SUMMARY

MISSOURI RIVER

Revised Draft

Environmental Impact Statement

Master Water Control Manual

Review and Update

August 2001

U.S. Army Corps of Engineers
Northwestern Division

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Environmental Impact Statement

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U.S. Army Corps of Engineers
Northwestern Division

Dear Concerned Citizens:

The Missouri River Master Water Control Manual (Master Manual) is the guide used by the U.S. Army Corps of Engineers (Corps) to operate six dams on the mainstem of the Missouri River — Fort Peck, Garrison, Oahe, Big Bend, Fort Randall, and Gavins Point. Shortcomings identified during the drought of the late-1980s as well as listings under the Endangered Species Act (ESA) require another look at the Master Manual. The Corps Missouri River Master Manual Revised Draft Environmental Impact Statement (RDEIS) represents many years of effort by Corps engineers, scientists, and technical staff. The document reflects input received from technical experts at all levels of government. Most importantly, the document incorporates the concerns expressed by watchful basin citizens who have participated throughout this lengthy process.

The RDEIS identifies the impacts associated with six alternative operation plans for the dams and their reservoirs. Presenting the RDEIS in this manner, without a preferred alternative, is intended to facilitate further comment from all necessary parties, agencies, and the public to provide valuable input to officials who must make the final decision. In addition to the current Water Control Plan (CWCP) and a modified conservation plan (MCP), the RDEIS analyzes the impacts of a set of options that include changes in Gavins Point Dam releases. These options are referred to as the GP options. The U.S. Fish and Wildlife Service (USFWS) recommended changes in Gavins Point Dam releases in its recent Biological Opinion (BiOp) to the Corps. The USFWS recommended changes to ensure that the Corps does not jeopardize the continued existence of threatened and endangered species provided protection under the ESA. This Summary presents an overview of the RDEIS and process.

All of the alternatives evaluated in detail in the RDEIS and described in this Summary embrace an adaptive management strategy. This strategy promotes an environment for testing hypotheses and exploring promising changes based on sound scientific data and analysis. Monitoring and evaluation of actual results of changes in operation of the system and the flexibility to adapt as new information becomes available are key to the strategy. Stakeholder participation in the adaptive management process is also critical.

The Corps' role in this effort is that of an honest broker, serving our Nation and its citizens. The Missouri River is a National treasure that must be protected, and the dams are National investments that should serve the contemporary needs of the Missouri River basin and the Nation. As stewards of both the river and the dams, the Corps' challenge is to develop a flow management plan that accomplishes both objectives.

I urge you to read this Summary, participate in upcoming workshops and hearings, and express your opinion. For more information about available documents, other sources of information, and the comment procedures, please refer to the back cover of this Summary.

Finally, as we approach the upcoming commemoration of the historic journey of Lewis and Clark up the Missouri River, please get out and enjoy the river and our rich heritage!

Sincereley,

Carl A. Strock
Brigadier General, U.S. Army
Division Engineer

Glossary and Acronyms

Annual Flood Control Zone-The desired operating zone of a reservoir (lake). Water from the annual high spring and summer inflows is stored in this zone and then released during the remainder of the year to serve other authorized purposes.

Deposition-The process of laying down sediments after a transportation process (sedimentation).

Drawdown-The distance that the water surface of a lake is lowered from a given elevation as water is released from the lake. Also refers to the act of lowering lake levels.

Drought Conservation-Reduction of releases from the Mainstem Reservoir System to conserve water in the lakes for authorized project purposes.

Endangered-A plant or animal species that is in danger of extinction throughout all, or a significant portion, of its range. The U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS) designates endangered species.

Erosion-The wearing away of a land surface or river channel by water, wind, ice, gravity, or other geological activities.

Eutrophication-The build-up of nutrients in a water body that promotes excessive algal growth.

Fledged Bird-An immature bird that has reached flight stage.

Flood Control Zone-The storage zone of a lake that is used to store annual spring runoff as well as infrequent extremely high flood events.

Habitat-The environment occupied by individuals of a particular species, population, or community.

Intrasystem Regulation-Regulation of water releases and storage volumes within a system of dams.

Levee-A dike or embankment that protects land from flooding.

Lower River-The segment of the Missouri River that extends from Gavins Point Dam to the mouth of the river near St. Louis.

Mainstem Reservoir System-The portion of the Missouri River from the headwaters of Fort Peck Lake to Gavins Point Dam that includes the six large dams and their lakes.

Master Manual-The manual which describes the operation of the Mainstem Reservoir System including the Water Control Plan. It establishes operational policy for the multiple project purposes of flood control, hydropower, water supply, water quality, irrigation, navigation, recreation, and fish and wildlife.

Navigation Season-The period of time that flow support is provided to serve navigation on the Lower River from Sioux City to the mouth near St. Louis. The length of a normal navigation season is 8 months (April 1 through December 1).

Navigation Service-The release of water from the Mainstem Reservoir System necessary to maintain 8 to 9 feet of water depth in the navigation channel between Sioux City and St. Louis.

Permanent Pool-The minimum water level necessary to allow the hydropower plants to operate and provide minimum service to recreation and fish and wildlife. The permanent pool also provides reserved space for sediment storage.

Release of Water-The controlled discharge of water from a lake to serve one or more authorized purposes.

Reservoir-An artificial body of surface water (lake) retained by a dam.

Riparian Habitat-The area adjacent to a stream channel, a lake, or wetland that supports the growth of woody vegetation that is not adapted for life in saturated soil conditions.

Sedimentation-The process of deposition of sediment.

Super Saturation-The buildup of gases in water above the normal fully saturated level. Water quality standards for streams and rivers normally limit this to 110 percent of normal saturation.

Tailwater-The river reach immediately downstream from a dam.

Threatened-Legal status afforded to a plant or animal species likely to become endangered within the foreseeable future throughout all or a significant portion of its range, as determined by the USFWS or the NMFS.

Upper Lakes-The three most upstream Missouri River lakes formed by Fort Peck Dam, Garrison Dam, and Oahe Dam.

Water Control Plan-A detailed plan outlining the guidelines for operation of the Mainstem Reservoir System that is contained in the Master Manual.

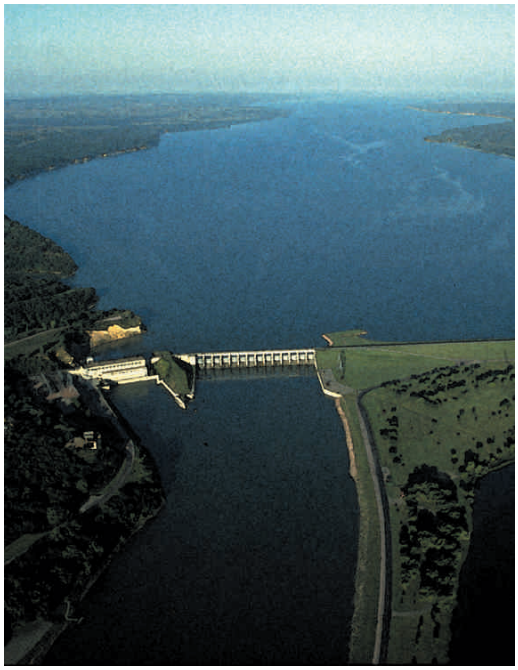
Water Evacuation-The release of water from the flood control zone of a lake. This is usually done prior to the beginning of each year's flood season to reduce the chances of flooding.

Wetland Habitat-Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support vegetation adapted for life in saturated soil conditions.

