through September). Ackley Lake, an off-stream storage facility located high in the watershed, is the only significant storage facility in the Judith River basin, and has a modest 5,800 acre-foot capacity.

Strictly from a hydrologic standpoint, the Judith River and several other smaller streams in the lower basin exhibit hydrologic characteristics suitable for storage projects. Conceptually, there are periods of early high snowmelt streamflows that could be stored for release later in the irrigation season of peak demand.



Figure VIII-1: Median Daily Flow of the Judith River near mouth.

## MUSSELSHELL RIVER SUB-BASIN

The Musselshell River sub-basin contains a succession of storage reservoirs beginning high in the watershed with Bair Reservoir on the North Fork Musselshell River, and Martinsdale Reservoir on the South Fork Musselshell River. Deadman's Basin Reservoir, located downstream between Harlowton and Roundup, is an off-stream facility with a storage capacity of 76,900 acre-feet.

## Horse Creek

In 2010, two provisional permits were issued to the Petroleum County Conservation District for a water marketing project located below Roundup, near the town of Musselshell. The project includes a 4,464-acre-foot storage reservoir on Horse Creek, which is a tributary to the Musselshell River. According to DNRC documents, the maximum annual appropriation from Horse Creek would be 560 acre-feet, and the maximum diversion from the Musselshell River main stem would be an additional 3,950 acre-feet. Water would be marketed through contracts for irrigation use in the lower basin. The deadline for project completion is December 31, 2020.



#### **Flatwillow Creek**

Flatwillow Creek is a major tributary of the Musselshell River, contributing substantial flow to the main stem, just upstream of Mosby. The USGS gage is located very near the confluence of these streams, downstream of Yellow Water and Petrolia reservoirs. Yellow Water Reservoir has a capacity of 3,840 acre-feet, and Petrolia has a capacity of 9,190 acre-feet, for a combined capacity of 13,030 acre-feet. According to the USGS, average annual runoff at this gage site is 73,710 acre-feet, so current storage is only about 12 percent of the average runoff at the site. Strictly from a hydrologic or water supply perspective, it would appear that Flatwillow Creek could accommodate additional water storage (Figure VIII-2).





## ST. MARY RIVER - MILK RIVER BASINS

A USBR feasibility study was conducted to identify present and potential water supplies, water uses and management, major water issues, and alternatives to address these issues, including potential storage projects (USBR, 2003. North Central Montana Alternatives, Scoping Document). The following alternatives were examined within this document.

#### Babb Dam

One alternative was the construction of a large dam and reservoir on the St. Mary River near Babb, Montana. According to the study, the conceptual Babb Dam could store 297,000 acre-feet of water and would add water slightly to the St. Mary River supply, and add water significantly to the Milk River supply. Strictly from a hydrologic perspective, the St. Mary River exhibits characteristics favorable for additional storage projects. This dam and reservoir would sit entirely on the Blackfeet Indian Reservation.

#### **Enlarge Fresno Reservoir**



Another alternative examined in the feasibility study is the enlargement of Fresno Reservoir. Storage capacity of Fresno has been reduced by siltation at the rate of about 500 acre-feet per year. Originally constructed with a storage capacity of 130,000 acre-feet, the current capacity is at around 93,000 acre-feet (USBR, 2003. North Central Montana Alternatives, Scoping Document). According to the study, alternatives of increasing storage of Fresno Reservoir have very modest effects to the Milk River water supply. Increasing storage at Fresno Reservoir could contribute to implementation of the Fort Belknap Compact, contribute water more consistently to Bowdoin Waterfowl Refuge, and improve recreational and hydropower opportunities.

#### **Enlarge Nelson Reservoir**

This option would store an additional 16,000 acre-feet of water in Nelson Reservoir, adding flexibility to operation of the reservoir. Agriculturally, this alternative would add very minor amounts to the supply, and could contribute slightly to implementation of the Fort Belknap Compact. The benefit-to-cost ratio for this alternative was estimated at 0.10, marginal at best.

#### **Reservoir on Peoples Creek**

This option would impound 34,900 acre-feet of water for release during irrigation season. It was determined that alternatives relating to this project would contribute only modestly to agricultural water supplies in the basin. However, this project could contribute to implementation of the Fort Belknap Compact, and water could be more consistently supplied to Bowdoin Waterfowl Refuge.

#### **Reservoir on 30 Mile Creek**

This Milk River tributary is located 9 miles upstream from Harlem, Montana. Two alternatives for this project would store either 47,850 or 80,490 acre-feet of water. Again, this project would contribute only modestly to overall water supplies in the basin, increasing delivered water by 1.10 inches per acre annually. This project could contribute to implementation of the Fort Belknap Compact.

#### **Reservoir on Beaver Creek**

Beaver Creek enters the Milk River several miles to the east of Malta in Phillips County. Storage capacity of a reservoir here would be a maximum of 9,800 acre-feet and contribute a small benefit of 0.27 inch per acre annually. This project could contribute to implementation of the Fort Belknap Compact.

#### **US–Canada Joint Storage Alternative**

Past discussions and investigations have examined the possibility of a joint US–Canada storage project on the Milk River in Canada. The storage facility would be constructed just below the confluence of the North Fork and Milk River main stem in southern Alberta, and would have a theoretical capacity of 237,000 acre-feet of water (USBR and DNRC, 2012, St. Mary River and Milk River Basins Study Summary Report).

#### LOWER MISSOURI RIVER SUB BASIN

#### Frenchman Dam and Reservoir

Frenchman Dam is on Frenchman Creek north of Saco, and was constructed in 1951 with a storage capacity of 7,010 acre-feet. Since construction, the reservoir has lost more than half of its capacity to siltation, and now has a capacity of only 2,800 acre-feet. The DNRC State Water Projects Bureau is currently investigating alternatives to rebuild or remove the dam, or to restore the lost storage capacity without dam removal (DNRC, 2014. Frenchman Dam Technical Feasibility Study: Enlarging Frenchman Reservoir).

Modeling of Frenchman Dam reconstruction alternatives was also presented in a previous study by the USBR (USBR and DNRC, 2012, St. Mary River and Milk River Basins Study Summary Report). Various storage capacities were modeled that would provide a reliable water supply for irrigation interests, and possibly mitigate impacts of implementing the Fort Belknap Compact. One modeled alternative was for a 50,000-acre-foot facility, which



would significantly reduce water shortages for Frenchman River water users in most years. A reservoir of this size would also reduce irrigation shortages downstream on the Milk River during dry years.

## **Non-Structural Storage**

Natural or augmented storage in floodplains and associated alluvial aquifers are important sources of nonstructural storage. Floodplains with healthy riparian areas slow runoff and promote groundwater recharge to effectively store water when there is a surplus for release later during times of shortage, functioning similarly to constructed reservoirs. Flood water connectivity and access to floodplains can be limited by impervious surfaces, degraded vegetation, stream incision, stream channelization, and subsurface drains.