Acronyms/ Abbreviations

ACT	Agency Coordination Team
AOP	Annual Operating Plan
BiOp	Biological Opinion
Corps	U.S. Army Corps of Engineers
CWCP	current Water Control Plan
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
GP	Gavins Point
kcfs	thousand cubic feet per second
MAF	million acre-feet
MCP	Modified Conservation Plan
MRBA	Missouri River Basin Association
MW	megawatt
MWh	megawatt hours
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NWD	Northwestern Division, Corps of Engineers
PRDEIS	Preliminary Revised Draft Environmental Impact Statement
RDEIS	Revised Draft Environmental Impact Statement
ROD	Record of Decision
ROR	run of river
RPA	reasonable and prudent alternative
Study	Master Water Control Manual Review and Update
T&E	threatened and endangered
USFWS	U.S. Fish and Wildlife Service
WAPA	Western Area Power Administration

The INTRODUCTION



The purpose of this Summary is to provide an overview of the findings developed for the Missouri River Master Water Control Manual Review and Update (Study) Revised Draft Environmental Impact Statement (RDEIS). For detailed information please refer to the RDEIS and the supporting technical documents. The Study was initiated by the U.S. Army Corps of Engineers (Corps) during the first major drought (1987 to 1993) the Missouri River basin experienced since the Missouri River Mainstem Reservoir System (Mainstem Reservoir System) became fully operational in 1967. The purpose of the Study is to identify a water control plan that serves the contemporary needs of the basin, complies with current environmental laws, and serves Congressionally authorized project purposes.

The primary purpose of the RDEIS is to analyze the environmental effects of a set of six alternative operating plans for the Missouri River Master Water Control Manual – the current Water Control Plan (CWCP), a modified conservation plan (MCP), and four alternatives that add various Gavins Point Dam release changes to the MCP. These latter four alternatives, referred to as the Gavins Point (GP) options, address changes in water releases from Gavins Point Dam that the U.S. Fish and Wildlife Service (USFWS) recommended in its Biological Opinion (BiOp).

The USFWS feels that these changes are necessary to ensure that operation of the Missouri River projects is not likely to jeopardize the continued existence of any listed species or result in the destruction or modification of critical habitat for the listed species. The RDEIS presents detailed data on the CWCP, MCP, and the four GP options. The Corps invites interested parties to review this Summary (and the full RDEIS if more detailed information is desired), to participate in the workshops and public hearings that follow publication of the RDEIS, and to submit their comments.

The Corps will make known its decision regarding the USFWS' recommendations at the conclusion of the National Environmental Policy Act (NEPA) process for the Master Manual. After publication of the Final Environmental Impact Statement (FEIS), which will identify the selected plan, the Corps will issue a record of decision (ROD). This ROD will include the Corps' conclusions and determinations on how it intends to meet its statutory authorizations and requirements to include project authorities and Endangered Species Act (ESA) requirements.

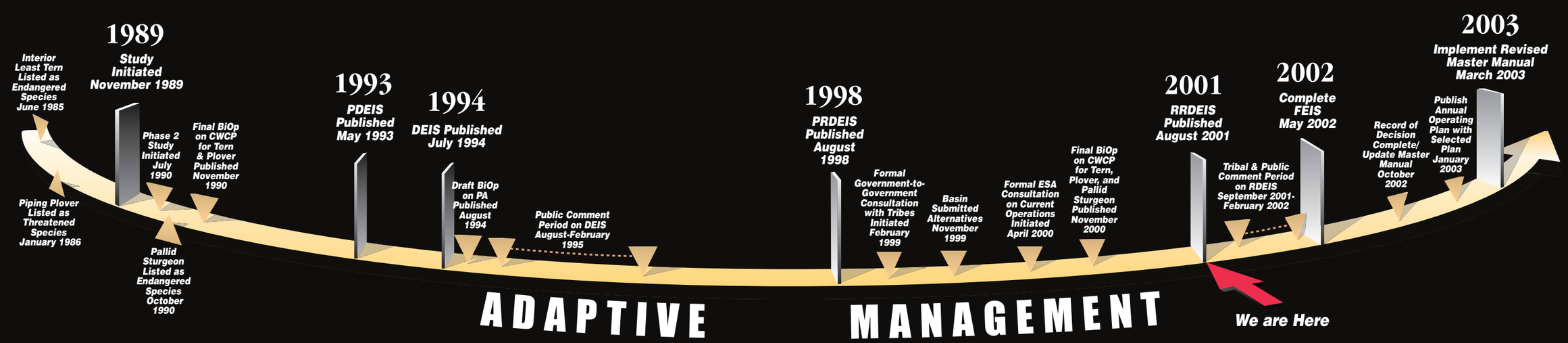
The JOURNEY

The Study is being accomplished under NEPA in the form of an environmental impact statement (EIS) process. The Study began in November 1989, and the NEPA process was initiated in mid-1990. In 1994, the Corps published a Draft Environmental Impact Statement (DEIS) that identified a preferred alternative. Extensive public comment was received regarding the alternative and the public requested additional and revised studies. While the Corps was conducting requested studies, the basin States and other interests began efforts to reach consensus regarding how the Mainstem Reservoir System should be operated. To foster these efforts, the Corps prepared an additional document in 1998 not required by NEPA. That document, called a Preliminary Revised Draft EIS (PRDEIS), identified eight representative alternatives but did not include a preferred alternative. An information exchange period followed release of the PRDEIS and the Corps conducted workshops to assist the Tribes and public in better understanding the alternatives and their impacts. During this period, the Corps was also engaged in informal Section 7 ESA consultation with the USFWS on current operation of the Mainstem Reservoir System.

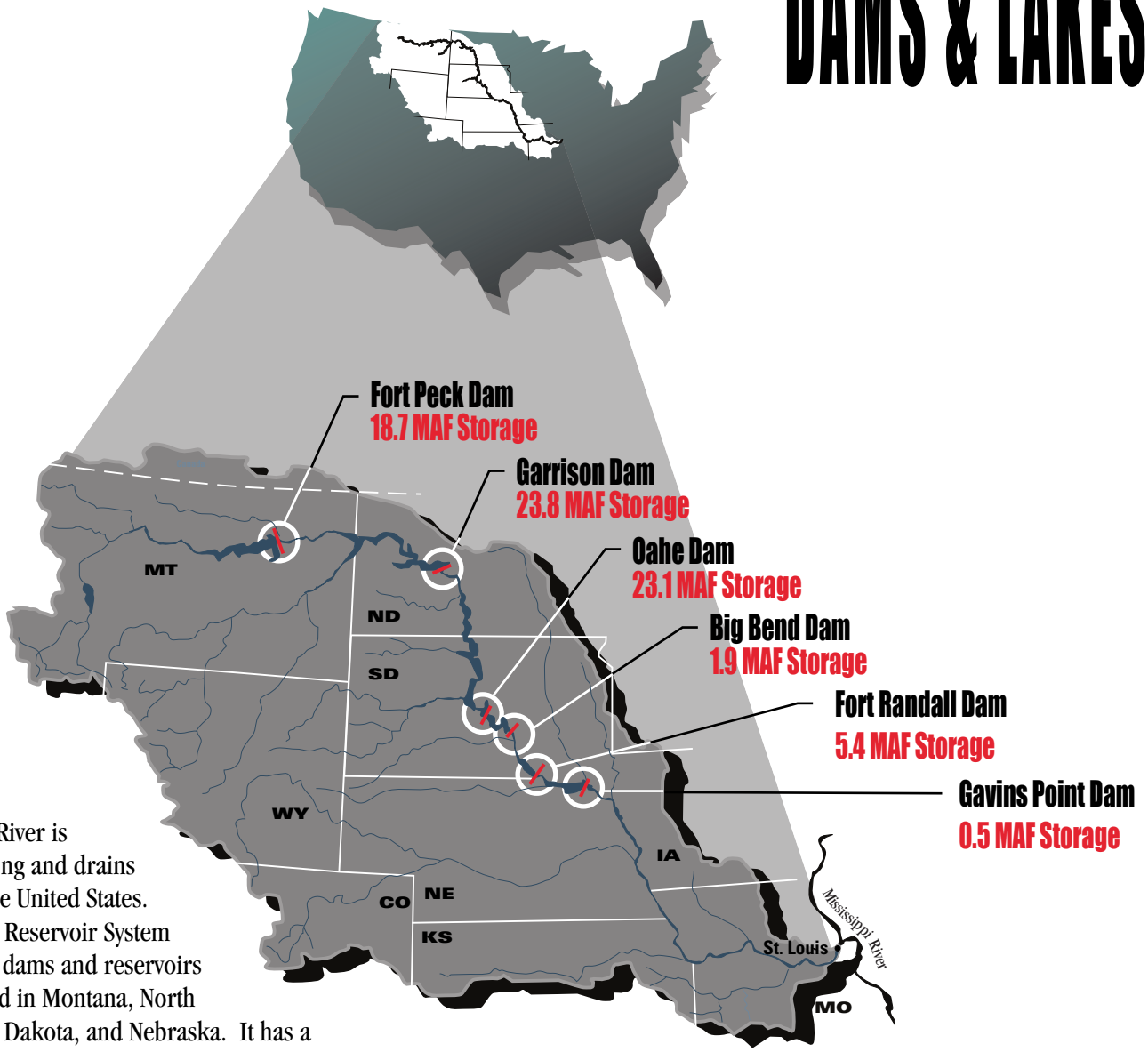
Seven basin entities submitted alternatives to the Corps following the PRDEIS. In January 2000, after reviewing those alternatives, the Northwestern Division of the Corps (NWD) proposed a preferred alternative. That alternative included drought conservation measures and flow changes from Fort Peck Dam for threatened and endangered species, but did not propose Gavins Point Dam flow changes for threatened and endangered species.

In March 2000, the USFWS indicated that the NWD preferred alternative would not preclude jeopardy of threatened and endangered species provided protection under the ESA. In April 2000, the Corps entered into formal consultation under Section 7 of the ESA, to ensure that the Corps develops a revised water control plan that complies with the ESA. In November 2000, the Corps received a final BiOp from the USFWS. In this BiOp, the USFWS concluded that the Corps' current operation of the Mainstem Reservoir System jeopardizes the continued existence of three protected species – the endangered interior least tern, the threatened piping plover, and the endangered pallid sturgeon. The BiOp prescribed flow changes, including flow changes from Gavins Point Dam, necessary to preclude jeopardy of these species. The GP options presented in this RDEIS address these flow changes.

A 6-month public comment period will follow publication of this RDEIS. Workshops and hearings will be held at numerous locations throughout the Missouri River basin, including Tribal Reservations, and at some Mississippi River locations. Following the public comment period, the Corps intends to identify a Selected Plan in a FEIS, prepare a ROD, and update the Master Manual. It will then prepare an Annual Operating Plan (AOP) that conforms to the guidelines established under the revised Master Manual, and implement the new water control plan. To comply with the BiOp, the new plan must be implemented by 2003.



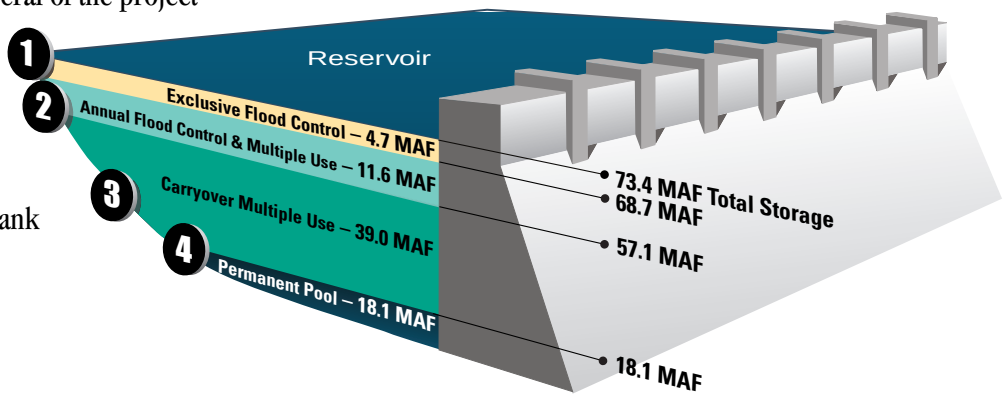
The Missouri River DAMS & LAKES



The Missouri River is 2,341 miles long and drains one sixth of the United States. The Mainstem Reservoir System consists of six dams and reservoirs (lakes) located in Montana, North Dakota, South Dakota, and Nebraska. It has a capacity to store 73.4 million acre-feet (MAF) of water, which makes it the largest reservoir system in North America. The Corps operates the Mainstem Reservoir System to serve Congressionally authorized project purposes, of flood control, navigation, irrigation, hydropower, water supply, water quality, recreation, and fish and wildlife. Runoff from above the Mainstem Reservoir System dams is stored in the six lakes, where it serves several of the project purposes. Water is released from the Mainstem Reservoir System as needed for downstream purposes. Released water from the lowest dam in the Mainstem Reservoir System, Gavins Point Dam, flows down the Lower River, which includes the Bank Stabilization and Navigation Project from Sioux City to St. Louis.

Mainstem Reservoir System

73.4 MAF Total Storage



How Dams OPERATE

Spillway

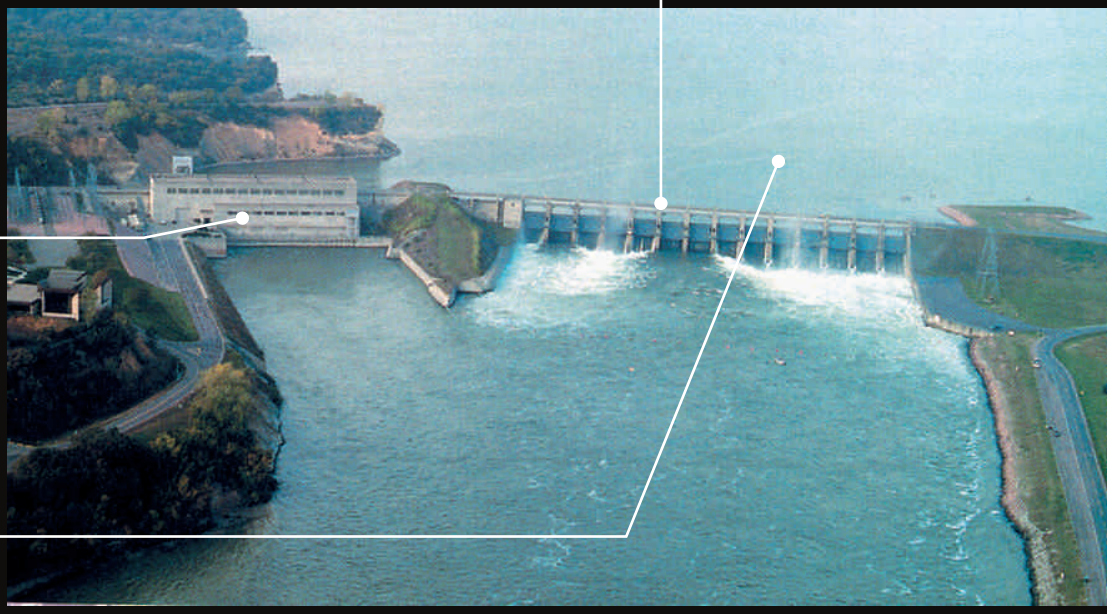
The spillway is composed of a series of gates that are used to control lake levels and to make releases of flow that exceed the capacity of the powerhouse and outlet works.