Drought and floods that damage vegetation, cause avulsions, or otherwise disturb the connection between a steam and its floodplain also can reduce the storage capacity of floodplains and alluvial aquifers. Eliminating disturbances and restoring health to riparian areas provides the greatest opportunity for increasing storage to supply or offset the effects of future water demands. Urban encroachment, livestock and wildlife grazing, forest practices, and storm water discharge are areas where improved management can augment floodplain storage.

Storage in floodplains and alluvial aquifers, and base flow of streams they feed depend on regular seasonal influx of flood waters that is interrupted during droughts. Severe floods, as seen in 2011, can cause avulsions that disconnect a stream from its floodplain, thereby reducing storage capacity. Healthy riparian areas are adapted to and recover quickly from drought and flood cycles.

Artificial recharge to alluvial aquifers can increase storage during spring runoff or through aquifer recharge plans implemented to offset depletion by new groundwater uses. Irrigation infrastructure and wetlands provide ready means for augmenting storage in floodplains and associated alluvial aquifer systems. Montana has more than 3,000 miles of irrigation canals from which ditch loss often far exceeds natural recharge. For example, the East Bench Irrigation Canal in the lower Beaverhead River may lose as much as 398 acre-feet per mile; with a length of about 17 miles between Dillon and Beaverhead Rock, the seasonal ditch loss would be about 6,800 acre-feet. Additional recharge occurs from direct flood irrigation.

The groundwater flow systems in nearly all of the watersheds of western Montana and the large watersheds of eastern Montana have been substantially altered by recharge from irrigation canals. The significance of this is two-fold. First, significant volumes of water recharged from irrigation conveyance and application are stored in alluvial aquifers and released to support base flow. Second, irrigation infrastructure provides the means for augmenting non-reservoir storage to store water in floodplains and alluvial aquifers.

## Voluntary Water Management - A Case Study

Ever since the early years of water use in Montana, demands for water focused primarily on agriculture and mining. In times of shortage, it was not uncommon for neighbors to ration water to get by. In the 1970s and 1980s river recreation came into its own in Montana. Interest in whitewater kayaking, rafting and fishing grew with increasing popularity in the headwaters of the river basins of Montana.

By June of 1994, the last vestigial population of riverine Arctic grayling in the lower 48 states was threatened by high water temperatures and dewatering in the upper reaches of the Big Hole River near the town of Wisdom. At the urging of instream flow advocates, then Governor Marc Racicot directed Montana Fish, Wildlife, and Parks to monitor the flow status of the river day to day and report back to his office through the drought advisory committee. Instantaneous discharge records of U.S. Geological Survey Records from July 6, 1994, indicate that not only was the Big Hole River fishery in jeopardy of a fish-kill, but in headwaters tributaries throughout Western and Central Montana.



With the prospect of the Arctic grayling being listed under the federal Endangered Species Act an accord between the Big Hole water users and the U.S. Fish and Wildlife Service and the state would soon be necessary. With temperatures rising and stream flows dropping, tension and acrimony erupted between the agricultural and instream flow advocates. Fisheries such as the Jefferson, Ruby, Beaverhead, and Gallatin east of the Continental Divide and the Blackfoot, Bitterroot, and Rock Creek west of the Divide were reaching critical high day time water temperatures and low flows as well, putting dwindling populations of bull trout and Westslope cutthroat trout as well as brook, rainbow and brown trout in jeopardy.

In the wake of 1994, conservation districts, water user groups, fishing guides and outfitters, and other instream advocacy groups called for collaboration among the interests. Irrigators wanted science and tools to better manage water instead of negative publicity or criticism for the legal use their water right. While the relationship between the interests could at times become adversarial they also had much in common: they both wanted the local businesses to thrive; they both wanted more information on the behavior of threatened and endangered species; they were both eager to learn more about the local hydrology of their river source; they wanted water rights to be respected, and they wanted the fisheries to be respected and lost habitat restored.

From the mid-1990s onward there was slow but steady progress on conservation. In 1993, the Governor's Drought Advisory Committee received over \$1 million from the U.S. Bureau of Reclamation's Emergency Drought Relief Act of 1991. Reclamation also provided assistance through its Agri-Met (Agricultural – Meteorological) field stations for scientific irrigation scheduling; the purchase of water for threatened and endangered species; conjunctive use wells to take pressure off of dwindling surface water supplies; irrigation canal lining to reduce seepage; stock water provided from Reclamation storage projects; fish ladders; head-gates and other control structures , stream gages critical for managing chronically-dewatered stream reaches, and well-drilling for small town municipal water supplies. The Future Fisheries Program provided restoration for riparian habitat benefitting fisheries as well.

As the 2000s wore on and impacts of the drought carried over into the succeeding year, water users worked even harder to stretch water supplies. Further investigation of local water supplies revealed that if a group of irrigators formed an informal alliance they could satisfy their regular right because it was a matter of *timing* their diversions of water. Some groups hired a professional to calculate just how much water each irrigator in a tributary basin would need for a particular crop. When the flows got very low the users apportioned precious water supplies and shared the sacrifice by cutting back on diversions to take pressure off of the fishery. Outfitters stepped-up in return by agreeing to limit guiding hours per day, using barbless hooks, and not playing fish too long. Fish, Wildlife and Parks participated by placing restrictions on the hours in a day that fishing was allowed.

By 2008, there were over 40 watershed groups across the state formed by Conservation districts, irrigation districts, canal companies, and instream flow advocacy groups like Trout Unlimited. With assistance from state and federal scientists, and the local knowledge of water availability the groups began a shared knowledge period where the Montana Watershed Coordination Council hosted workshops for group coordinators and other interested parties.

The once ad hoc groups now have their own sophisticated water management and drought plans. And they celebrate their hard work and success with community events like golf matches on their hayfields, noxious weed pulling, barbecues, and fundraisers for worthy causes such as restoration of Trumpeter swans or Arctic grayling. With advances in climatological forecasting, improved water delivery systems, and tools such as automated mountain snow water stations and stream gauges the groups are better able to manage their shortages autonomously. And since those dreadful water years of the 2000s they remain vigilant never failing to meet year



around to discuss and revise their flow plans on a regular basis no matter how good the mountain snowpack and water supply outlook may be.





# IX. Major Findings and Recommendations

The following findings and recommendations represent the primary work product of the LMRB Basin Advisory Council. A complete presentation of this effort along with additional background information is presented in The LMRB Final Recommendation Development Report. This document is available online (Link - Final Recommendation Development Report} and as Appendix A to this report.

## Water Use Administration

The principle of beneficial use is a cornerstone of the Prior Appropriation Doctrine. Beneficial use is the basis and measure of a water right. The accuracy of water right processes is paramount to the protection, administration and enforcement of valid water rights. The accuracy of existing claims is critical to the future development of state waters. Any strategy to meet future water demand needs to include examination of Montana's water right system to more closely align water use with established priority and legal availability. The water rights adjudication process must be accurately completed to determine how much water is legally and physically available for existing and future use.