Powerhouse

Powerhouses are located at the dams of each of the six mainstem projects. The powerhouse generally is used to pass the water from the lake through turbines that rotate and generate electricity.

Lake (Reservoir)

Spanning the river, the dam forms a physical barrier that impedes the river's flow, forming an artificial lake, or reservoir. Water pools behind each dam, covering land that was previously exposed. The storage in, and release of water from, the lakes allow the Corps to serve the many project purposes.



Gavins Point Dam

Storage in the lake is distributed among Four Zones

1. The **exclusive flood control zone** is the upper-most storage zone of the mainstem lakes that is reserved to store runoff from extremely high flood events. Water is released from this zone as quickly as downstream channel conditions permit so that sufficient space remains for capturing future floodwaters.

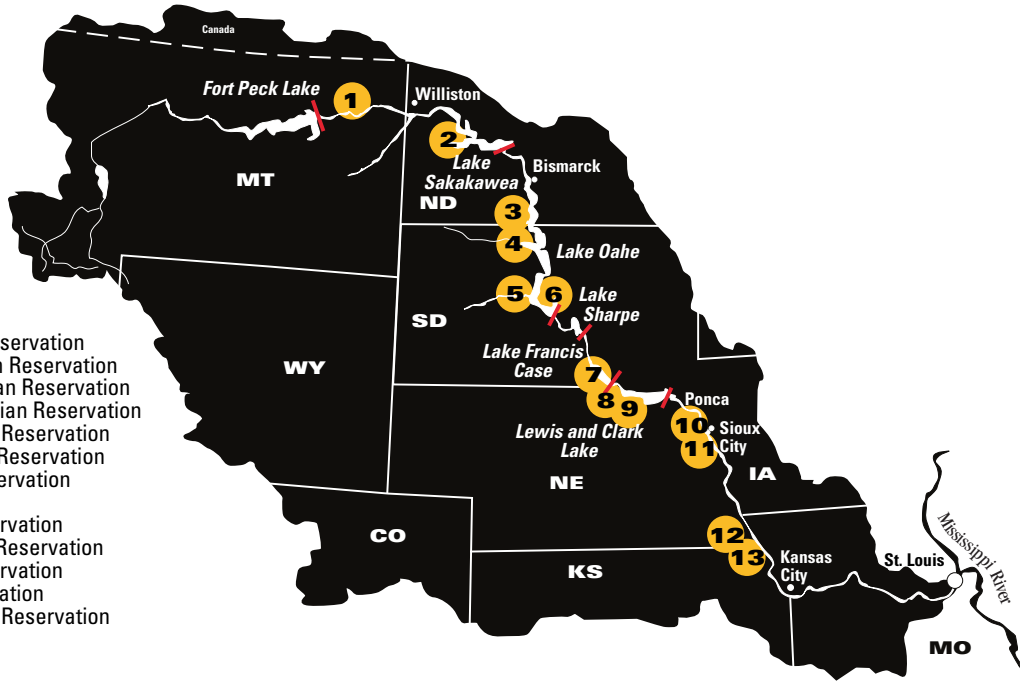
2. The **annual flood control and multiple use zone** is used to capture high spring and summer river runoff into the system. Later in the year, water stored in this zone is released for downstream uses so that the zone is emptied by the beginning of the next flood season on March 1. This zone provides benefits for flood control, irrigation, navigation, water supply, hydropower, water quality control, recreation, and fish and wildlife. As with the exclusive flood control zone, most of the water is released from the lakes during the summer and fall navigation season.

3. The largest zone of storage, the **carryover multiple use zone**, remains full in most years but is gradually drawn down during droughts. Release of water from this zone is to serve project purposes during droughts.

4. The top of the remaining storage zone, the **permanent pool**, is the minimum water level necessary to operate the hydropower plants at the dams. The permanent pool also provides the minimum amount of water necessary for recreation, fish and wildlife, and water supply for towns and irrigators located around the lakes, as well as storage for sediment.

Native Americans and the Master Manual Revisions

Thirty Native American Tribes are located within the Missouri River basin. Thirteen Tribal Reservations or Tribal Lands are located directly on the Mainstem Reservoir System, the river reaches between the dams, and downstream of the Mainstem Reservoir System along the Lower River. The Tribes are dependent sovereign Nations, and the Corps is currently in Government-to-Government consultation with five basin Tribes. Because of this Government-to-Government relationship with the Corps and because the Corps has a Trust responsibility with the Tribes, they are given special consideration in the RDEIS. For the Tribal Reservations located on the Missouri River and the river reaches between the Mainstem Reservoir System, the RDEIS identifies impacts to Tribal resources resulting from the alternatives evaluated. The RDEIS also includes a Tribal Appendix that addresses Master Manual issues important to the Tribes, presents the consultation history and process to date, and contains all written comments the Corps has received from the Tribes to date. Workshops following publication of the RDEIS will be developed in partnership with the Tribes. The Corps continues to urge all basin Tribes to participate in Government-to-Government consultation.



1. Fort Peck Indian Reservation
2. Fort Berthold Indian Reservation
3. Standing Rock Indian Reservation
4. Cheyenne River Indian Reservation
5. Lower Brule Indian Reservation
6. Crow Creek Indian Reservation
7. Yankton Indian Reservation
8. Ponca Tribal Lands
9. Santee Indian Reservation
10. Winnebago Indian Reservation
11. Omaha Indian Reservation
12. Iowa Indian Reservation
13. Sac and Fox Indian Reservation

State Participation in the Master Manual Process

States have participated in the Study since its initiation, primarily through the Missouri River Basin Association (MRBA). The MRBA is made up of Governor-appointed voting representatives from the States of Wyoming, Montana, North Dakota, South Dakota, Nebraska, Iowa, Kansas, and Missouri, as well as a voting representative of the Mni Sose Intertribal Water Rights Coalition (Mni Sose). All MRBA meetings are open to the public and basin stakeholders frequently attend. Federal agency participation in the MRBA is ex-officio and limited to facilitation and technical support. The MRBA held four basinwide conferences during the Study to solicit input from diverse basin interests. Following publication of its basin-planning document in 1998, the MRBA engaged basin stakeholders in developing a consensus flow management plan for the operation of the Mainstem Reservoir System. In November 1999, the MRBA submitted its recommendations for operation of the system to the Corps. Both flow and environmental recommendations supported by seven of the eight basin States were submitted. Many of the MRBA recommendations, including additional drought conservation measures, have been incorporated into the MCP alternative and the GP options. Most recently, the MRBA is leading basin discussions on adaptive management strategies for the Missouri River.

FEATURES of the ALTERNATIVES

The RDEIS contains six alternatives that are addressed in detail, one of which is the CWCP. A second alternative, the MCP, contains four of the features discussed on the following pages: adaptive management, increased drought conservation measures, Fort Peck Dam release changes, and unbalancing the upper three lakes. The four other alternatives referred to as the four GP options include a fifth feature, Gavins Point Dam release changes. The USFWS recommended Gavins Point Dam and Fort Peck Dam release changes to insure that Mainstem Reservoir System operations will not likely jeopardize the continued existence of the three listed species or result in the destruction or adverse modification of critical habitat.

Adaptive Management

Adaptive management is an overall strategy for dealing with change and scientific uncertainty. This strategy could be incorporated in any water control plan for the Mainstem Reservoir System. Adaptive management promotes an environment for testing hypotheses and exploring promising changes based on sound scientific data and analyses. Monitoring and evaluation of actual results of changes in the operation of the Mainstem Reservoir System and the flexibility to adapt as new information becomes available are key to the strategy. An Agency Coordination Team (ACT), made up of primarily Federal biologists, has been established to facilitate the adaptive management approach. It will recommend operational changes that take advantage of climatic conditions for the benefit of threatened and endangered species, and review monitoring and evaluation results of those changes. At a minimum, basin stakeholders can provide their opinions on any changes through the coordination activities for each year's AOP preparation and implementation process. Additional stakeholder participation with the ACT is currently being discussed. The MRBA has taken the lead in exploring a broader adaptive management concept that would involve stakeholder participation in recovery of endangered species and restoration of the Missouri River ecosystem. Further, at the request of the Corps and the U.S. Environmental Protection Agency, the National Academy of Sciences (NAS) is conducting a study that explores adaptive management strategies for the Missouri River and identifies gaps in Missouri River science. A report will be completed by the NAS in the fall of 2001 that should assist in shaping an adaptive management strategy for the basin.

Drought Conservation Measures

Many of the alternatives evaluated for the RDEIS have more stringent drought conservation measures than the CWCP. During extended drought periods, navigation service level would be reduced earlier under these alternatives than it is under the CWCP. This would allow more water to be stored in the upper lakes. During severe droughts, such as the 1930 to 1941 drought, releases for navigation would be eliminated at a higher total system storage level than under the CWCP.

Figure 1 compares the lowest elevations that would have occurred under the various alternatives for each of the upper three lakes during the 1987 to 1993 drought. The figure also contains the minimum storage for the CWCP if the current drought conservation measures had been strictly followed. Inclusion of these measures for the MCP and GP options would increase total system storage from 39 MAF to about 43 MAF during a similar drought. The drought conservation measures are those that were recommended by the MRBA.

Figure 1
Lowest Lake Elevations
(1980s Drought)~(Feet)

Alternatives	Fort Peck Lake	Lake Sakakawea	Lake Oahe
CWCP	2,206	1,813	1,585
MCP	2,209	1,817	1,586
GP1528	2,206	1,818	1,588
GP2021	2,206	1,819	1,590
GP1521	2,206	1,819	1,590
GP2028	2,206	1,818	1,588

Fort Peck Flow Changes

Increased releases of 23 kcfs for 3 weeks from Fort Peck Dam in the mid-May through June timeframe approximately every third year were recommended as a starting point in the USFWS BiOp. The USFWS recommended a range of 20 to 25 kcfs, which is a small enough range that further modeling and EIS documentation are not required to go up to 25 kcfs. This change is necessary to ensure that operation of the Mainstem Reservoir System does not jeopardize the continued existence of the endangered pallid sturgeon. The increased release would be split between the spillway (warmer water) and the powerhouse to trigger pallid sturgeon spawning by increasing both flow and temperature in the river reach downstream from the dam (see **Figure 2**).

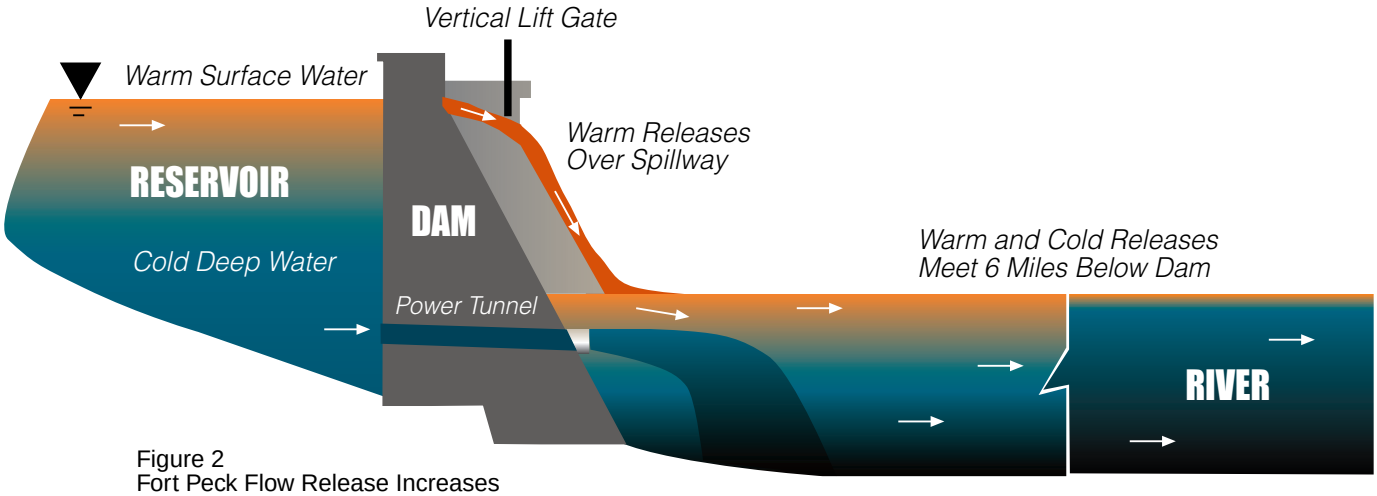


Figure 2
Fort Peck Flow Release Increases
for Spawning Cue

Gavins Point Dam Release Changes

The GP options include a range of changes in releases from Gavins Point Dam. According to the BiOp, an increase in spring releases (the spring rise) and a decrease in summer releases relative to those of the CWCP are necessary. These flow changes are recommended by the USFWS to avoid jeopardizing the continued existence of the pallid sturgeon, interior least tern, and piping plover, three species that are listed and protected under the ESA. Four options are included in the RDEIS to provide flexibility for potential flow changes under adaptive management.

The spring rise would occur on an average of once every 3 years between May 1 and June 15, as conditions allow. A potential starting point for the spring rise is 15 thousand cubic feet per second (kcfs) above full navigation service releases. The amount of the spring rise would be adjusted upward to 20 kcfs if monitoring and data analysis indicate this measure is necessary for the species. The rise is intended to provide a spawning cue for the pallid sturgeon.

Summer flows would be lower every year as conditions allow under the GP options. The lower summer flows would expose more sandbar acres for tern and plover nesting and create shallow water habitat for young pallid sturgeon. A potential starting point for the lower summer releases from Gavins Point Dam would provide minimum service to Missouri River navigation (modeled as a 28.5-kcfs flat release but could be variable under actual operations). Spring rise releases would initially be stepped down to provide minimum service to navigation (6 kcfs less than full service) by June 21. The lower releases would be held steady until September 1 when releases would be increased back to full navigation service or greater if necessary to evacuate excess water from the flood control zones in the system. Summer releases could be adjusted downward toward a combination of 25 kcfs from June 21 to July 15, followed by 21 kcfs to August 15, followed by 25 kcfs to September 1, if monitoring and data analyses indicate this is necessary for the species. These releases would normally not be adequate to provide even minimum service to navigation.

The RDEIS identifies the potential starting point option for the changes in Gavins Point Dam releases as GP1528 and the option with the highest spring rise and lowest summer release as GP2021. The GP1528 and GP2021 options represent the full range of NEPA coverage for the Gavins Point Dam release changes.