There is growing public sentiment for enforcement against illegal water use. Montana's water users are hesitant to file suit against their neighbors. They want assurances that existing water rights will be protected whenever new water right permits and changes in use are granted by the state. Water users also want a more efficient, less expensive, and less adversarial approach to the enforcement of water rights.

## ALIGNMENT OF ADJUDICATION WITH ACTUAL HISTORIC USE - GOAL:

The support of efforts and processes to address claims of water use, and proposed changes to claimed water rights is essential for the protection of existing, valid water rights. It is also critical for determining how much water is available for future development and beneficial use.

- A. **Objective:** Water right decrees should accurately reflect the status of existing water rights as they historically existed prior to July 1, 1973. By strengthening the existing water right system, water managers would be in a better position to ensure that water is allocated according to established historic beneficial use.
  - I. **Short-Term Recommendation:** The Water Court and DNRC need to do a better job of communicating the adjudication process generally and the process of filing appropriate objections specifically to ensure the most accurate adjudication process possible.
  - II. **Long-term Recommendation:** Evaluate and develop processes to ensure water rights are accurately and consistently defined across Montana. DNRC and the Water Court should work together to develop a post-adjudication strategy to address issues such as place of use on claims that were verified by a less demanding process than current examination methods. This effort will ensure a more consistent evaluation of all water right claims across Montana.
- **B. Objective:** Analysis of historic water use in DNRC's change application process is important for the protection of existing water rights. The DNRC administrative process is more rigorous than that conducted for adjudication purposes, and is science based. DNRC must maintain the integrity of its change process and continue to analyze water right claims for actual, historic beneficial use, including consumptive volume.



However, there are issues of trust and credibility that undermine implementation of the change process. Better understanding among the public on the change process would strengthen this system.

I. **Short term Recommendation:** DNRC needs to educate water users and other appropriate agencies and entities of the importance of the change process. DNRC also needs to provide a better explanation of measures that have streamlined and simplified the current change process.

## COMPLETION OF ADJUDICATION -- GOAL:

Completion of the adjudication process is critical to the ability of water users and water managers to understand, manage, enforce, and defend Montana's water resources.

- A. **Objective:** The completion of water rights adjudication process will determine how much water is put to historical beneficial use. The process must be completed as efficiently and accurately as possible.
  - I. **Short-term Recommendation:** Provide the tools (funding and personnel) necessary for the Water Court and DNRC to complete the adjudication process at least to the point of Temporary Preliminary or Preliminary decrees not later than 2020.
  - II. **Medium -term Recommendation:** Support funding and if necessary extension of the Adjudication Program to move Temporary Preliminary to Preliminary decrees to complete an accurate adjudication process by 2024 and Final Decrees by 2027.
- B. **Objective:** The resolution of outstanding federal and tribal reserved water rights presents an obstacle to the final adjudication of state water rights. The state must continue its efforts to negotiate water compacts with tribal nations, and advocate for ratification by Congress.
  - I. **Short-term Recommendation:** The state and the state's Congressional delegation must continue working to complete all the tribal water compacts still in process.

## Storage, Distribution, Infrastructure Maintenance, and Application Efficiencies for Irrigation Water

Montana's irrigation water storage and distribution infrastructure is in many cases nearly a century old, and has become increasingly inefficient in storing spring runoff and delivering it to crops during the irrigation season. Once the water reaches the end user, application efficiency may be improved by a switch to, for instance, pivot sprinkler systems, but the switch may have unanticipated effects on surface water or groundwater. There is a lack of research on the consequences of changing delivery systems and application methods.

## STRATEGY FOR UPDATING INFRASTRUCTURE - GOAL:

Montana's aging water storage and delivery infrastructure inventory must be updated, and a prioritization process for repair, alteration, or replacement implemented. In addition, more research on the positive and negative consequences of changing methods of water application will help avoid unintended consequences in the future.

- A. **Objective:** The cost of maintaining and/or altering water storage and delivery infrastructure is often too high to be paid by local water users alone. The state needs to develop a project prioritization strategy to use available funding in the most efficient manner possible. New funding methods that involve all stakeholders who benefit from water projects should be explored
  - I. **Short Term Recommendation:** Support operational funding to develop public/private partnerships to assess local capacity, incentives and financial commitments necessary to support state and federal authorizations that are adequate to complete infrastructure rehabilitation efforts.



- II. **Short-term Recommendation:** Set up an infrastructure improvement funding program to address problems with water storage and delivery systems, and increase funding caps for currently authorized grants and loans.
- **B. Objective**: Improvements in water storage and delivery efficiency may have either positive or negative effects on surface water. Improved methods of water application on crops may conserve water, but the effects of changing methods on return flows, groundwater, soil, and water quality vary from site to site, and need to be carefully explored before any particular method is encouraged.
  - I. Short-term Recommendation: Quantify the surface water-ground water impacts from changes in irrigation water distribution, application methods and timing across watersheds to account for wide-ranging precipitation patterns, geology and topography.

## Water Resource Inventory and Measurement

The current status of water measurement and water resource research makes it difficult to determine how much water is legally and physically available for existing and future uses. Wise management of the state's water resources requires an adequate assessment of surface and groundwater availability and an inventory of how much water is beneficially used. The state's network of streamflow gages does not cover enough streams to provide critical water quantity and quality data in all the sub-basins. In addition, many water delivery systems have no accurate method of recording the quantity supplied to a specific user. It is difficult for managers to fairly distribute water without knowing how much is available, and how much is arriving at the place of use. The State of Montana needs to increase its water measurement and monitoring program so that it is sufficient to understand water supply and use, enforce water right decrees and compacts, and better understand the relationship between water quality and quantity.

## STREAMFLOW GAGES -- GOAL:

Funding for Montana's existing streamflow gage network must be ensured, and new gages installed to monitor flows on streams that lack historical data. Selected water quality parameters should also be monitored by many of the gages. As demand for water within and outside the state increase in the future, measurement of water availability and water deliveries to end users will be essential for sound water management.

- A. **Objective**: Partnerships among federal, state, and local agencies and organizations should be supported to fairly pay the costs of installing and maintaining streamflow gages. The data collected needs to be immediately available to anyone who needs the information for impending flood warnings, water availability, distribution of water, wastewater releases, water quality, and those who want to know streamflow levels.
  - I. **Short-term Recommendation:** Maintain the existing stream gage network operated by the USGS for key mainstem and tributary gages via the USGS/DNRC Cooperative Agreement Program.

Note: USGS maintains approximately 180 gages in Montana; there are many local, state and federal cost-share partners on these gages. DNRC provides cost-share on 43 of these gages with annual budget of \$296,000. The cost share program is continually facing reductions federal funding forcing Lower Missouri Basin users to make choices between gages—Musselshell River gages are examples.

I. **Short-term Recommendation:** Institute a telemetered (real-time) stream gage program operated by DNRC/MBMG. Sub-basin watershed organizations should submit recommendations for new streamflow gage installation sites.



- B. **Objective:** In order to distribute available water to users, measuring devices should be installed on pumps, headgates, unmetered municipal water systems, and all non-exempt wells in all watersheds.
  - I. **Medium-term Recommendation:** DNRC should develop a program to encourage and incentivize the installation of measuring devices at the point of diversion.
- C. **Objective**: A good understanding of surface and groundwater resources is necessary to ascertain the status of water resources in Montana. Surface and groundwater research, whether accomplished by federal, state, or contracted private entities, must be funded, starting with the most critical areas first, and eventually the entire state.
  - I. **Short-term Recommendation:** Adequate funding should be appropriated for research on surface and groundwater quantities in the state.
  - II. **Short-term Recommendation:** The Ground Water Steering Committee should re-evaluate project funding criteria for the Ground Water investigation Program to better reflect statewide priorities and directly implement priorities reflected in the State Water Plan.

## GROUNDWATER AQUIFERS: QUANTITY AND QUALITY - GOAL:

There is a need for additional research on the quality and quantity of Montana's aquifers. As more users tap the state's groundwater sources, it is essential to document the quality and quantity of groundwater. Water quality must be periodically monitored using site-specific parameters. An aquifers' ability to recharge at a rate that meets water withdrawals/discharge must be monitored to avoid depleting the resource. A more comprehensive system of groundwater monitoring for quantity and quality should be adopted by the state.

A. **Objective**: Montana's aquifers and groundwater/surface connections must be defined and characterized.

- I. **Short-term Recommendation:** Support additional funding for groundwater assessments and investigations so that additional aquifers and groundwater/surface connections can be defined and characterized.
- II. **Short-term Recommendation**: Identify and develop public/private partnerships to accomplish the stated objectives.
- III. Short-term Recommendation: Change the Ground-Water Assessment Steering Committee prioritization process for groundwater research to divide the funding among all four state river basins. This will balance priorities across rural-urban conflict situations, emerging ground water needs/limitations and quantifying new ground water resources.
- B. **Objective:** Statewide groundwater testing data should all be included in the existing public web portal. The availability of improved data will help inform and protect all water users.
  - I. **Short-term Recommendation:** Request that DEQ and DNRC work together to educate and encourage local sub-basin groups to address water quality and other issues associated with water use or activities that affect water quantity or quality.
- C. **Objective:** As more groundwater is used for beneficial operations, aquifers must be monitored to avoid overuse or adverse impacts to surface water connected to aquifers.
  - I. **Short-term Recommendation:** Support local, state, and federal efforts and increase funding through existing DNRC grant programs to control artesian flowing wells to better conserve groundwater resources.
  - II. **Medium-term Recommendation:** Increase funding levels for the Ground Water Assessment Program (GWAP) and the Ground Water Investigation Program (GWIP) administered through the MT Bureau of Mines and Geology to advance more projects across all four major river basins. Funding needs to address the increased need for information and keep pace with rising research costs.



## **Future Demands on Water Resources**

Basin scoping meeting participants agreed that more water from spring runoff should be captured by increasing the capacity of existing reservoirs, by building new small-scale off-stream reservoirs, or by enhancing natural floodplain wetlands water storage. Negotiation for additional water from federal storage projects to meet demand within the state is a possibility, keeping in mind the role full reservoirs play in recreation. Adoption of voluntary conservation programs, or in the case of industrial water use, development of recycling technology, might free up water for reallocation to additional uses. Some of the state's aquifers contain water of sufficient quantity and quality to help meet new demands. A water banking program could serve as a tool to help facilitate transfers of water to uses associated with rapidly changing demands.

#### FUTURE DEMANDS -- GOAL:

There may be strategies that if adopted would increase the quantity and quality of water available to help meet future resource demands for both consumptive and non-consumptive uses.

- A. **Objective:** State water resource agencies should work together to increase water supplies by actively exploring additional storage opportunities, considering incentives for voluntary water conservation by users, instituting more aquifer monitoring programs, and testing new wastewater recycling technologies.
  - I. **Short-term Recommendation:** Explore the potential for small off-stream storage projects in the Lower Missouri River basin
- **B. Objective:** Water banks would create greater certainty for prospective water users, thereby enhancing economic development and providing options to boost stream flows during periods of drought.
  - I. Short-term Recommendation: Various water banking strategies should be explored as a tool to facilitate transfers of water to differing uses.

## Watershed Organizations

During the Montana Water Supply Initiative scoping meetings in the Lower Missouri River Basin, four facts became evident. First, local watershed organizations provide a very important structure for promoting communication and collaboration on water resource issues. Second, local watershed organizations provide an effective forum that earns the trust and respect of participating stakeholders. Third, functioning watershed and sub-basin groups provide a workable and cost-effective structure for local stakeholders, state agencies, and federal agencies to communicate more effectively and arrive at solutions that all parties support and are willing to implement in good faith. Fourth, local mediation efforts reduce the need for costly judicial solutions to water resource management.

A number of sub-basins across the state have established watershed organizations with a goal of promoting communication and collaboration on water resource-related issues -- efforts that have reduced the need for costly judicial solutions to water resource problems. Existing groups, including the Clark Fork Coalition, the Musselshell Watershed Coalition, the Big Springs Watershed Council, the Greater Gallatin Watershed Council, the Big Hole Watershed Committee, and the Blackfoot Challenge were organized for different reasons, yet they all provide a trusted forum for discussion of issues. These organizations can serve an educational function, assist in the periodic updating of a statewide water use plan, and evaluate successes and failures in implementation of the statewide plan.



## WATERSHED ORGANIZATIONS -- GOAL:

The state should recognize and support autonomous grassroots organizations in watershed basins. These organizations will help local, state and federal agencies, organizations, and citizens work from the same water resource playbook in order to optimize collaborative problem-solving efforts.

- A. Objective: Local citizen groups allow diverse interests to come together to discuss and adopt water management strategies to solve problems that are critical in their watershed. If water management strategies are to be successful, water users need to trust and respect the decisions of water managers. Watershed organizations provide a forum for building that trust. Current technical and financial support of these groups by state and federal agencies is a key to their success, but additional funding for general staffing of the organizations is needed.
  - I. Short-term Recommendation: Support continuation and expansion of the Watershed Capacity Building Program initiated by the 2013 Legislature.
  - **II. Short-term Recommendation:** Build on Montana's Watershed Coordination Council's work, to increase the capacity of sub-basin community forums to function collaboratively with agencies to identify, respond, and resolve important water quantity and quality issues within their region.
  - III. **Short-term Recommendation:** Utilize the MT Watershed Coordination Council to distribute financial and technical assistance to existing and new watershed groups.
- B. **Objective:** To request that state and federal agency representatives work with water users, local watershed groups, municipalities, tribes, and conservation districts to improve cooperation and facilitate shared dialogue among all stakeholders in Montana's water resources.
  - I. Short-term Recommendation: Enhance education opportunities through the state's conservation districts to more broadly address water resource issues by providing additional grant funding opportunities.
  - II. **Short-term Recommendation:** Review the roles of resource agencies in data collection, data analysis, data publication, collaboration with other state and federal agencies, and enforcement of laws and regulations. Make necessary changes to clarify roles, responsibilities and effectiveness. Create a user-friendly template to communicate all of the above to those who work with and depend on water.
- A. **Objective**: Evaluate continuation of the BACs in each region to help support, network, facilitate, and evaluate the implementation of recommendations adopted in the final state water plan.
  - I. **Short term recommendation:** Convene water resource agencies, BAC members, and local sub-basin stakeholders for conferences and workshops to assess the merits, purpose and structure for ongoing BACs in all the four regions.