Two other options, identified as GP2028 and GP1521 in the RDEIS, are also analyzed so that readers can compare the impacts of specific changes resulting from a potential future higher spring rise only or a lower summer release only. Decisions to adjust Gavins Point Dam releases would occur through the adaptive management process.

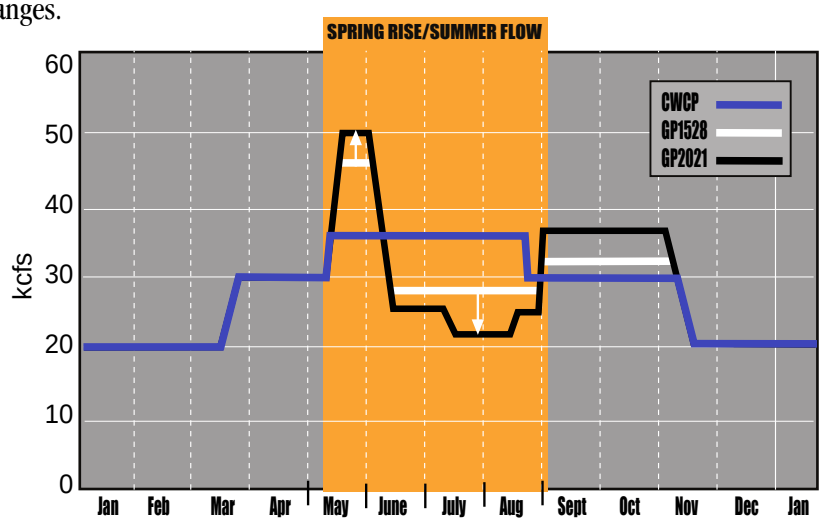


Figure 3 presents an idealized hydrograph showing proposed Gavins Point Dam releases for the CWCP and the GP1528 and GP2021 options.

Figure 4 presents the changes in river stage at various Lower River locations for the GP1528 and GP2021 options as compared to the CWCP. These stage changes are presented relative to the stage changes that would occur under the CWCP, which has a flat 34.5-kcfs release from Gavins Point Dam during the spring rise and summer low-flow periods recommended in the USFWS BiOp.

Maximum Stage Changes for the GP Options for Selected Lower River Locations (feet)

	Spring Rise Stage Changes		Summer Low-Flow Stage Changes	
	GP1528/GP1521	GP2021/GP2028	GP1528/GP2028	GP1521/GP2021
Sioux City	3.8	5.0	-1.5	-3.4
Omaha	3.3	4.4	-1.3	-3.0
Nebraska City	3.3	4.3	-1.3	-2.9
St. Joseph	3.3	4.4	-1.3	-3.0
Kansas City	3.0	4.0	-1.2	-2.7
Boonville	3.0	4.0	-1.2	-2.7
Hermann	2.0	2.7	-0.8	-1.8

Unbalancing the Upper Three Lakes

Under the CWCP, when system inflows are above or below normal, the amount of water in the upper three (largest) lakes is balanced so that the effects are shared equally among these lakes. To preclude jeopardy for the listed species, the USFWS BiOp recommends unbalancing the amount of water in these lakes as long as an extended drought (more than 1 year long) or an extremely high runoff into the system is not occurring. Unbalancing also provides benefits to young fish in these three lakes.

Unbalancing consists of purposely lowering one of the three lakes approximately 3 feet to allow vegetation to grow around the rim, and then refilling the lake to inundate the vegetation (see **Figure 5**). The unbalancing would rotate among the three lakes on a 3-year cycle. Movement of water among the lakes as they are lowered, held constant, and refilled benefits species in both the intervening river reaches and the lakes. Higher spring releases in some years are intended to trigger spawning of the pallid sturgeon and scour vegetation on sandbars so that more suitable bare sandbar habitat is available for nesting terns and plovers.

The subsequent 2 years of lower flows would expose that bare sandbar habitat for use by the interior least tern and the piping plover. Unbalancing would also provide more bare sandbar habitat around the perimeter of the lakes for the birds. In subsequent years, inundated vegetation around the perimeter would be used by adult fish for spawning and by young lake fish hiding from predators.

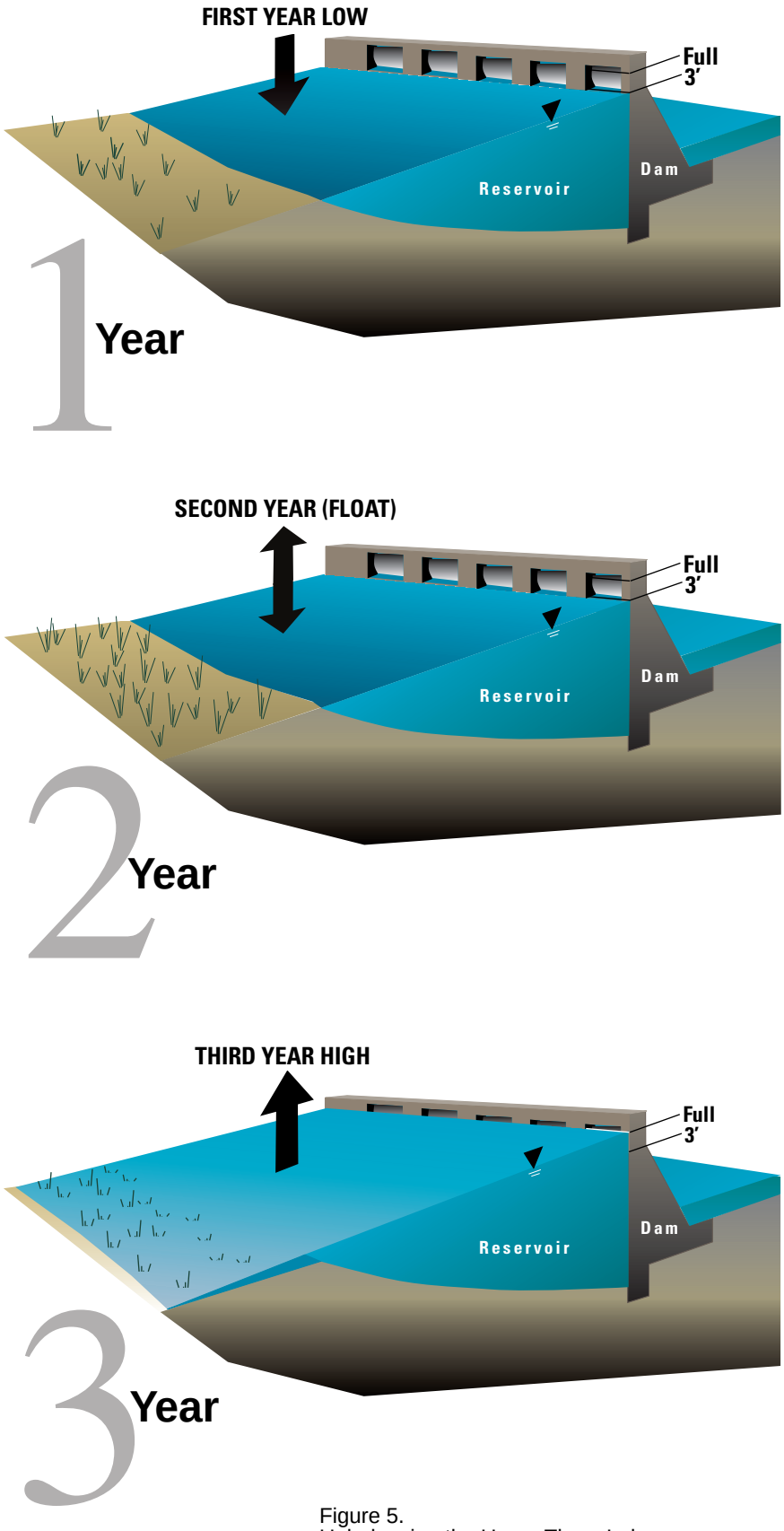


Figure 5.
Unbalancing the Upper Three Lakes for ESA Species

IMPACTS of the Alternatives on KEY USES / RESOURCES

The alternatives addressed in detail in the RDEIS would have different effects on several important economic uses and environmental resources in the basin, and on two Mississippi River economic uses/resources. Comparisons of average annual effects of the four GP options (GP1528, GP2028, GP1521, GP2021); MCP, which is similar to the GP options except that it does not include Gavins Point Dam release changes for threatened and endangered (T&E) species; and the CWCP are presented for most resources. These effects were analyzed for the 100-year simulation period for most resources. Results of the various impact models are briefly discussed, and a summary of impacts table is provided following the discussion of the individual uses and resources (page 28). Relative differences among the alternatives are important to understand, and the summary of impacts table presents percent changes from the CWCP to focus on this perspective.