## **Sub-Basin Issue Statements**

The issue statements in this section were developed by BAC members residing in each of the four sub-basins of the lower Missouri River basin. Specifically, these sub-basins are the Judith River Sub-basin, Milk River Sub-basin, Musselshell River Sub-basin, and the Lower Missouri River Sub-basin, which is the Missouri River below Fort Peck Dam. These sub-basin issues and recommendations are meant to inform the public of priority issues in each of the sub-basins that emerged through the course of this process. They will not be included in the final state water plan developed by DNRC at the conclusion of this phase of the Montana Water Supply Initiative. Instead, they will serve to inform watershed organizations, conservation districts and other entities in the sub-basins about issues that should be addressed locally.



#### JUDITH RIVER SUB-BASIN

#### Madison Group and Kootenai Aquifers in the Judith River Basin

Judith River basin residents are protective of the quality and quantity of water flowing from Big Spring. There is a concern that development of high volume wells tapping the Madison Group and Kootenai aquifers, and an increase in activities that could contaminate the aquifer, will jeopardize the quantity or quality of the water.

**Aquifer Research – Goal:** A better understanding of the dynamics of the Madison Group Aquifer's recharge capacity and of the hydrological connections between the aquifer and the surface water of the Judith River basin, is essential to protection of water quality and quantity.

- A. **Objective:** The state should conduct additional research on how the Madison Aquifer functions, and on the connections between the aquifer and its surface outlets.
  - I. Short-term Recommendation: The BAC supports the 2014 RRGL application by the Central Montana Regional Water Authority to characterize the hydrology of the Madison Group and Kootenai aquifers.
  - **II. Medium-term Recommendation:** The BAC supports development of private/public partnerships to explore the effects of large volume groundwater water withdrawals on springs and other wells to ensure no adverse effects on existing water rights in the Judith River basin.
- **B. Objective:** Effective regulations addressing monitoring and control of possible sources of contamination of the Madison Group, Kootenai, and other shallower aquifers should be adopted as soon as possible.
  - I. **Short-term Recommendation:** Regulations governing surface and groundwater quality monitoring should be strengthened, and agencies involved in enforcement or monitoring activities encouraged to share data with each other and the public.

## LOWER MISSOURI RIVER SUB-BASIN (BELOW FT. PECK DAM)

#### Impacts of Water Releases from Ft. Peck Dam and Flood Waters From Tributaries

When large releases of water from Ft. Peck Dam occur, the resulting flows damage irrigation infrastructure downstream, and cold water from the power plant affects warm water fisheries. Fast-moving water also causes channel migration, causing water rights holders additional expense to access their water from the Missouri River.

**Mitigation of damage – Goal:** The state, municipalities, landowners, the Fort Peck Tribes, and the Army Corps of Engineers need to discuss ways to mitigate damage caused by releases of water from Ft. Peck Dam.

- **D. Objective:** Agencies that have interests in the Missouri River below Ft. Peck Dam, i.e., the Army Corps of Engineers, county DES offices, Montana FWP, irrigation districts, municipal water departments, should work together to develop joint plans to address potential damage caused by water released from the dam.
  - I. Short-term Recommendation: Explore capacity of Milk River watershed to help control floodwater.
  - II. Short-term Recommendation: Encourage bank stabilization along the Missouri River at points of diversion. Initiate at a minimum bi-annual stakeholder meetings to monitor and assess what is working and what is not working in mitigation efforts

## Missouri River and Aquifer Water Quality and Quantity

There is increasing development along the Missouri River and its drainages below Ft. Peck Dam. This leads to a concern that new water uses could contribute to increased sediment levels, chemical contamination and



excessive aquifer depletion of the water resources. Development is impacting both ground and surface water quality in the area.

**Water Quality and Quantity in Lower Missouri River Watershed – Goal**: Water quality in the Missouri River below Ft. Peck Dam should be monitored for contaminants. Existing laws and regulations governing water quality should be enforced, and perhaps strengthened. The major aquifers, such as the Fox Hills Formation, need additional study and monitoring to determine the recharge capacity. Currently the aquifers have no quantity limits on withdrawal.

- A. **Objective:** DEQ should implement practices and policies to require testing by all entities holding permits under Montana's Clean Water Act to make sure water quality standards are being met.
  - I. **Short-term Recommendation:** Agencies charged with enforcement of water quality standards and drilling practices must be given the resources to do their job.
  - II. **Short-term Recommendation:** Permits for uses that could contaminate groundwater or surface water should require the applicant to test and periodically monitor for contamination after the permit is issued, with test results submitted to DEQ and/or the GWIC public database at the Montana Bureau of Mines and Geology. This would require a change in existing statutes.
- III. **Short-term Recommendation:** Install streamflow gages on tributaries, and include water quality monitoring for sedimentation and contamination of surface water.
- B. **Objective:** The study of the Fox Hills aquifer should be completed in the next two years. This should determine the recharge quantity and withdrawals allowed to achieve sustainability in the aquifer. It has been shown recently that over-withdrawal effects others' ability to get water at an artesian level and also threatens the aquifer itself with possible collapse.
  - I. Short-term Recommendation: Adequate funding is needed for this additional study.
  - **II. Short-term Recommendation:** A locally-driven group, with state DNRC guidance, needs to help monitor the aquifer.
- C. **Objective:** The MT DEQ director has agreed to meet and discuss local water quality concerns. A small (working) group made up of all concerned and affected parties should be organized. This group will help guide DEQ on real, not perceived, issues, help to assure that current laws are followed, and that local individuals and companies are educated on the current laws. If current laws are not adequate, then this group would recommend changes.
  - I. **Short-term Recommendation:** Organize a local watershed group to work with DEQ to address water quality concerns.

#### MILK RIVER SUB-BASIN

#### St. Mary's Diversion Project

The Milk River contains "natural flow" from runoff that originates in the basin and "project water" from the Bureau of Reclamation (BOR) Milk River Irrigation Project that includes an inter-basin transfer water from the St. Mary River Basin and diversion structures. Without this transfer of water, natural flows alone would not keep the Milk River flowing 6 out of 10 years. The majority of the infrastructure of the St. Mary's Diversion and Conveyance Project is 100 years old and in danger of failure. In addition to tribal water claims, the project serves ten to fifteen thousand domestic users and approximately 700 farms comprising more than 110,000 irrigated acres on the Milk River. The loss of the diverted water from the St. Mary's river would be catastrophic for the individuals that depend on this source as well as for the river ecosystem.



Address St. Mary Diversion and Conveyance Works infrastructure – Goal: A collaborative effort for repairing or replacement of the St. Mary Diversion and Conveyance Works infrastructure should be implemented before catastrophic failure occurs.

- **A. Objective:** Create sufficient capacity for the St. Mary's Rehabilitation Working Group to achieve its ultimate goal for a complete rehabilitation.
  - I. Short-term Recommendation: Provide funding to hire a coordinator for the St Mary's Rehabilitation Working Group.
  - II. **Short-term Recommendation:** Secure support from the Governor's office to recognize and elevate this project as priority within its administration.
- **III. Short-term Recommendation:** Secure support from Montana's Congressional Delegation to prioritize this project at the national level.
- IV. Medium-term Recommendation: Develop the local capacity and financial commitments across the Milk River sub-basin necessary to support a state and federal authorization that is adequate to complete the rehabilitation project.

#### **Milk River Basin Erosion and Sedimentation**

Increased siltation occurring in storage facilities at Fresno Dam is reducing storage capacity. Riverbed siltation downstream from Fresno Dam has presented extra management for operation of water intakes/pumps along the river for irrigators and municipalities. Flooding events erode stream banks and move sediment in the river basin, affecting water quality. Riverbed siltation downstream from Fresno Dam has presented extra management for operation of water intakes/pumps along the river for irrigators and municipalities.

**Milk River Water Quality – Goal:** Better understanding of the Milk River water quality issues and storage capacity concerns to improve protection of water quality and quantity.

- A. **Objective:** Investigate and research storage capacity improvements to Fresno Dam facility while addressing water final ratification of the Blackfeet Tribal Water Compact should occur quality issues within the Milk River Basin.
  - I. Short-term Recommendation: Investigate the options and benefits of adding storage to Fresno Dam facility with an inflatable bladder dam.
  - II. **Short-term Recommendation:** Establish collaborative effort with stakeholders to develop ideas and solutions

#### **Tribal Water Compacts**

Until water rights compacts within the Milk River Basin have been ratified by Congress and the Tribes, planning for rehabilitation of the St. Mary's Diversion Project is difficult.

**Establish Communication – Goal:** Tribal leadership and the Montana Water Compact Commission should be encouraged to communicate and work to resolve differences.

- A. Objective: Final ratification of Tribal Water Compacts should occur within the next five years.
  - I. **Short-term Recommendation**: Re-establish the legislative authority of the Montana Water Compact Commission and fund its work until all the compacts have been ratified by Congress and the tribes.

## MUSSELSHELL RIVER SUB-BASIN

## **Musselshell River Water Rights Adjudication**

The water rights adjudication process in the Musselshell River basin occurred at an accelerated pace during a period when water disputes were common and creation of a water enforcement project was an immediate



necessity. The claims verification process used was less stringent than that used in some other basins around the state, and the inaccuracies have yet to be corrected. Most of the Musselshell's tributaries have not yet been adjudicated. All three of the Musselshell River's adjudicated sub-basins, and the tributaries, would benefit from accurate completion of the adjudication process to the point of Preliminary decrees.

Water Rights Adjudication – Goal: Accurate adjudication of all three Musselshell River basins.

- **A. Objective:** Bring water rights adjudication in the Musselshell basins up to the same standards that were applied in examination of other basins in the state.
  - *I.* **Short-term Recommendation:** DNRC should review claims in the Musselshell basins' Temporary Preliminary decrees using resource surveys, and any other data available, to determine which should have issue remarks to be resolved.
- **B. Objective:** Bring Musselshell tributaries up to the same standards imposed on the mainstem for water measurement and distribution by the time Preliminary decrees are issued.
  - I. **Short-term Recommendation:** Water Court and DNRC need to complete Temporary Preliminary decrees on the Musselshell River tributaries.
- C. **Objective:** Create a uniform process for accurate distribution and measurement of decreed water upon issuance of a Preliminary decree.
  - I. **Short-term Recommendation:** Encourage the Lower Missouri River Basin Advisory Council to support uniformity of decreed water distribution in all basins in the state.

## **Off-Stream Water Storage**

The Musselshell River frequently experiences short, intense periods of spring run-off that can cause flood damage to homes and infrastructure. The existing off-stream storage projects (Martinsdale Reservoir and Deadman's Basin Reservoir) do not have inlet canals of sufficient size to divert more than a small fraction of the run-off, so most of it goes on downstream through Ft. Peck Reservoir, and out of state, its use lost to Montana.

**Water Storage – Goal:** More spring run-off should be stored within the Musselshell River watershed for use during periods of limited precipitation.

- A. **Objective:** Additional off-stream water storage sites should be evaluated and funded. The state should identify more funding partners for potential projects, including recreational users, flood control agencies, wildlife resource agencies, hydroelectric companies, and irrigators.
  - I. **Short-term Recommendation:** Water users interested in pursuing off-stream storage projects should work to secure funding sources and the state should support their efforts through grant funding.

#### **Riparian Weeds**

The 2011 flood delivered millions of weed seeds to the banks and gravel bars of the Musselshell River. There is no coordinated effort among all the counties through which the river runs to control the resulting infestations, which have now gained a firm foothold.

**Noxious Weeds – Goal:** To successfully combat noxious weeds, infestations must be controlled by cooperative efforts throughout a watershed.

- A. **Objective:** The state should encourage counties to pool allocations from the weed trust fund to establish cooperative weed management areas, and provide additional sources of funding to combat weeds in riparian areas.
  - I. **Short-term Recommendation:** The state could allow bonus grants of Weed Trust funds when multicounty cooperative weed management areas are established.



#### **Musselshell Watershed Coalition**

The Musselshell Watershed Coalition (MWC), established in 2009, has brought stakeholders in the basin together to work collaboratively to manage water resources and improve the ecological health of the river. By working together, the partners have implemented a number of successful strategies and projects with funding assistance from DNRC, DEQ, NRCS, and non-profit organizations. Many of the administrative functions of MWC have been provided by volunteers. The organization has reached a point in its evolution where secure funding for a Coordinator is a necessity.

**Capacity-Building – Goal:** MWC needs some assurance that its efforts on behalf of helping to better manage the state's water resources will be supported into the future by secure funding assistance.

A. **Objective:** MWC partners should adopt long-range goals for capacity-building for the organization.

- I. **Short-term Recommendation:** MWC should work with the Montana Watershed Coordination Council go develop a long-range plan for building capacity and securing funding.
- II. **Short-term Recommendation:** The state should allocate a portion of its water resource budget to support local watershed organization staff expenses now and into the future.