Flood Control

Agricultural lands, residential areas, business districts, and navigation benefit from flood control provided by the Mainstem Reservoir System. Approximately 1.4 million acres of farmland are subject to flooding along the mainstem Missouri River. There are approximately 30,400 residential and 5,345 nonresidential buildings with an approximate worth of $17.6 billion located within identified flood zones.

Flood control benefits for each alternative were determined by calculating the damage reduction from a scenario simulating a system operation that passes inflows without storing them. The analysis was conducted for the entire 100-year period of record for all river reaches downstream from Fort Peck Dam. In general, approximately 83 percent of the benefits resulting from Mainstem Reservoir System operation are provided to non-cropland and 17 percent to cropland.

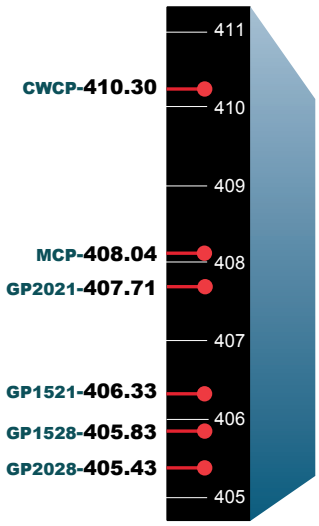


Figure 6. Average Annual Flood Control Benefits for the Alternatives ($ millions)

Figure 6 presents the flood control benefits for the MCP and the four GP options. Each of the alternatives provides less flood control benefits than the CWCP. The GP options have the greatest adverse impact to flood control benefits, with GP2028 resulting in the greatest reduction in benefits. Adverse impacts to flood control benefits result from the movement of water from the summer to the fall and, in some years, during the following April. The lower summer flow apparently reduces damages more in the summer months; however, it increases damages in the spring and fall compared to the higher summer flow option. Overall, impacts to flood control benefits resulting from any of the alternatives are considered insignificant. Much of the credit for limiting impacts is due to the flood control constraints included in all alternatives that limit Gavins Point Dam releases during high inflow events on the Lower River. They limit the spring rise to those years downstream flooding is less likely to occur.

Interior Drainage and Groundwater

In response to the public comments on the 1994 DEIS regarding the lack of interior drainage and groundwater information, the Corps conducted additional studies of these two sources of crop damages. Because of the complexity of the two analyses, studies were limited to seven representative locations.

Interior drainage impacts for each alternative were determined by calculating the crop damages resulting from water ponding at the drainage outlets through the levees to the river. The analysis was conducted for the period of 1950 to 1994 using current-day economic values. Ponding of water at drainage structures for six leveed areas along the Lower River was studied. Crop production through the season for an equal distribution of corn and soybeans was tracked to compute the costs of interior drainage ponding on the crops. **Figure 7** presents the total average annual interior drainage damages (negative impact) in millions of dollars per year for the six sites. Damages range from $1.34 million to $1.47 million. The primary source of the increased damages is the modified Gavins Point Dam releases. Of the Gavins Point Dam options, GP1528 and GP2028 have slightly lower damages than the other two options.

Groundwater impacts for each alternative were determined by calculating the crop damages resulting from high groundwater levels. High groundwater levels limit crop planting and production, and the resulting increased costs of putting in the crop or harvesting a lower yield were computed as damages. The analysis was conducted for the period of 1970 to 1979 using current-day economic values. Three leveed areas and one unleveed area along the Lower River were studied to determine the impact to drainage and recharge of the water table resulting from flow differences among the alternatives. **Figure 8** presents the groundwater damages in millions of dollars for the alternatives. Impacts range from $4.50 million to $4.99 million. Adding the conservation measures has essentially no effect on the damages. Both Gavins Point Dam release changes increase groundwater damages. The spring rise increases damages in the spring; however, the lower the combination of the spring rise and the summer low flow, the greater the amount of water that needs to be released in the fall. Fall damages are, therefore, greater for all four GP options.

Both groundwater and interior drainage impacts would be largely experienced on lands that are affected by current operations under the CWCP. Further, the Corps would continue to make every effort to manage increased risk to croplands resulting from the Gavins Point Dam release changes.

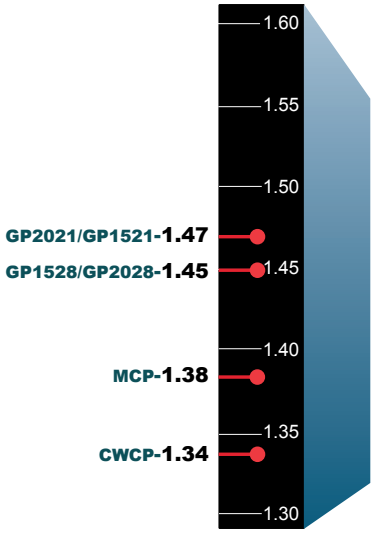


Figure 7. Average Annual Interior Drainage Damages for the Alternatives ($ millions)

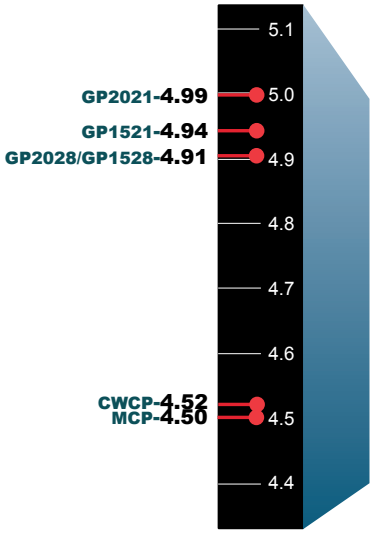
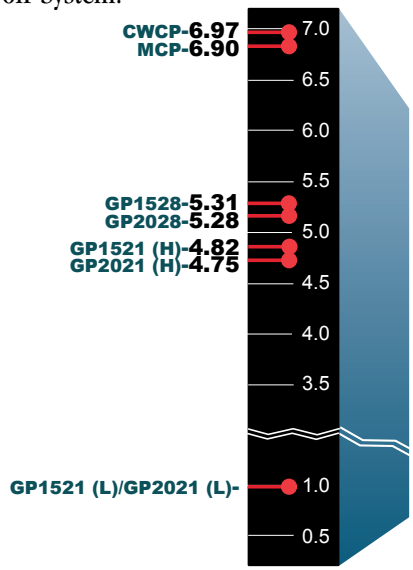


Figure 8. Average Annual Groundwater Damages for the Alternatives ($ millions)

Navigation

Navigation on the Missouri River occurs from Sioux City to the mouth at St. Louis. In 1994, commercial barge traffic on the river was 1.5 million tons. Approximately 140 docks and terminals operate along the river. The Missouri River Bank Stabilization and Navigation Project provides a 9-foot deep, 300-foot-wide navigation channel. Navigation flow support is provided to maintain an 8- to 9-foot depth in the navigation channel depending on the amount of water stored in the Mainstem Reservoir System.