## X. Glossary of Terms

Abandonment – The intentional, prolonged, non-use of a perfected water right.<sup>1</sup>

**Acre-feet** - A unit of volume, mostly used in the United States, to describe large-scale water volumes. It is the volume of one acre of surface area to the depth of one foot which is equal to 43,560 cubic feet.

**Adjudication of Water Rights** - In the context of Montana water law this refers to the statewide judicial proceeding to determine the type and extent of all water rights claimed to exist before July 1, 1973.<sup>2</sup>

**Adverse Effect** – Interference with a water right owner's ability to reasonably exercise their water right. In the context of new water use permits and change applications, the applicant must prove lack of adverse effect prior to appropriating water for a beneficial use pursuant to \$85-2-311, MCA, or changing a water right pursuant to \$85-2-402, MCA.<sup>3</sup>

**Appropriate** - To divert, impound, or withdraw, including by stock for stock water, a quantity of water for a beneficial use.<sup>1</sup>

**Appropriation Right/Water Right** - any right to the beneficial use of water which would be protected under the law as it existed prior to July 1, 1973, and any right to the beneficial use of water obtained in compliance with the provisions and requirements the Title 85, Chapter 2.<sup>1</sup>

**Aquatic Ecology** - The relationships among aquatic living organisms and between those organisms and their water environment.

Aquatic Invasive Species - Non-native plants, animals or pathogens that cause environmental or economic harm.

**Beneficial Use** - Use of water for the benefit of the appropriator, other persons, or the public, including but not limited to agricultural (including stock water), domestic, fish and wildlife, industrial, irrigation, mining, municipal, power, and recreational uses; use of water to maintain and enhance streamflows to benefit fisheries pursuant to conversion or lease of a consumptive use right.<sup>1</sup>

**Call** - The request by an appropriator for water which the person is entitled to under his/her water right; such a call will force those users with junior water rights to cease or diminish their diversions and pass the requested amount of water to the downstream senior water right holder making the call.

**Claim/Statement of Claim** - The assertion that a water right exists under the laws of Montana or that a reserved water right exists under the laws of the United States in Montana's general adjudication.<sup>2</sup>

**Climate** - The average weather over a period of time, typically taken as a 30-year period from a human perspective. Geologists and paleoclimatologists refer to the earth's climate over thousands to millions of years.

**Climate Variability** - The fluctuation of temperature, precipitation, wind, and other climate descriptors, over a period of time. This variation may be due to natural processes or human-induced factors.

**Compact** – a negotiated agreement for the equitable division and apportionment of waters between the State and its people and: 1) the several Indian Tribes claiming reserved water rights within the state (MCA 85-2-701); or, 2) between the State and its people and the federal government claiming non-Indian reserved waters within the state.

**Conjunctive Management** - Management of ground and surface water as a single resource.



Conjunctive Use - The deliberate combined use of groundwater and surface water.

**Conservation District** - A political subdivision of state government, possessing both public and private attributes, that primarily distributes irrigation water in a given region and that may also administer electric power generation, water supply, drainage, or flood control.

**Consumptive Use** - Use of water that reduces supply, such as irrigation or household use.<sup>1</sup>

**Decree** - Is a final product of adjudication and is a legal document issued by a district court or the Montana Water Court defining the priority, amount, use, and location of a water right or set of water rights. The Montana Water Court adjudicates and prepares decrees for entire basins as part of the adjudication process.<sup>2</sup>

**Dewatering of Streams, Chronic and Periodic** - Dewatering is a reduction in stream flow below the point where stream habitat is adequate to support healthy fish populations. Chronic dewatering is a significant problem in all years while periodic dewatering is a significant problem only in drought years.

**Means of Diversion/Diversion** - the type of structures, facilities, or methods used to appropriate, impound, or collect water including but not limited to a dike, dam, ditch, headgate, infiltration gallery, pipeline, pump, pit or well.<sup>1</sup>

**Evapotranspiration (ET)** - means the loss of water from the soil both by evaporation and by transpiration from living plants. Evaporation accounts for the movement of water to the air from sources such as the soil, canopy interception, and water bodies. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through stomata in its leaves.<sup>1</sup>

**Exempt Wells** - Under Montana water law, wells that divert 35 gallons per minute or less, and do not exceed 10 acre-feet per year in the total volume of water diverted are considered exempt from the permitting process. Appropriators of water under these conditions are, however, required to file a notice of completion with DNRC.<sup>4</sup>

**Existing Water Right** - "Existing right" or "existing water right" means a right to the use of water that would be protected under the law as it existed prior to July 1, 1973. The term includes federal non-Indian and Indian reserved water rights created under federal law and water rights created under state law.<sup>1</sup>

**Federal or Tribal Reserved Water Rights** - Established by an act of Congress, a treaty, or an executive order. Gives a right to use water; the amount of water reserved depends on the purpose for which the land was reserved.

**Flowing Well** - An oil or water well from which the product flows without pumping due to natural or artificially supplied subterranean pressure.

**Flow Rate** - is a measurement of the rate at which water flows or is diverted, impounded, or withdrawn from the source of supply for beneficial use, and commonly measured in cubic feet per second (cfs) or gallons per minute (gpm).<sup>1</sup>

**Geographic Information System (GIS)** - a computer system designed to capture, store, manipulate, analyze, manage, and present geographical data.

Ground Water - Any water beneath the land surface.<sup>1</sup>

**Ground Water Recharge or Aquifer Recharge** - Can refer both to the natural process of ground water recharge (achieved by infiltration of precipitation or discharge from surface water), OR can refer to human efforts to enhance more groundwater storage. Artificial aquifer recharge (AR) is the enhancement of natural ground water supplies using man-made conveyances such as infiltration basins or injection wells. Aquifer storage and recovery



(ASR) is a specific type of AR practiced with the purpose of both augmenting ground water resources and recovering the water in the future for various uses.<sup>1</sup>

**Hydrologic Regime** - The relationship between precipitation inputs and streamflow outputs in a basin or watershed. The amount and timing of water moving through a watershed often characterized by the average annual hydrograph.

**Hydrograph** - A chart showing the relationship between flow rate and time at given point (gage) in a watershed flow network. Time is usually on the horizontal axis and flow rate is usually on the vertical access.

**Instream Flow** - Water left in a stream for non-consumptive uses such as aquatic habitat, recreation, navigation, or hydropower.

**Interstate Compact** - A legal agreement between two states that divides (or apportions) water crossing the states' boundaries.

**Junior Appropriator/Junior Water Right** - A general term referring to a water right or the owner of a water right with a priority date that is later in time than another water right.

Channel Migration - Natural movement of river channels through the processes of erosion and deposition.

**Legal Water Availability** - Typically determined based upon comparison of physical water availability to the legal demands on a source or reach of a source by subtracting the legal demands from physical water availability.<sup>3</sup>

**METRIC** (Mapping Evapotranspiration at high Resolution and with Internalized Calibration) is an imageprocessing tool for computing evapotranspiration (ET) using Landsat Thematic Mapper data.

Montana Code Annotated (MCA) - Laws of Montana classified by subject. Title 85 contains laws pertaining to water use.

**Murphy Rights** – Instream flow rights on 12 Blue Ribbon trout streams for the preservation of fish and wildlife. Named for the legislative author, Jim Murphy of Kalispell. Murphy Rights exist for specific reaches of the following rivers: Big Spring Creek, Blackfoot River, Flathead River, Middle Fork Flathead River, South Fork Flathead River, Gallatin River, West Gallatin River, Madison River, Missouri River, Rock Creek, Smith River, and Yellowstone River. The priority dates are 1970 and 1971 and only protect flows when senior water rights have been satisfied.

Natural Storage of Water - See storage of water, natural.

Non-Consumptive Use - Use of water that does not consume water.

Overstated Water Rights - Water rights in excess of what was perfected through beneficial use.

**Permit** - An authorization to use water, issued by DNRC, specifying conditions such as type, quantity, time, and location of use.<sup>3</sup>

**Physical Water Availability** - the amount of water physically available at a specific point on a source typically measured in flow rate and volume.<sup>3</sup>

**Priority Date** - The clock time, day, month, and year assigned to a water right application or notice upon DNRC acceptance of the application or notice. The priority date determines the ranking among water rights. <sup>1</sup>

**Federal Reserved Water Right** - A special water right accompanying federal lands or Indian reservations, holding a priority date originating with the creation of the land.



**Resource Indemnity Trust** - Article IX of the Montana Constitution provides for the protection and improvement of the Montana environment and requires the existence of a resource indemnity trust (RIT) fund for that purpose, to be funded by taxes on the extraction of natural resources.

**Return flow** - Part of a diverted flow that is applied to irrigated land or other beneficial use and is not consumed and returns underground to its original source or another source of water. Other water users may be entitled to this water as part of their water right. <sup>1</sup>

**Riparian** - Riparian means related to or situated on the banks of a river. A *riparian* zone or *riparian* area is the interface between land and a river or stream.

**Riverine Processes** - The processes of erosion, transport and deposition of sediment that shape a river's channel(s) and floodplain.

**Senior Appropriator/Senior Water Right** - A general term referring to a water right or the owner of a water right with a priority date that is earlier in time than another water right.<sup>1</sup>

Storage of Water, Artificial or Constructed - Storing water in reservoirs or other human made impoundments.

**Storage of Water**, **Natural** - Storage of water in natural landscape features such as groundwater aquifers, ponds (including beaver ponds, floodplain ponds), wetlands and swales.

**Stream Depletion Zone** - An area where hydrogeologic modeling concludes that as a result of a ground water withdrawal, the surface water would be depleted by a rate equal to a rate of at least 30% of the ground water withdrawn within 30 days after the first day a well or developed spring is pumped at a rate of 35 gallons a minute.<sup>1</sup>

**Stream Gage** - A stream gage measures the flow of water at a point along a stream. The U.S. Geological Survey defines a stream gage as, "an active, continuously functioning measuring device in the field for which a mean daily streamflow is computed or estimated and quality assured for at least 355 days of a water year or a complete set of unit values are computed or estimated and quality assured for at least 355 days of a water year".

**Sub-basin** - A structural topographic feature where a basin forms within a larger basin. For example, the Bitterroot River basin is sometimes referred to as a sub-basin of the Clark Fork River basin.

**Surface water** - All water of the state at the surface of the ground, including but not limited to any river, stream, creek, ravine, coulee, undeveloped spring, lake, and other natural surface source of water regardless of its character or manner of occurrence.<sup>1</sup>

**Telemetered (real-time) Stream Gage** - A telemetered gage has the capability to transmit water elevation and streamflow data to a central location where it may be viewed (for example, via the Internet) as the data is collected.

**Waste** - Unreasonable loss of water through the design or negligent operation of an appropriation or water distribution facility or the application of water to anything but a beneficial use.<sup>1</sup>

**Water Bank** - An institutional mechanism used to facilitate the legal transfer and market exchange of various types of surface water, groundwater, and storage entitlements. Water banks use the market to make water available for new uses.

Waterway and Water Body - Usually refers to surface water features like rivers, streams, lakes, or ponds.



**Waterway Health** - Waterways are considered to be healthy when surface & groundwater flows & levels are of a timing and duration that provides habitat capable of supporting self-sustaining populations of native fish species and water dependent wildlife. In addition, waterway health refers to flows that help meet water quality standards, support beneficial uses, and support stream renewal functions.

**Water Commissioner** - Local water users can petition for a water commissioner after the water rights in a basin have been verified by the Montana Water Court. The commissioner ensures that daily water allocations in the basin occur in accordance with the users' rights. The local district court appoints the commissioner, and oversees his or her work. <sup>5</sup>

**Water Court** - Located in Bozeman, the Montana Water Court's primary function is to carry out the state-wide adjudication. Disputes between water right holders are still handled in local district court, and the local district courts oversee water commissioners in their area.

**Water Lease** - An agreement with a water user to allow a person or organization, for a fee, to lease water from the user. Water leases are often used in Montana to maintain instream flow.<sup>6</sup>

**Water Quality** - Chemical, physical, and biological characteristics of water that determine its suitability for a particular use.

**Water Right Change** - A change in the place of diversion, the place of use, the purpose of use, or the place of storage of a water right. These changes need the approval of DNRC to assure that the change will cause no adverse effect to other water users.<sup>3</sup>

**Watershed** - All the land that drains to a river or lake, with boundaries defined by topography (and includes wetlands, floodplains, riparian areas and uplands). For the purpose of this planning document, the term "watershed" is referring to a subunit of a sub-basin (smaller area).

**Watershed Health** - A watershed is considered healthy if it can continue to perform without depletion or degradation of watershed services such as: water collection, storage & delivery, flood and drought moderation; water purification, wildlife habitat and support of waterway health (see Waterway Health).

**Water Reservation**: A water right created under state law after July 1, 1973, that reserves water for existing or future beneficial uses or that maintains a minimum flow, level, or quality of water throughout the year or at periods or for defined lengths of time.<sup>7</sup>

<sup>4</sup> See §85-2-306, Mont. Code Ann.

<sup>&</sup>lt;sup>1</sup> See §85-2-102, Mont. Code Ann., and Rule 36.12.101, Admin. Rules Mont.

<sup>&</sup>lt;sup>2</sup> See Title 85, Chapter 2, Part 2, Mont. Code Ann.

<sup>&</sup>lt;sup>3</sup> See §85-2-311, and 402, Mont. Code Ann., and Title 36, Chapter 12, Subchapters 17 through 19. Admin. Rules Mont.

<sup>&</sup>lt;sup>5</sup> See Title 85, Chapter 5, Mont. Code Ann.

<sup>&</sup>lt;sup>6</sup> See Title 85, Chapter 2, Part 4, Mont. Code Ann.

<sup>&</sup>lt;sup>7</sup> See §85-2-316, Mont. Code Ann.



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