Figure 9 presents the impacts to navigation in millions of dollars per year for each alternative. For the GP1521 and GP2021 options, the impacts are presented for two potential outcomes. The Corps believes these outcomes represent the full range of potential impacts to Missouri River navigation. Outcome 1(H) assumes that commercial navigation on the Missouri River remains during the months on either side of the summer low-flow period. Outcome 2 (L) assumes that Missouri River navigation is limited to local sand and gravel throughout the normal 8-month navigation season. Because the CWCP has the highest value for navigation, inclusion of additional drought conservation measures appears to negatively affect navigation. Lower summer releases from Gavins Point Dam result in further negative impacts to navigation, with the GP1521 and GP2021 options having the lowest values. Adaptive management decisions to adjust flows downward from the potential starting point of the GP options (GP1528), must be weighed carefully to consider the Corps' responsibility to serve the authorized purpose of navigation for the Mainstem Reservoir System.



(H) Includes benefits if navigation continues before and after the split season.
(L) Includes remaining sand/rock benefits if navigation is essentially extinguished.

Figure 9. Average Annual Navigation Benefits for the Alternatives ($ millions)

Hydropower

The six mainstem dams support 36 hydropower units with a combined plant capacity of 2,436 megawatts (MW) of potential power generation. These units provide an average of 10 million megawatt hours (MWh) of energy per year. Power generation at the six mainstem dams generally must follow the seasonal pattern of water movement through the system; however, adjustments have been made (when possible) to provide maximum power production during summer and winter when demand is high. Total hydropower benefits are presented in millions of dollars per year, which includes energy values (a measure of the amount of power generated in a specified period of time) and capacity values (the amount of generation capacity available from the hydropower units).

Figure 10 presents the total economic hydropower benefits for each alternative. Total benefits range from $741.5 million to $758.8 million annually. Overall, when compared to the CWCP, the addition of more stringent drought conservation measures increases hydropower benefits. Reductions in Gavins Point Dam releases slightly reduce benefits, with the GP2021 option having the lowest value.

This analysis of hydropower benefits alone does not reflect potential impacts to the Western Area Power Administration (WAPA) and its firm power customers. WAPA markets the hydropower generated by the mainstem dams and is a cooperating agency for this NEPA process. Total marketed energy is broken down into two components—firm energy and the energy generated in excess of that amount. When the available energy falls short of the firm energy, WAPA must purchase the difference; when excess energy is available, WAPA sells it. Energy demand varies throughout the year, which affects the value of this energy from month to month.

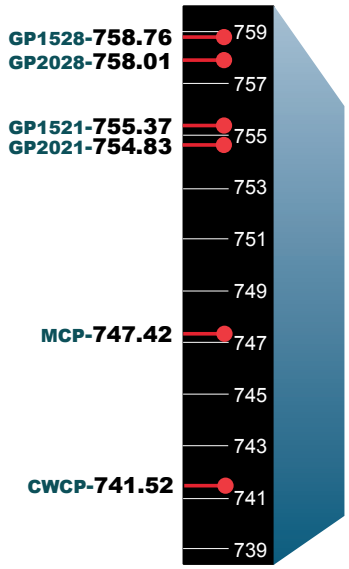
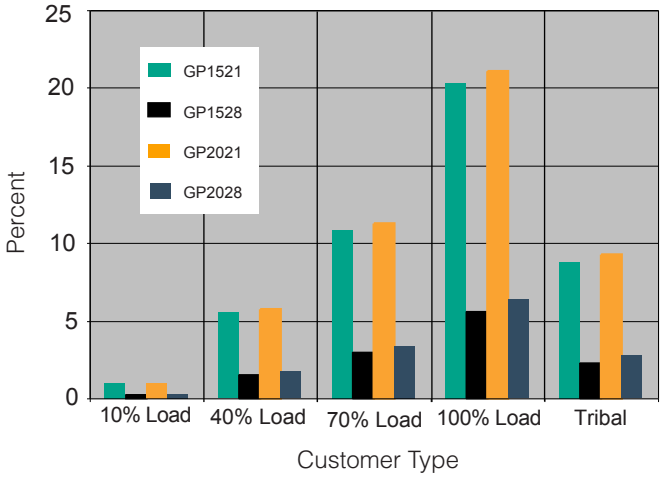


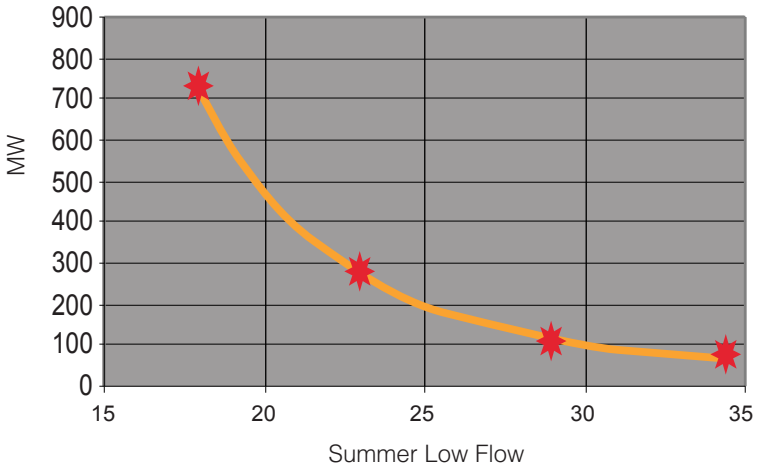
Figure 10. Average Annual Hydropower Benefits for the Alternatives ($ millions)

Hydropower.....cont.

The net effect of the redistribution of these shortfall purchases and excess sales affects the net revenues, which are used by WAPA to repay the Federal Treasury. When compared to the net revenues of the CWCP, the MCP provides $1.6 million more revenues. GP1528 and GP2028 provide $8.2 million and $9.1 million fewer revenues, respectively. Finally, GP1521 and GP2021 provide $29.6 million and $29.7 million fewer revenues, respectively. Revenues are most directly affected by the reduction in the summer flow.

If WAPA were to continue to pay the Federal Treasury at the rate it would under the CWCP, it would have to raise the rates its customers pay for hydropower to offset the revenue losses the GP options would create. **Figure 11** presents the impacts of the alternatives to representative WAPA firm power customers who rely upon WAPA for varying percentages of their firm power supply. Generally, WAPA determined that the greater the dependence on hydropower for energy, the greater the impact on the purchase power cost to each consumer. For example, a 100 percent consumer would have increased costs of about 5 to 6 percent if the Gavins Point Dam release were to drop to 28.5 kcfs (GP1528 and GP2028) and 20 to 21 percent for a drop to 21 kcfs (GP1521and GP2021).





Additionally, the RDEIS includes a regional power supply risk analysis that considers hydropower and thermal generation in a regional power supply context. **Figure 12** presents the risk to thermal power generation at the powerplants that rely on river water for cooling and heat dissipation (see Water Supply). The risk of losing energy and capacity during July, a high power use month, goes up exponentially as the Gavins Point Dam releases go down. An estimated 387 MW of capacity and 203 million MWh of energy could be lost if Gavins Point Dam releases were to drop to the 21-kcfs level in July (GP1521 and GP2021).